26 October 2015

Sheila Leonard
USDA-NRCS
PO Box 2890
Washington, DC 20013

RE: Submittal of Final Report for NRCS Grant #69-3A75-11-131 (Palouse Soil Carbon Project CIG)

Dear Ms. Leonard,

On behalf of the AES, Inc. team, we want to thank USDA-NRCS for your patience in working with us by granting us a one year no cost extension to finalize this project. This final report summarizes the project accomplishments as required. We have learned greatly from this project about the challenges of soil carbon project marketplaces in a time in the USA where no carbon marketplace of substance or supporting policy exists.

At the time of approving the no cost extension, AES and USDA-NRCS created a summary letter of outstanding deliverables that needed to be finalized to close out this project. These were submitted previously under separate cover to USDA-NRCS. And, we have subsequently been notified by Steve Campbell, NRCS's technical representative for this project, that all technical product submittals have been received, reviewed and approved.

We expect to continue this project and are very close to actually putting final carbon transaction agreements in place with farmers. Upon execution of the first sales of soil carbon credits, we would like to work with USDA-NRCS, if your agency is willing, to document the success of this Palouse CIG project in creating another example of a marketplace ecosystem service transaction. Who should we correspond with in regard to this possible opportunity?

We have asked Adam Chambers to allow Tom Stoddard, the attorney working with us from *Native*Energy to talk with USDA-NRCS attorneys about the Securities and Exchange Commission (SEC) decision to not grant an exemption for SEC regulations when farmers are aggregated under carbon trades. We would still appreciate the opportunity to coordinate this conclusion with USDA-NRCS.

Again, thanks so very much for this opportunity to work with USDA-NRCS on this project. We are very pleased to have completed the science work and marketplace investigations on this project with USDA-NRCS. We truly appreciate this project and what we and others have learned and look forward to contributing to USDA-NRCS programs in the future.

Yours very truly,

Steven I. Apfelbaum
Chairman and Senior Ecologist

cc:
Steve Campbell, NRCS, Portland, OR
Adam Chambers, NRCS, Portland, OR
Jacqueline Roscoe, NRCS, Washington, DC

Ry L. Thompson

From: Campbell, Steve - NRCS, Portland, OR <Steve.Campbell@por.usda.gov>
Sent: Monday, October 05, 2015 1:09 PM
To: Steven I. Apfelbaum
Cc: Ry L. Thompson; Thomas C. Hunt
Subject: RE: Applied Ecological Services - CIG Grant 69-3A75-11-131
Attachments: Applied Ecological Services - CIG Grant 69-3A75-11-131

Hello Steven,

Sorry for the delay in responding to your message below. I just returned from vacation.

I have received the deliverables described in the attached e-mail from Ry Thompson. They all met with my approval.

I just checked with Adam Chambers and we have not received the final report and financial reporting documents, which are due on October 31.

Steve

Steve Campbell
Soil Scientist
USDA - Natural Resources Conservation Service
West National Technology Support Center
1201 NE Lloyd Blvd., Suite 1000
Portland, OR 97232-1208
Phone: 503-273-2421
E-mail: steve.campbell@por.usda.gov

From: Steven I. Apfelbaum [mailto:Steve@appliedeco.com]
Sent: Tuesday, September 15, 2015 12:44 PM
To: Campbell, Steve - NRCS, Portland, OR <Steve.Campbell@por.usda.gov>
Cc: Ry L. Thompson <ry.thompson@appliedeco.com>; Thomas C. Hunt <tom.hunt@appliedeco.com>
Subject:

Steve

Did you ultimately receive the technical report submittals for our Palouse CIG? Hopefully you did and they met with your approval.

Steven I. Apfelbaum
Applied Ecological Services, Inc.
www.appliedeco.com

Applied Ecological Services, Inc. (AES)
Final Report
USDA-NRCS CIG-GHG Project No. 69-3A75-11-131
October 26, 2015

PROJECT DESCRIPTION / ABSTRACT

Applied Ecological Services, Inc. (AES) and *Native*Energy (NE) together (AES/NE) with others are working toward a large-scale agricultural carbon restoration project that includes Shepherd's Grain members and surrounding farmers located in the loess hills of the Palouse and Columbia Plateau region. Historic farming practices across the region have resulted in the near extinction of the native grasslands, serious soil losses, and degradation of hydrological resources.

Based on a variety of models derived from years of research along with additional sampling completed in 2009, AES/NE further developed and extrapolated models to fit a scale across the entire Columbia Plateau landscape. Utilizing a protocol under development through the American Carbon Registry, AES/NE has measured, monitored, and expects to have validated carbon credits stemming from "Low Disturbance Cropping" agricultural practice that disturbs less than 30% of the soil between planting rows, and retains more than 50% of the crop residue using one pass no-till, and other direct seeding technologies, crop rotation, and improved soil management. This project demonstrates the role of carbon farming practices in greenhouse gas policy development as well as the importance of quantitative soil carbon measurements and approved standard methods that can create verified carbon offset credits. It also provides a roadmap for aggregating landowners across large areas at low cost. Ultimately the project could be replicated as a model for marketing and monetizing agriculturally derived carbon credits. And, this will be one of the largest land-based carbon measurement-based carbon marketplace projects to date. It is currently anticipated that this project will continue outside of this CIG grant process and consummate carbon credit transactions.

Project Outcomes:

- Scale-up the project by developing a carbon farming agricultural partnership with Shepherd's Grain and neighboring landowners across the Palouse and larger Columbia Plateau eco-region. The project can be scaled due to the robust analytic and technical methodologies (GIS mapping, stratification, soil sampling, model projections, etc.).

- Aggregate landowners using a model whereby landowners collaborate across large acreages at a relatively low cost, a feat that is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. Through relationship building with landowners, AES/NE will develop, test, and refine a low-cost aggregation model. To this end, AES/NE is building on previous experience in aggregating landowners, developing standard partnership structures, and streamlining landowner interactions and engagement. During this CIG process, over 300,000 acres of land has been directly involved or interested in participating in this early stage demonstration project.

- Model a successful land-based carbon transaction even though agricultural carbon credits cannot currently be monetized in the marketplace. This project seeks to ensure that credits derived from this project are acceptable in emerging compliance markets, as well as voluntary markets like VCS and ACR. To this end, AES/NE has developed a unique partnership of farmers, project developers, carbon investors, scientists, and government officials.

- Produce data, maps and templates to inform policy and support further research. AES/NE utilizes GIS landform and geomorphic modeling and mapping to design, evaluate, and implement regional, on-the-ground baseline analysis of soil carbon levels across the Palouse and Columbia Plateau eco-region. The data and map products represent integrated information heretofore lacking in the region, but useful for agricultural producers, government agencies, scientists, university researchers, and others.

FINAL REPORT

1. **USDA-NRCS CIG-GHG Project Number and Contract Period**

69-3A75-11-131 – August 1, 2011 to July 31, 2015 (one-year no-cost extension granted 5/8/14)

2. **Project Title**

Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region

Project Director / Principal Investigator

Steven I. Apfelbaum, Chairman of the Board/Principal Ecologist, Applied Ecological Services, Inc.

3. **Date of Report / Period Covered**

October 26, 2015 for Report No. 8 (Final Report): August 1, 2011 – July 31, 2015

4. **Proposed Changes requiring Prior Approval**

No further modifications are proposed at this time.

5. **Accomplishments**

Task 1 – Business Origination with Shepherd's Grain

YEAR 1 (August 2011 – July 2012)

During Year One, AES and TEP successfully kicked off the partnership with the Shepherd's Grain producers and the other parties involved in the CIG grant. Primary project activities included the following:

- Project Kickoff – The project team had a project kickoff meeting in September, 2011 with all of the key project partners to review the discuss the overall project, while having a more detailed discussion on grant terms, project timeline, and next steps to kick off the project.
- Shepherd's Grain Producer Meetings – The project team traveled to Washington in November 2011 to hold an initial learning journey with Shepherd's Grain producers. Team members attended the annual Shepherd's Grain producer meetings and presented the overall soil carbon program, answered producer questions, and discussed concerns that were raised.
- Business Development Meeting – The project team had a business partner meeting in December 2011, where the partners discussed potential business models and soil carbon accrual opportunities based on existing models developed from pre-sampling of soil carbon levels.
- Learning Journey Listening Sessions – During January, 2012, members of the project team had a series of excellent meetings with producers in Washington and Idaho, with a focus on building relationships, understanding producer concerns and cementing support for the program. The team received completed data release forms that allowed AES to collect geospatial and related data for the stratification of the landscape and preparation for soil sampling, and gain access to producer fields during the 2012 soil sampling season.
- Producer Enrollment Agreement – In late 2011 and early 2012, the team developed a first-of-its kind contractual structure for enrolling producers in this land-based carbon project. There were very few problems around the economic distribution of any future carbon credits — which all parties found fair. Even if carbon markets did not develop, the producers remained interested in the useful scientific data and analysis that would come out of the implementation of the methodology. Producers were also eager to be the innovators and first-movers that could help define and shape emerging policy around land-based carbon markets and their ability to reward producers for

implementing sustainable agricultural practices in a scientifically rigorous way. However, this process of developing an acceptable contract to all parties was more challenging than expected due to the following complexities:
    - *Needing a contract before knowing the terms of the carbon deal.*
    - *Landowner/tenant relationships.*
- Challenges and Proposed Changes to Acreage Targets – During the enrollment process, it became clear that there was a misrepresentation of the total acreage available for aggregation amongst the Shepherd's Grain producers, which was informally reported as 300,000 acres in the CIG grant application: These turned out to be anecdotal estimates, as the actual acreage where the team acquired geospatial data was about 150,000 acres, or half of what was projected in the grant. In addition, the actual amount of land in wheat production (which would be included in the PDD and subsequent carbon project) is only about 2/3 of the total acreage owned or rented by each of the producers. The remaining acreage is composed of CRP, pasture, other cropland, etc.—some of which may go back into crop production over time. So in total, there is about 100,000 acres of cropland among the Shepherd's Grain producers. During early 2015, AES/NE presented the project at the Pacific Northwest Direct Seeding Association Annual conference and enrolled an additional 175,000 to 200,000 acres of interested farmers in this project. As a result, but only after the initial soil carbon measurement results verified the accruals that can be expected, did we approach additional farmers beyond Shepherd's Grain. Once the additional farmers learned about the carbon accrual potentials and the possilbity of a new revenue stream associated with packaging and selling carbon credits from the additional accrual of soil carbon, they showed interest in participating in this program. As of early 2015, this program has enrollment and interest in approximately 300,000 acres of farmland owners. However, early in this process (in part because the soil science analytical results were required to inform farmers) AES notified USDA-NRCS that the original enrollment targets set forth in the grant during the grant program of 300,000 acres and as high as 1 million acres were likely unattainable during the grant period.

YEAR 2 (August 2012 – July 2013)

During Year Two, AES and TEP continued to build on the relationships developed with Shepherd's Grain producers and neighboring producers while also developing a working relationship with Pacific Northwest Direct Seeding Association (PNDSA), one of the largest producer groups in the Palouse region. TEP presented the program at their annual conference about the project. TEP and AES began working with local conservation districts, universities, and NRCS to build support around the program and find ways to leverage other conservation initiatives in the region. AES worked closely with the Perfect Blend, a biotic fertilizer company based west of the Palouse region in Othello, WA, to secure several loads of biotic fertilizer that could be used for yield trials on Shepherd's Grain fields. In addition, a load was delivered to Dr. David Huggins at Washington State University's Cook Farm research fields near Pullman to analyze the nitrous oxide emissions associated with this fertilizer product as compared to conventional anhydrous ammonia fertilizers.

YEAR 3 (August 2013 – July 2014)

During Year Three, the AES cash match partner, EKO Asset Management Partners, left the project and The Earth Partners phased out their involvement as well. AES continued to work closely with Shepherd's Grain to provide updates on project status and project challenges faced through regular conference calls and email updates. After a period of dormancy, AES secured a new cash match partner, *Native*Energy, and introduced them to Shepherd's Grain through several conference calls. AES worked closely with Perfect Blend, a biotic fertilizer company based west of the Palouse region in Othello, WA, to present on the Palouse project and carbon markets at their Biotic Conference in December, 2013.

YEAR 4 (August 2014 – July 2015)

During Year Four, AES and *Native*Energy continued to coordinate with the Shepherd's Grain management team to provide updates on project status and seek technical information related to the conservation cropping activity necessary for development of a new methodology. Much of the collaboration emphasis during the reporting period was focused on finalizing the development of a Participant Solicitation document titled "*Soil Improvements with Reduced Tillage and Improved Fertility Management in the Palouse*", a farmer information piece focusing on the project requirements necessary to meet the ACR standards for a carbon project. After extensive discussions with Shepherd's Grain, this document was finalized and is being used to convert the "enrollment agreements" into carbon "transaction agreements" and engaging additional farmers in the CIG project/carbon transaction.

Task 2 – Mapping, Screening and Stratification of the Palouse

YEAR 1 (August 2011 – July 2012)

During Year One, AES began the mapping, screening and stratification of the Palouse region. Primary project activities included the following:

- Base Mapping – Basic data gathering and mapping was conducted for the entire Columbia Plateau for visualization and regional context, with a dozen or more data themes including: political boundaries, eco-regions, roads, surface landform, surface water and watersheds, average precipitation and temperature, general soils, land cover, geology, and aerial photography. Advanced data gathering and preliminary stratification for soil sampling was concentrated in the eastern counties of the Columbia Plateau, within which most of the Shepherd's Grain farm operations are located.
- Preliminary Analysis of Soils – Initial geospatial analysis was used to filter or screen out soil map units that are the least homogeneous with regard to soil carbon and that are difficult to sample because of rock and shallowness. The ideal soils were the deep silt loams derived from loess parent materials that are typical of the Palouse Hills L4 eco-region within the Columbia Plateau.
- Preliminary Analysis of Topography – Since soil carbon varies with topographic characteristics, preliminary topographic analysis was conducted to determine likely stratification for soil sampling. Two terrain characteristics were investigated, aspect and topographic position. Further research considered possible categories for temperature/precipitation/elevation which are highly correlated from lower to higher elevations across the plateau.
- Base Mapping – As the project progressed during year one, data gathering and base mapping expanded both in geographic scope and type of content in order to meet the needs of soil sampling throughout the Columbia Plateau. For instance, USGS 10m DEMs were obtained for the entire region and mosaiced together, with derivative rasters including slope, aspect and shaded relief developed for screening, stratification and field survey maps. Contours with 20 foot intervals were generated for 26 counties where field survey maps were needed. Additional SSURGO soils data were obtained and generalized for a total of 29 counties. 2011 NAIP aerial photography was obtained for 25 counties where soil sampling occurred.
- Screening – The screening process eliminated certain areas from consideration for soil sampling using the factors of: 1) access permission and field land use, 2) soils, and 3) terrain. Using GIS, the majority of 2012 soil sample locations were allocated randomly before sampling began within the areas known to be accessible and appropriate for sampling. The following 4 screening factors were used:
    - *Screening Factor 1 – Access Permission and Field Land Use* – Data from the USDA Farm Services Agency (FSA) was obtained with permission from participating operators and used to focus initial plot allocation on fields under no till / direct seed practices. Operators provided detailed descriptions of farming practices, including the year no till practices began for each field. The screening process classified each field into one of the following groups relevant to sampling:
        - "No-Till Cropland" – fields with continuous no till
        - "No-Till-0 Cropland" – fields where conversion to no till began in 2012
        - "CRP Cropland" – fields under CRP contract
        - "Grass Cropland" – fields that are not being cultivated and are not under CRP
        - "Other Cropland" – fields that have 'non-standard' or mixed tillage histories, unknown number of years in direct seed or rotational cultivation
        - "Reference" – area reported by an operator as never having been under cultivation.
    - *Screening Factor 2 – Soils* – The initial analysis focused on the most uniform and easiest to sample soils; those largely from loess parent material with silt-loam surface textures. Very few of the accessible no till fields were screened out because of soils.
    - *Screening Factor 3 – Topography* – The only use of topography for screening was to remove areas of greater than 25 percent slope from pre-allocation of samples in the no till and CRP fields. This was done to ensure safe operation of the soil sampling equipment. Sampling in reference areas used hand-carried tools so steep slopes were not necessarily a limiting factor for these crew-allocated plots.
- Stratification For Sample Plot Allocation – The initial steps at stratification used four discrete variables that would ensure an adequate distribution of samples in the sampling effort. The four variables included: 1) Slope Position (2 categories), 2) Aspect (2 categories), 3) Precipitation Zone (5 categories) and 4) Tillage History (7 categories) for a total of 2 x 2 x 5 x 7 = 140 unique combinations or strata. These are described below.
    - *Stratification Factor 1 – Topographic Slope Position* – The Jenness topographic model was used to classify two categories: Upper Slope and Lower Slope.

- *Stratification Factor 2 – Topographic Aspect* – Two aspect categories were used in the stratification: Southwest (between 135 and 315 degrees azimuth) and Northeast (between 315 and 135 degrees azimuth).
- *Stratification Factor 3 – Precipitation Zone* – Average Annual Precipitation data based on the PRISM model was used to develop precipitation zones. The data was re-classed into 6 categories: <9 in, 9-12 in, 12-15 in, 15-18 in, 18-25 in and >25 in.
- *Stratification Factor 4 – Tillage History* – This is the primary independent variable of interest. Foundational to the modeling effort is the expected continuum of the dependent variable, soil carbon, from a low value for conventional tillage, through increasing values for length of time in direct seed, to reference or natural areas with the highest values. For plot allocation the histories were grouped as follows: Conventional, 1-5 Yr. Direct Seed, 6-12 Yr. Direct Seed, 13-20 Yr. Direct Seed, 21+ Yr. Direct Seed, Natural/Reference Area, and CRP.

- Sample Plot Allocation For Soil Carbon Modeling – The purpose of predictive model building for this project warranted a different sampling approach than the stratified random sampling proposed in the TEP Soil Carbon Quantification methodology. Plot allocation for predictive model building allocates samples in equal number across all factor levels or strata combinations.

YEAR 2 (August 2012 – July 2013)
During Year Two, AES continued the QA/QC process on the data points collected during the 2012 field sampling season. Data from the stratification process characterizing each sample point was provided to the statisticians for use in the statistical analysis and modeling process. The primary sample point attributes analyzed for fit in the model development phase included: slope position, aspect, precipitation, curvature, and years in no-till. As the project team delved deeper into the statistical analysis process with the team statisticians, additional data was queried from the GIS database for more precise analysis. Where available, continuous variables were utilized in the analysis process, rather than those that represented a range of values, for more precise analysis.

YEARS 3 & 4 (August 2013 – July 2015)
During Years Three or Four, no major mapping or stratification activities were completed. Several maps were provided to NRCS staff to ensure deliverable 1 was complete. Additional work was completed on the Map of Soil Carbon Levels for use at the Pacific Northwest Direct Seeding Association meeting in January 2015 and for delivery to NRCS in February 2015. The map included interpretive information on soil carbon accruals within each of the primary climatic zones of interest. The carbon accrual findings were presented in a formal presentation to the attendees at the conference and walk-ups who came to a conference booth staffed by AES/NE. There was significant interest in participating in the soil carbon program demonstrated by farmers signing up for learning more and enrolling in the program.

Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region

YEAR 1 (August 2011 – July 2012)
During Year One, AES completed soil sampling phase of the Palouse Soil Carbon Project. Project activities included the following:

- Literature and Data Review – A literature review was completed for the project to begin understanding the study area in more detail, with particular emphasis on the following: geologic history, pre-settlement ecological conditions, carbon-friendly farming /no-till practices, and related agricultural research that emphasized conservation of soil and water resources. Through the literature search and through discussions with the technical team members, the project team also began to understand the key soil scientists and agricultural researchers in the region, and their respective universities, that could provide insight into the topics of our research. Soil surveys from the counties in the study area were collected and reviewed. The statistical team analyzed the soil carbon dataset from the initial sampling of Shepherd's Grain farmer fields conducted in summer 2009. Initial stratification maps were reviewed to assist in developing a preliminary sampling plan for November 2011.

- Preliminary Soil Sampling – During the November visit to the Palouse and Columbia Plateau eco-region, the project team conducted preliminary soil sampling at five Shepherd's Grain member farms and collected 45 soil cores. The goals of the sampling effort were:
    - Test the physical sampling methods and determine sampling efficiency with new equipment;
    - Gain insight into variation in carbon levels by slope position and aspect;
    - Gain insight into variation in carbon levels by geographic region and land management practices; and
    - Gain insight into changes in soil carbon levels throughout the 1m soil cores.

  At each of the five sites, the team surveyed the landscape to assess the geomorphic position in the landscape, then collected soil cores in a north-south transect at numerous slope positions (summit, shoulder, back, foot, toe) and aspects (north or south facing). At each sampling location, one core was collected for lab analysis and a second soil core was collected for description on site by the sampling team, including: depth of genetic horizons, soil texture, soil structure, and soil color (wet and dry). Additional information was documented in the GPS unit, including: farm name, time in no-till practice, soil core number, slope position, slope shape (convexity/concavity), and aspect.
- Laboratory Analysis of Soil Cores – The 45 soils cores collected during the November 2011 preliminary sampling trip were described and bulk density and soil carbon analysis completed. Once analyzed, the project team and statistical consultants used the results to help guide the development of the soil sampling plan for spring 2012.
- Soil Sampling Field Season – Preparation – The preparation for the field season began during winter 2012 and included completion of the stratification process and allocation of samples across the available producer fields, as described in Task 2 above. Extensive planning to ensure all logistics were in place to ensure a safe and successful field season was proceeding on a parallel track. Logistics included securing and preparing field sampling equipment, purchasing supplies and safety equipment, hiring and training crew members, securing permission to fields with standing crops, and so on.
- Soil Sampling Field Season – Sampling in Shepherd's Grain No till and CRP Fields – Once soil sample locations were allocated across the strata, as described in Task 2 above, the team provided maps to every Shepherd's Grain producer by email and followed up with a phone call to ensure there were no concerns with the sample locations. The vast majority of the points were acceptable to producers and the crews were ok to access fields after the phone call. The sampling included approximately 700 soil cores total, with the vast majority occurring in the no till and CRP fields managed by the Shepherd's Grain producers.
- Soil Sampling Field Season – Sampling on Conventional Tillage Fields – In addition to the primary task of sampling in no till, soil sampling crews were tasked with securing samples from conventional tillage and minimum tillage fields. Since all Shepherd's Grain farmers primarily utilized no till cultivation methods, this additional land had to be secured during the field season. One of the more effective ways of finding new producers to add to the sample base, particularly conventional till farmers, was to ask for recommendations.
- Soil Sampling Field Season – Reference Natural Areas – Once field season began, AES identified potential reference natural areas that could be sampled throughout the region once sampling in time-sensitive crop fields was completed. We sampled a variety of sites in Oregon, Washington and Idaho owned by Washington Department of Natural Resources and The Nature Conservancy (Oregon or Washington chapters), as well as smaller sites owned by individuals (prairie remnants) and small conservation organizations. General characteristic of these natural areas included the following: thin, rocky soils, steep slopes, shallow bedrock, dry precipitation zones, rare plant species, etc.
- Soil Sampling Field Season – Sampling Protocols – A high-level description of the sampling protocols follows below:
    - *Navigating to the Sample Location* – Hardcopy aerial/topographic maps, in combination with Trimble GPS units, were used to locate the sample points. The topographic maps allowed for navigation through the fields (around steep slopes and mature crop fields) to get within close range of the sample locations, then the GPS units were used to the precise sample point.
    - *Collection / Extraction of Soil Core with Giddings Sampler* – Upon arriving at a sample location, the crew followed a specific step-by-step process for extracting a soil core using the Giddings hydraulic soil sampler.
    - *Collection of Duplicate Soil Core* – A duplicate soil core was taken for each of the strata combinations by rotating the probe about one foot to either side (of center), then collecting another soil core.
    - *Manual Soil Sampling Protocol (for Reference Natural Area Sampling)* – Due to the ecological sensitivity of the reference area sites, the crews fabricated and used a manual soil sampler that allowed for utilization of existing plastic soil sleeves and collection of an identical 2" diameter x 1m long soil core for analysis (though at most sites refusal was met prior to reaching 1m).
- Soil Sampling Field Season – Data Collection at Soil Core Locations – Protocols on supplemental data collection at each soil core sampling location were provided to the field crews, including:

- *GPS* – Once the soil core was extracted, a sub-meter accuracy GPS point was collected.
    - *Sample Location and Site Attributes* – A data sheet was completed documenting the bar code number, slope shape/position, GPS coordinates, current crop, field history, or other site notes were recorded.
    - *Soil Core Attributes* – Soil core depth was documented at each location as a QA/QC metric with the lab. If refusal was met, the depth was documented.
    - *Photographic Documentation* – Photographs in the four cardinal directions were collected at each soil core location. Additional photos were taken documenting crops, interesting features, scenic beauty, etc.
- Soil Sampling Field Season – Sample Labeling, Processing and Shipment – Protocols on the proper handling and care of soil cores were provided to the field crews, including:
    - *Labeling* – Once the soil core was extracted, it was capped and a barcode label applied.
    - *Handling* – Soil core handling was kept to a minimum between field collection and shipping.
    - *Storage* – Soil cores were stored until a sufficient quantity were collected for shipment to the soils lab.
    - *Shipping* – The soil cores were packed/shipped in a heavy-duty wood crate that held 575 cores.

At the completion of the sampling period, two field crews had collected 710 total cores. The goal was to collect a full 1m core, but this was not possible at every location. The 710 cores reflected 608 unique sampling locations and included 102 duplicates. Samples were collected from a wide variety of field histories and included the following: Conventional Tillage (81 samples), 1-5 yrs. in no-till (73 samples), 6-12 yrs. in no-till (100 samples), 13-20 yrs. in no-till (84 samples), 21+ yrs. in no-till (52 samples), CRP (101 samples), Miscellaneous (Irrigated) (8 samples), and Reference Natural Areas (109 samples).

YEAR 2 (August 2012 – July 2013)

During Year Two, AES began the laboratory analysis phase of the Palouse Soil Carbon Project. During the second half of 2012, cores were shipped to the University of Missouri Soils Characterization Lab for sample analysis. To begin, laboratory staff extracted the cores from the sample casing. Each soil core was described by a PhD soil pedologist and split into native soil horizons (A, Ap, AB, Bt, etc.) for more detailed physical and chemical analysis. After they were split and described, the soil pedologist recorded notes of unusual structure or evidence of erosion and took a digital photo. In sum, 2062 laboratory samples were analyzed from the 710 cores (~3 horizons/core). The analyses completed on each soil core included the following: Core Description and Splitting by Horizon, Course Fragments, Bulk Density, Total Carbon (%), Organic Carbon (%), and Inorganic Carbon (%). AES worked closely with the Soil Characterization Lab and project statisticians to QA/QC the laboratory analysis dataset for statistical analysis.

YEARS 3 & 4 (August 2013 – July 2015)

During Years Three and Four, no sampling or analysis activities were completed.

Task 4 – Analysis and Baseline Development

YEAR 1 (August 2011 – July 2012)

During Year One, AES assembled its statistical team and began assembling the technical team to review the soil carbon projections, once completed. Initial discussions between the statistical team and the University of Missouri Soils Lab were held to understand laboratory analysis procedures and potential for statistical variation during laboratory tests. As reported above, the project team conducted preliminary soil sampling with the following goals:

- Test the physical sampling methods and determine sampling efficiency with new equipment;
- Gain insight into variation in carbon levels by slope position and aspect;
- Gain insight into variation in carbon levels by geographic region and land management practices; and
- Gain insight into changes in soil carbon levels throughout the 1m soil cores.

Laboratory analysis of the initial 45 soil samples was completed in spring 2012 and analyzed by the team's statistician, Dr. Kevin Little of Informing Ecological Design, and were used to inform the soil sampling field season and future laboratory analyses. Though the dataset was very small, several initial findings informed future work, including:

- The sampling confirmed our model for stratification, and the reconnaissance sampling verified our understanding of the importance of landscape/slope position, aspect, precipitation, etc. on soil carbon values.

- Our predictive model matched well with other models in widespread use, such as the Topographic Wetness Index (TWI) – an important cross-convergence of data in our work and research.

YEAR 2 (August 2012 – July 2013)

During Year Two, AES worked closely with the soils lab and the project statistician on an iterative QA/QC process for laboratory data. As the analyses were completed and data became available from the lab, an intensive process of data review and QA/QC was completed by the project statisticians to ensure any issues that arose with data were addressed as soon as possible. This review process is outlined below. Because of this staggered method of receiving data, it was agreed that no detailed statistical analysis of the data would be conducted or completed until all data was received.

- Data Review and Cleaning – As cores were processed by the lab, project statisticians prepared diagnostic plots and tables to identify aberrant values.
- Revise Master Data Table – In addition to horizon labels that will be incorporated in the basic data analysis, the lab also generated data on probable soil movement for later analysis. Project statisticians worked with the lab to assure consistency of horizon labels in the data table.
- Generate Initial Statistical Models of Soil Carbon – Project statisticians built a number of linear models in both original scale and log (base 10) values. The log values appeared to provide a better basis for analysis, stabilizing the variance over the range of responses. Project statisticians worked with total soil core carbon (kg C/m^2), derived from lab values of percent carbon and density, summed over the horizons (typically 3 horizons), fitting models in both organic and organic + inorganic carbon.

AES hired Informing Ecological Design (IED) to provide statistical services with the intent of developing a landscape scale model for soil carbon based on physical characteristics and years of no-till management. Ultimately, we wanted to show evidence that increasing the number of no-till years caused an increase in soil carbon accrual. The design and analysis focused on a related but different problem: is an increase in no-till years associated with an increase in soil carbon, when we look at a set of cores sampled in one year? In other words, we conducted a cross-sectional study (with respect to years of no-till farming) to give us insight into a longitudinal problem, the effect of increasing no-till years on given locations.

The statisticians derived a linear model that provided an estimate of soil carbon as a function of years of no-till management. The point estimate is 0.135 kg/m2/year over the range of 0 to 20 years, with an approximate 95% confidence interval: (0.044, 0.225). This model applied to areas within the Palouse roughly above median 30-year precipitation levels and above the first quartile of a slope position parameter. We also analyzed an extensive set of duplicate cores that yields an estimate of core to core variation that may be used for TEP method planning.

In addition to the statistical analyses, the project team developed a set of "qualitative findings" from the observations of the sampling team and laboratory analysis team:

- The project team's understanding of the landscape is improving – we can account for a lot of the variability, but not all. These are natural systems and we're still learning about them.
- The project team and statisticians are working toward a predictive model for carbon accruals in this landscape.
- The early results confirmed that Carbon is located in the wetter precipitation zones and lower slope positions.
- There are many instances of deeply buried soil carbon in this landscape.
- The carbon levels in the uplands/upper slope positions may never equal those in the lower slope positions, but the lab analysis is indicating there is great potential for accrual there.
- The data tables from the lab allow summations of the data (as needed) – e.g. sort by A and B horizons; look at an overall average number; include range in soil carbon values; soil carbon in topsoil – x tons / acre to y tons / acre; Split between upland vs. lowland, etc.
- It is still difficult to ferret out the direct influence of cultivation practices in this landscape.

YEARS 3 & 4 (August 2013 – July 2015)

During Years Three and Four, no major analysis or baseline development activities were completed, however, ongoing discussions on project sampling, analysis and baseline development continued with NativeEnergy as they conducted due diligence on the project and envisioned next steps required to translate the technical body of work into a viable carbon project. These discussion led to the cooperative development of a new ACR methodology titled "*Cropland Management Greenhouse Gas*

Mitigation Methodology", which evolved into the "*Methodology for Soil Carbon Sequestration from Low Disturbance Cropping*". Project team members completed deliverables 2 and 3 including:

- Summary report titled "Comparative Analysis of Alternative Carbon Accrual Estimation Methods"; and
- Summary report titled "Macro-level Regional Environmental, Economic and Societal Benefits from Soil Carbon Improvement Practices in the Columbia Plateau Eco-Region of Idaho, Oregon and Washington".

Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers

YEAR 1 (August 2011 – July 2012)

During Year One, no deal packaging activities were completed.

YEAR 2 (August 2012 – July 2013)

During Year Two, the project team developed a term sheet that would govern the rights to carbon credits and the contractual relationship between an investor and a developer in the case of this project. This agreement provided protection for the investor and developer to commit the risk capital while also ensuring the producers certain rights. The agreement merged the language and structure of an Emissions Reduction Purchase Agreement (ERPA) with the flexibility that a legal agreement that can accommodate early-stage investment in a project where the carbon has not been verified, and as such, where the developer cannot provide warranties and guarantees around the carbon asset. In November 2012, TEP went on a trip to the Palouse, to meet with producers, facilitate program enrollment, and provide an on-the-ground due diligence opportunity for the investor, EKO Asset Management Partners.

The project team discussed with the Verified Carbon Standard (VCS) the challenges associated with the eligibility criteria for producers under their program. It was deemed that further research was needed to determine if a PDD would be the appropriate avenue for the programmatic approach and regional program that the Palouse Soil Carbon project was seeking to develop.

Despite the positive discussions between TEP and numerous interested parties (e.g. The Carbon Neutral Company, British Gas, and The Climate Trust), the market for carbon weakened globally – in particular the voluntary market. Overarching marketplace concerns affected the likelihood that a carbon deal could be completed as a part of this project, some of which have transpired or become much more of a concern. These issues were no longer obstacles for the project, but became barriers to successful completion of a carbon deal within the project grant period, including:

1. Lack of Carbon Market – With a largely non-existent carbon market in the US and around the world, it appeared unlikely that the project could attract an investor or generate carbon credits with value capable of covering the costs associated with their certification. Though the California Air Resources Board (C-ARB) formalized the rules for their carbon program, agricultural projects outside of California would be excluded for the foreseeable future.
2. Project Design Document – Due to the lack of a carbon market, development of a PDD, as originally proposed for the project, would have been a hollow exercise of limited value. Additionally, it appeared highly unlikely that a PDD could be developed facing the barriers of eligibility, additionality, and permanence within the VCS rules.
3. Voluntary Signup – Participation in a carbon program requires voluntary participation from both producers and landowners, where leases are involved. Both parties must be in agreement with, and committed long-term to, the goals of the program being developed. When the focus is on soil carbon accrual, this commitment may be up to 30 years to ensure "permanence" of the soil carbon resource.

Throughout the US, most agricultural communities are in transition as the current generation of farmers and landowners are retiring in large numbers, their children are leaving the farm, and the land is in flux. The Palouse region is no exception. The producers who enrolled in the program initially through Shepherd's Grain both own and lease the land they farm. Many of the leases are short-term and landowners are unwilling to commit to long-term to leases, much less to practices occurring in their fields for 30 years. Often, the fields they lease are owned by several family members (e.g. family trusts) who live far from the community and have more interest in the revenue than long-term stewardship of the soil resource. These land tenure issues are complex and create a situation that is beyond our control in recruitment for the soil carbon program.

YEAR 3 (August 2013 – July 2014)

EKO Asset Management Partners notified AES of their intent to leave the project team and no longer serve as the cash match partner late in year two. As a result, several months were spent during year three searching for a new cash match partner. Discussions between AES and The Climate Trust were held in Portland in December 2013. Though they did not have the flexibility with the funds they manage to co-develop the project, they were interested in any carbon credits or offsets generated from the project and encouraged the project team to continue the conversation as the project continued if a replacement cash match partner was secured.

Discussions between AES and *Native*Energy of Burlington, Vermont began in December 2013 about the potential for their group to replace EKO Asset Management Partners as the cash match partner on the project, who left the project team. *Native*Energy was interested in co-developing the project in the Palouse region with funds from their HelpBuild™ program and helping to broker any carbon credits generated from the project. Many of their existing clients and partners were very interested in the program. In April 2014, *Native*Energy provided a commitment letter to AES and NRCS to co-develop the project and help to market and sell the carbon credits generated from the project. AES and Native Energy created a draft Participant Solicitation Document titled "*Soil Improvements with Reduced Tillage and Improved Fertility Management in the Palouse*" for discussion with Shepherd's Grain, initially, and focused on the project requirements necessary to meet the VCS standards for a carbon project. Primary sections of the document include:

- Project History;
- Farm Benefits;
- Eligibility Requirements (Ownership/Control, Commitment to No-Till, and Financial & Management Plan);
- Farm Responsibilities (Access to Farm, Training, and Reporting);
- Estimated Project Revenues and Costs;
- Estimated Reduced Operations and Maintenance Savings;
- About AES; and
- About NativeEnergy.

YEAR 4 (August 2014 – July 2015)

During Year Four, after a detailed review of the aggregation model and project development model proposed on the Palouse soil carbon project, Tom Stoddard, an attorney from *Native*Energy raised a concern that the grouping of multiple farmers into a single "grouped project" with revenues variable based on market value of the carbon credits and success in marketing them might result in the contracts with the farmers being considered to be investment contracts, and thus securities, by the SEC or state securities regulators. Outside counsel confirmed that it was indeed an issue, and recommended either requesting a "no action" letter from the SEC, or structuring the project as an exempt offering of securities under Rule 506 of Regulation D, with the former being the preferred option. Accordingly, Mr. Stoddard conducted the necessary research and prepared and filed a lengthy no action request with the SEC. In addition, Mr. Stoddard researched the state securities laws, and applicable case law, of each of the States of Washington, Oregon and Idaho, and prepared and filed no action requests with each state, customized based on its laws. After several months, the SEC requested additional research on a particular issue and further discussion of it in a revised request letter, which Mr. Stoddard did, for the SEC and again for each of the three states. Months later, the SEC staff formally declined to grant relief, refusing to state whether they viewed the prospective farmer contracts as investment contracts or not. Subsequently, Mr. Stoddard withdrew his requests from the SEC and each state, as is routine when relief is denied. Ultimately, it was determined that the project could proceed under Rule 506, but not without significant additional burdens.

The final SEC request letter was provided to Adam Chambers, USDA-NRCS, in January, 2015 to share with internal USDA attorneys. It was agreed that further discussion, if necessary, would take place with Tom Stoddard and USDA legal team prior to interagency discussions.

Multiple requests were made of the USDA CIG project contract representative to provide or arrange the follow-up telephone meetings with Tom Stoddard, but USDA follow-up was never arranged and requested.

Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members

YEAR 1 (August 2011 – July 2012)

During Year One, building relationships with Shepherd's Grain producers remained the primary focus of the aggregation work. By establishing and building on a foundation of mutual trust and understanding, it was deemed that any efforts for further aggregation work beyond Shepherd's Grain would be much easier. During the field season, the sampling crews regularly interacted with the Shepherd's Grain producers and asked them about additional producers in the area (both conventional and no-till) that may allow soil sampling in their fields and may be interested in the program. Through this farmer to farmer and community-based approach, we were able to continue to build interest in the program from a dozen additional farms.

YEAR 2 (August 2012 – July 2013)

By the end of Year Two, the project team had approximately 100,000-acres of Shepherd's Grain producers committed and/or under contract of the Producer Enrollment Agreement. During summer 2012, TEP sent out a final Producer Enrollment Agreement following multiple iterations that incorporated input from farmer groups, lawyers, and potential investors. During the second half of 2012, the project team communicated with producers, answering their questions, and encouraging them to sign up in the program. It became easier to engage later in the year once the fall harvest and winter wheat and cover crop planting seasons were completed. Also, the validation of the TEP Soil Carbon Methodology, and the resulting press release, encouraged a few of the unsigned producers to participate.

To build on this success, TEP continued to strengthen its relationship with the Pacific Northwest Direct Seeding Association (PNDSA), one of the largest producer groups in the Palouse region of which many Shepherd's Grain members are a part, and gave a presentation at their annual conference on the CIG soil carbon project.

During early 2013, AES staff worked closely with USDA-NRCS field staff focused on the rollout of the EQIP funding being made available to support the CIG-GHG projects. Over the course of several weeks, AES staff participated in numerous conference calls NRCS staff to craft the EQIP opportunity for the Columbia Plateau region of Oregon, Washington and Idaho to be symbiotic with the CIG project, where possible. In the end, it was determined that the NRCS could not directly encourage EQIP eligible farmers to participate in the GHG-CIGs. As a result, minimal interest in the project resulted from the large pool of EQIP funding made available in the region for no-till and other soil carbon friendly management practices.

YEAR 3 (August 2013 – July 2014)

During Year Three, Steve Apfelbaum presented to approximately 200 grain growers from the region at the Perfect Blend Biotic Conference 2013. Steve's presentation was titled "Ecosystem Services and Credits" and emphasized soil carbon and GHG emission credit projects. He focused on the Palouse CIG soil carbon sequestration project and walked producers through the project study design and technical work completed to date, discussed the market opportunity, and invited farmers to learn more about potential participation. During his visit to the region, Steve met with several Shepherd's Grain farmers who were in attendance at the conference. The project team held additional strategy sessions with project partners on the who and how of engaging more farmers and including more land in the project.

YEAR 4 (August 2014 – July 2015)

During Year Four, Steve Apfelbaum (AES) and Kirsten McKnight (*Native*Energy) attended the Pacific Northwest Direct Seed Association conference to present a talk and poster on the soil carbon science findings. During the conference Environmental Markets breakout session, Steve presented an overview of the Palouse Soil Carbon project. The Palouse Soil Carbon Project (AES/*Native*Energy) was one of the sponsors for the conference and the project had a booth in the Exhibitor space to solicit additional farmers interested in participating in the program.

Over the course of the 2.5 day conference, Steve and Kirsten spoke to dozens of farmers from the 500 present who were very interested in the program. A total of 43 growers representing nearly 150,000 acres signed an information sheet requesting more information on eligibility for enrollment, and next steps after the conference. A ~additional 50,000 acres of farmland owners who didn't disclose the actual owned or leased acreages on the additional information request/enrollment form are also now involved in the conversation. In addition, several farmers suggested the project team reach out to several large landowners not present at the conference to gauge their interest in participating in the program.

During the PNDSA meeting, Steve and Kirsten had the opportunity to meet with Shepherd's Grain leadership to strategize about the next steps for collaboratively scaling up acreage in the program. We discontinued the conversation with these additional interested farmers until resolution of the Security and Exchange Commission findings at the advice of legal counsel. We have begun resurrecting the conversations with farmers now that the legal issues have been resolved resolution has been occurred.

Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

YEAR 1 (August 2011 – July 2012)

Third-party verification is the core of quality assurance, and under the VCS Program, all projects must be validated and all emission reductions must be verified by approved validation / verification bodies. The methodologies verified by VCS have been used by over 600 projects quantifying emission reductions and issuing GHG credits in the voluntary markets. The Earth Partners developed the first modular soil carbon quantification methodology to be validated under the VCS. The Methodology can be used to quantify the emission reduction and carbon sequestration benefits of projects such as this project. In order to create carbon offset credits certified under the VCS, the methodology had to undergo a public review process as well as a double validation process by two separate accredited independent validators/certification bodies. After the 30-day public review period, no substantive comments debating the technical aspects of the TEP Soil Carbon Methodology were received. The methodology underwent a third-party review by two independent external validators, per the VCS path to validation – Environmental Services Inc. (ESI) and Scientific Certification Services, Inc. (SCS). The carbon team addressed the issues raised by the validators and continued engaging VCS to ensure a timely validation of the methodology. Revisions were made along the way to ensure the method was in compliance with the VCS standard version 3.2.

During this time, TEP continued preliminary conversations with potential future carbon buyers so that they were aware of the status of the partnership with Shepherd's Grain producers and adjacent landowners and the potential for agricultural land based carbon credits through the project. TEP continued preliminary conversations with The Climate Trust, a potential voluntary carbon buyer in Oregon. They were very interested in the enrollment progress, scientific rigor of our methodology, and the fact that the producers are based in their regional areas of interest: the Pacific Northwest, and specifically Oregon.

YEAR 2 (August 2012 – July 2013)

In November, 2012, The Earth Partners' Soil Carbon Quantification Methodology received final approval from the VCS. There were some unanticipated delays in the final sign-off and public posting by the VCS. It was approved within the Sectoral Scope 14. Agriculture, Forestry, Land Use (ALM), and contains 18 modules. The methodology can be publically accessed at http://v-c-s.org/methodologies/VM0021. It was summarized as follows:

> "This modular methodology is designed to be applicable to ALM projects, including changes to agricultural practices, grassland and rangeland restorations, soil carbon protection and accrual benefits from reductions in erosion, grassland protection projects and treatments designed to improve diversity and productivity of grassland and savanna plant communities. The associated modules provide methods for quantifying and monitoring changes in carbon accrual in, and emissions from, soils as well as from other GHG pools and sources that may be affected by AFOLU projects."

TEP developed a press release, which was picked up by in several agricultural and environmental news organizations, including Ecosystem Marketplace.

The market for carbon weakened globally over the last year—in particular the voluntary market. Nevertheless, TEP continued to engage potential voluntary carbon buyers and brokers around the unique elements of this program. Entities included The Carbon Neutral Company, British Gas, and The Climate Trust.

TEP developed a stakeholder and advocacy group focused on soil carbon and sustainable land management to support the Palouse Soil Carbon project on the policy and market front. To this end, the team explored potential strategies for getting potential Palouse credits accepted into the California market through the California Air Resources Board. TEP discussed with VCS and American Carbon Registry the possibility of turning the Palouse program into an "eco-regional" protocol that could be accepted into California. This would result in a much-needed programmatic, measurement-based protocol that meets the requirements of being scientifically rigorous, large-scale, and low cost. It could be applicable to other large eco-regions that span millions of acres where, like the Palouse, there is continuity in ecological conditions and agricultural practices.

YEAR 3 (August 2013 – July 2014)

During Year Three, *Native*Energy provided a commitment letter to AES and NRCS to co-develop the project and help to market and sell the carbon credits generated from the project, as described in Task 5 above. After formalizing the partnership, discussions between AES and *Native*Energy focused on how to co-develop the soil carbon project in the Palouse region while navigating the VCS requirements related to early adopters/additionality, permanence and aggregation. The discussions with VCS centered around how the "activity" before and after a carbon transaction start date can remain the same in name (e.g. "no-till farming") and still meet the additionality requirements of VCS. AES and *Native*Energy held numerous telephone calls and an in-person meeting (May 2014) with VCS staff, including David Antonioli (Chief Executive Officer), Will Ferretti (General Manager), Jerry Seager (Chief Program Officer), and Rachel Steele (Senior Program Officer) focused on asking VCS to clarify how a project such as the Palouse project can formally go through the VCS program using their standard, and the approved The Earth Partners Soil Carbon Quantification Method (VM0021).

*Native*Energy and AES began communications with American Carbon Registry (ACR) once it appeared the VCS program creates barriers to accepting large landscape agricultural projects and allowing early adopters or anyone using the "activity" such as no-till agriculture (even for 1 year on a given field) in their program. The challenges identified by AES and NativeEnergy continue to be discussed with VCS staff to determine if there is a path forward with their program. In the meantime, AES and NativeEnergy continued to discuss the ACR path for the project.

YEAR 4 (August 2014 – July 2015)

During Year Four, *Native*Energy and AES developed a new ACR methodology titled "*Cropland Management Greenhouse Gas Mitigation Methodology*", based on ACR staff recommendations. The methodology was submitted to ACR in mid-November and reviewed internally by ACR staff. Comments were received in late December and after subsequent discussions with ACR, they suggested the following: 1) simplify the method and focus only on the conservation cropping (no-till) activity; 2) refer by reference to activities covered in other ACR methodologies (e.g. N_2O, CH_4, manure, etc.); and 3) include all components within the methodology, rather than proposing a modular methodology (e.g. VMD0021 Soil Carbon Quantification Methodology). As a result, a new ACR methodology titled "*Methodology for Soil Carbon Sequestration from Low Disturbance Cropping*" was developed and has gone through two additional levels of ACR staff review and is nearing the public review period. Though it appeared that ACR could expedite the review process because of the technical review the VCS method has already gone through, their protocols of internal review, public review, and two rounds of peer review must be closely followed.

Once the new methodology is approved, we believe the Palouse Soil Carbon project can proceed with a large landscape agricultural project in the Palouse region that includes some early adopters to participate in a project focused solely on the "low disturbance cropping" activity (single-pass, no-till) through a performance based program.

Task 8 – Reporting and Knowledge Dissemination

YEAR 1 (August 2011 – July 2012)

During Year One, initial communication were made with USDA administrative contacts Gregorio Cruz and Dan Lukash to ensure all administrative, budget and payment procedures were well-understood for the CIG grant. Project team members also initiated communications with Steve Campbell, NRCS Technical Contact, to understand his expertise and potential contributions to the project. The project team shared the highlights of its technical approach with Steve for any feedback or comments that he may have and clarified how he would prefer to remain apprised of project progress and updates. The project team scheduled time for an in-person meeting with Steve Campbell during the January 2012 travels to Washington, where they met with Steve about the project and he would attend the listening session meetings with farmers that followed. Project team members communicated with administrative and technical contacts throughout the year, on an as-needed basis.

After learning of the EQIP funding for CIG associated producers, Tom Hunt and Ry Thompson participated in several conference calls with Steve Campbell, Adam Chambers and Todd Peplin to learn about and discuss the opportunity and strategize for the CIG Palouse project.

Upon request of NRCS, team members scheduled and presented at the Coalition on Agricultural Greenhouse Gases (C-AGG) meetings in Washington DC (Nov. 2011), Sacramento, CA (Feb. 2012) and Chicago, IL (July 2012). David Tepper, CEO of TEP, presented on a moderated roundtable discussion with other CIG Greenhouse Gas (GHG) project representatives in DC, while Frederik Vroom, Carbon Analyst with TEP, presented on a similar roundtable in Sacramento. Tom Hunt and Ry Thompson presented a project overview at a CIG grant recipient dinner prior to the start of the C-AGG meetings, and also presented during two CIG related panel discussions on carbon markets and EQIP funding.

YEAR 2 (August 2012 – July 2013)

During Year Two, project team members communicated with administrative and technical contacts throughout the year, on an as-needed basis. Ongoing communications with USDA administrative contacts Gregorio Cruz continue on an as-needed basis to ensure all administrative and budget questions and issues are addressed for the CIG grant. Project team members regularly communicated with Steve Campbell to keep him informed of project progress and invite any contributions he may make to the project.

Upon the request of Adam Chambers, NRCS, Ry Thompson and Tom Hunt attended a pre-conference dinner attended by CIG-GHG grant recipients at the November 2012 C-AGG meeting in Washington, DC. Ry attended the CIG-GHG dinner prior to the C-AGG meeting in Sacramento in March 2013 and attended the meeting that followed.

During February 2013, the project team had a conference call with representatives from the USDA-NRCS offices in Portland, OR (Adam Chambers and Steve Campbell) and Washington, DC (Carolyn Olson and Marlin Eve) to detail the technical accomplishments of the project to date and discuss the financial challenges we face with the loss of our financial investor.

Project team members developed a Lessons Learned document to share what the project team has learned from the first 2 years of the CIG in the areas of methodology development and implementation, stratification, on-the-ground sampling, laboratory and statistical analysis and deal packaging. The document was prepared for an international audience, but was shared domestically at a supply chain conference sponsored by Sustainable Food Lab in April 2013 and with the USDA-NRCS for internal GHG-CIG discussions in May 2013.

YEAR 3 (August 2013 – July 2014)

During Year Three, ongoing communications with USDA administrative and technical contacts continue on an as-needed basis to ensure all administrative and budget questions and issues are addressed for the CIG grant. During September, 2013, the project team had a conference call with Adam Chambers, Steve Campbell, Gregorio Cruz and Stacy Swartwood to detail the technical accomplishments of the project to date, discuss the financial challenges we face with the loss of our financial investor, and seek guidance from Administrative staff on next steps to address our project challenges. During the call, Gregorio Cruz clearly stated that Administrative issues regarding the grant are outside of his area and he recommended speaking with our Administrative Contact for the project. After the departure of Dan Lukash, our project team was not notified of a new NRCS Administrative Contact for the project and were never notified that our semi-annual reports, where we detailed project issues (*in Section 5. Proposed Changes requiring Prior Approval*) were not reaching the appropriate NRCS Administrative staff. A follow-up email from Gregorio Cruz recommended that we contact Frankie Comfort, Grants Specialist for the Central region, though several phone calls and emails to Mr. Comfort before, during and after, the government shutdown in October 2013 went unanswered.

A conference call with Adam Chambers was held in December 2013 to discuss the project status and additional efforts to locate a potential cash match partner. Documentation of the events that followed are included below:

- On December 23, 2013, Adam requested a "comprehensive budget overview" be provided to NRCS detailing the status of all cash and in-kind accounting for the project.

- On January 15, 2014, this report was provided to Adam Chambers, Steve Campbell, Jacqueline Roscoe, and Sheila Leonard after informal discussion with Adam to ensure the appropriate information and level of detail was being provided.
- On February 11, Sheila Leonard of NRCS provided a report, in letter form, detailing results of a review of the grant. In that report, the majority of the deliverables were either complete or up-to-date. Incomplete project deliverables were also identified. The letter identified eleven deliverables and documented the status of each as incomplete (4), partially complete (1), complete (5), or up-to-date (1). The letter requested a response by March 14, 2014 with an update on the status of the incomplete deliverables or estimated date for completion.
- On March 14, AES provided a response letter to Sheila Leonard which addressed each of the deliverable items and a plan of action for each. A CD-ROM with a set of many of the incomplete deliverables was provided to the NRCS administrative and technical contacts. In addition, AES provided an update on the replacement of the cash-match partner and formally requested a no-cost extension for 12 months to complete the outstanding deliverables.
- On April 4, Ry Thompson and Tom Hunt of AES had a conference call with Steve Campbell and Adam Chambers to discuss the deliverables provided by CD-ROM discussed above, and a brief discussion about the overall project status and anticipated next steps.
- On April 4, Sheila Leonard of NRCS provided a letter acknowledging the receipt of the March 14 AES letter. It stated that before any consideration of the no-cost extension can be given, a written verification from the cash match partner was required by April 18, 2014. After email discussions with Jacqueline Roscoe, a one week extension of this deadline was granted.
- On April 18, and in compliance with Ms. Leonard's request, AES provided a commitment letter documenting NativeEnergy of Burlington, VT as the new cash match partner on the project (See Appendix J).
- On May 8, Jacqueline Roscoe Henry of NRCS provided a letter acknowledging and accepting the commitment by NativeEnergy, Inc. as the new cash match partner. Additionally, the letter documented the review and approval of the no-cost extension until July 2015.

Ry Thompson attended a pre-conference dinner attended by CIG-GHG grant recipients at the Coalition on Agricultural Greenhouse Gases (C-AGG) meeting in Washington, DC in early November, 2013, and attended the C-AGG meeting and briefings with USDA and NRCS staff that followed. He attended the March 2014 C-AGG meeting in Sacramento, CA to network with other CIG projects and remain up-to-date on new developments in the field.

YEAR 4 (August 2014 – July 2015)

During Year Four, ongoing communications with USDA administrative and technical contacts continued to ensure all administrative and budget questions and issues are addressed for the CIG grant. A few highlights of these communications are included below:

- In fall 2014 and mid-January, 2015, Steve Apfelbaum, Tom Hunt and Ry Thompson of AES had a conference call with Steve Campbell and Adam Chambers to discuss the overall project status and anticipated next steps, including the need for development of an alternative soil carbon accrual methodology through the ACR. During this call we discussed with Adam and Steve Campbell the remaining deliverables to satisfy the USDA, NRCS contract requirements and the final budget confirmation. They were informed that AES/NE were completing all deliverables and were not anticipating delays in their delivery. We discussed the unanticipated real cash costs and time delays in SEC due diligence, and how this SEC resolution was not allowing us to finalize carbon transaction contracts with Shepherds Grain and others farmers, and also how the science findings and associated marketplace representations were to be cautiously made.
- Steve Campbell provided valuable feedback and technical information during fall 2014 by email as the project team was working through several technical issues related to no-till farming, changes in no-till technology and adoption and related matters.
- In early October 2015, Steve Campbell acknowledged in email that he had received, reviewed and approved the technical delivery submittals, which included all remaining outstanding deliverables under the CIG program contract with USDA-NRCS.

6. Post-Conservation Innovation Grant Close-Out: Anticipated AES/NE Next Steps

This project is anticipated to continue after the USDA, NRCS grant is closed out. This information is included in this final report for information purposes only, and because we hope that USDA, NRCS will participate in future announcements and press coverage on the success of this project. We propose to communicate with a USDA, NRCS designee to keep them up to date on the status of the Palouse Soil Carbon project and to coordinate on USDA, NRCS's potential interest in participating in announcements, public relations and press coverage for this project.

USDA, NRCS's announcement and press coverage of the North Dakota Avoided Conversion Grassland CIG demonstration project was well received in the media and set an example of one of the intended outcomes of the portfolio of CIG projects that include our Palouse project. It seems to be of increasing value to ecosystem marketplace development in the USA for publicizing positive examples of conservation innovation and new ecosystem marketplace opportunities. The AES/NE team looks forward to working with a USDA, NRCS designee on this future coordination/cooperation.

After the grant period is complete, the following activities will be continued by the project team to bring the Palouse Soil Carbon Project to fruition, as previously envisioned:

I. Business Origination with Shepherd's Grain

Because of the SEC resolution, only accredited investors can participate in carbon transactions. For this reason, AES/NE will revise the business organization and governance requirements and finalize transaction contracts with Shepherd's Grain and continue the conversation with interested producers who have signed the preliminary enrollment agreement or who have expressed an interest in sign up.

II. Mapping Screening and Stratification of the Palouse

The project team will apply the stratification mapping to any new acreage that is secured for enrollment for analysis and modeling purposes. This acreage will primarily come from producers outside of the Shepherd's Grain group.

III. Sampling, Analysis and Baseline Development using ACR Methodology of Palouse Region

AES/NE will complete additional soil carbon sampling, including new producer acreage, in the Palouse region as required to statistically represent the soil carbon baseline and carbon accruals that are occurring. After sampling occurs on any additional enrolled farms, their baseline soil carbon levels will be analyzed. Any adjustments in regional baselines will be made. However, it is anticipated that new data will not result in alterations of scientific baselines established under this CIG demonstration. Instead, the analysis will simply provide Time (zero), individual field measurements of soil carbon for the newly participating farms.

IV. Deal Packaging for Shepherd's Grain and Surrounding Farmers

AES will continue to work with *Native*Energy and Shepherd's Grain on the co-development of the project. AES and *Native*Energy are have developed and are in the process of reviewing / approving a modified version of TEPs Soil Carbon Quantification Methodology focused on the conservation cropping (no-till) activity with ACR. In parallel, AES, *Native*Energy and Shepherd's Grain will secure participation contracts with Shepherd's Grain and neighboring producers and finalize development of the Project Plan, in preparation for a market transaction.

V. Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

*Native*Energy will continue discussions with potential carbon buyers in the voluntary market.

VI. Reporting and Knowledge Dissemination

No further reports will be submitted under this Palouse CIG program to USDA, NRCS. Future reporting will be provided through ACR and independent validators in association with any carbon transactions that occur. In addition, AES/NE anticipate cooperatively publishing the soil carbon science findings with local soil scientists to continue the progress in disseminating the findings from this USDA, NRCS Palouse project.

7. Cost Status

See ***Appendix A – SF 425 Federal Financial Reports*** for the final financials for this project.

The final SF-425 Federal Financial Reporting form is attached hereto.

8. Schedule/Milestone Status

A project schedule with milestones as completed for the project is presented in ***Appendix B – Updated Project Schedule with Milestones*** and extends the project tasks through July 31, 2015.

APPENDICES

Appendix A – SF425 Federal Financial Reports for January – July 31, 2015
Appendix B – Updated Project Schedule with Milestones
Appendix C – Semi-Annual Report #1
Appendix D – Semi-Annual Report #2
Appendix E – Semi-Annual Report #3
Appendix F – Semi-Annual Report #4
Appendix G – Semi-Annual Report #5
Appendix H – Semi-Annual Report #6
Appendix I – Semi-Annual Report #7

Appendix A – SF425 Federal Financial Reports for January – July, 31 2015

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page of
USDA-NRCS, Washington DC	**69-3A75-11-131**	1 of 1 pages

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	**39-1611274**		☑ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☑ Cash ☑ Accrual

8. Project/Grant Period (Month, Day, Year)		9. Reporting Period End Date (Month, Day, Year)
From: **January 1, 2015**	To: **March 31, 2015**	**March 31, 2015**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0**
b. Cash Disbursements	**806,034.45**
c. Cash on Hand (line a minus b)	**0**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000**
e. Federal share of expenditures	**550,000.00**
f. Federal share of unliquidated obligations	**0**
g. Total Federal share (sum of lines e and f)	**550,000.00**
h. Unobligated balance of Federal funds (line d minus g)	**0.00**
Recipient Share:	
i. Total recipient share required	**550,000**
j. Recipient share of expenditures	**256,034.45**
k. Remaining recipient share to be provided (line i minus j)	**293,965.55**
Program Income:	
l. Total Federal program income earned	**0**
m. Program income expended in accordance with the deduction alternative	**0**
n. Program income expended in accordance with the addition alternative	**0**
o. Unexpended program income (line l minus line m or line n)	**0**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number, and extension)
Ry Thompson, Ecologist/Project Manager **Applied Ecological Services, Inc.**	**(608) 897-8641 ext. 57**
	d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **04/30/15 (through 15th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

FEDERAL FINANCIAL REPORT
(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page of
USDA-NRCS, Washington DC	**69-3A75-11-131**	1 of 1 pages

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	**39-1611274**		☐ Quarterly ☐ Semi-Annual ☐ Annual ☑ Final	☑ Cash ☑ Accrual

8. Project/Grant Period (Month, Day, Year)		9. Reporting Period End Date (Month, Day, Year)
From: **April 1, 2015**	To: **July 31, 2015**	**July 31, 2015**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0.00**
b. Cash Disbursements	**1,109,325.16**
c. Cash on Hand (line a minus b)	**0.00**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000.00**
e. Federal share of expenditures	**550,000.00**
f. Federal share of unliquidated obligations	**0.00**
g. Total Federal share (sum of lines e and f)	**550,000.00**
h. Unobligated balance of Federal funds (line d minus g)	**0.00**
Recipient Share:	
i. Total recipient share required	**550,000.00**
j. Recipient share of expenditures	**559,325.16**
k. Remaining recipient share to be provided (line i minus j)	**0.00**
Program Income:	
l. Total Federal program income earned	**0.00**
m. Program income expended in accordance with the deduction alternative	**0.00**
n. Program income expended in accordance with the addition alternative	**0.00**
o. Unexpended program income (line l minus line m or line n)	**0.00**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number, and extension)
Steve Apfelbaum, Chairman / Principal **Applied Ecological Services, Inc.**	**(608) 897-8641 ext. 17**
	d. Email Address steve@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **10/15/15 (through 16th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

Appendix B – Updated Project Schedule with Milestones

	Year 1 Q1 Aug 15 - Sep 30, 2011	Year 1 Q2 Sep 1 - Dec 31, 2011	Year 1 Q3 Jan 1 - Mar 31, 2012	Year 1 Q4 Apr 1 - Jun 30, 2012	Year 2 Q1 Jul 1 - Sep 30, 2012	Year 2 Q2 Oct 1 - Dec 31, 2012	Year 2 Q3 Jan 1 - Mar 31, 2013	Year 2 Q4 Apr 1 - Jun 30, 2013	Year 3 Q1 Jul 1 - Sep 30, 2013	Year 3 Q2 Oct 1 - Dec 31, 2013	Year 3 Q3 Jan 1 - Mar 31, 2014	Year 3 Q4 Apr 1 - Jun 30, 2014	Year 4 Q1 Jul 1 - Sep 30, 2014	Year 4 Q2 Oct 1 - Dec 31, 2014	Year 4 Q3 Jan 1 - Mar 31, 2015	Year 4 Q4 Apr 1 - July 31, 2015
Project organization and set-up																
Introductory meetings																
Partnership development with Shepherd's Grain (SG) and surrounding landowners																
Partnership agreement finalized with farmers				◆												
Development and dissemination of educational materials																
Development of live farm field activity web site																
Mapping, screening, and stratification of the Palouse																
Mapping and stratification completed			◆													
Preparation for sampling																
Sampling across Palouse region																
Laboratory analysis of samples																
Statistical analysis and baseline development																
Review of analysis by experts and technical team																
Baseline developed for carbon project								◆								
Finalize soil method validation through VCS or other body																
Methodology validated						◆										
PDD drafting and review for SG and surrounding landowners																
Formal submittal of PDD to independent validator																
PDD delivered to market																◆
Aggregation beyond SG and surrounding landowners																
Partnership agreement finalized with famers										◆				◆		
Host meetings and discussions with high potential carbon buyers																
Drafting of deal structures to monetize credits																
Carbon deal structured												◆				◆
Engage ARB or other emerging compliance markets																
USDA communications																
Semi-annual Report (Due 1/31/12, 1/31/13, 1/31/14 and 1/31/15)			◆				◆				◆				◆	
Annual report (Due 7/31/12, 7/31/13 and 7/31/14)					◆				◆				◆			
Final Report ~~(Due 10/31/14)~~ (Update: Due 10/31/15)																◆

Project Seeking Cash Partner for much of Yr 3

Appendix C – Semi-Annual Report #1

Applied Ecological Services, Inc. (AES)
Semi-Annual Progress Report No. 1: August 13 – December 31st, 2011
USDA-NRCS CIG-GHG Project No. 69-3A75-11-131
January 31, 2012

PROJECT DESCRIPTION / ABSTRACT

Applied Ecological Services, Inc. (AES), in partnership with The Earth Partners, LP (TEP), and a consortium of secondary partners (the TEP/AES Team) seek to develop a large-scale agricultural carbon project in partnership with Shepherd's Grain members and surrounding farmers in the loess hills of the Palouse and Columbia Plateau region. Intensive farming across the region has resulted in the near extinction of the native grasslands, and the exhaustion of the soil and hydrological resources of the region. The introduction and widespread application of sustainable, low-carbon farming practices have the potential to restore the fertility and ensure the longevity of one of the United States' most important breadbaskets. Demonstrating the value to landowners of increased soil carbon stemming from these improved agricultural practices is a critical component in facilitating the large-scale adoption of such practices. To this end, this project seeks to provide a roadmap for developing large-scale, high-quality, and low-cost soil carbon transactions.

Building off literature reviews and preliminary sampling completed in 2009, we propose to further develop and extrapolate these models at a larger, landscape scale across the entire Columbia Plateau eco-region. Utilizing TEP's Soil Carbon Quantification Methodology, we seek to measure, monitor, validate, and monetize carbon credits stemming from low carbon agricultural practices such as no-till, direct seeding, crop rotation, and improved soil management. We believe that this project demonstrates both the importance of large-scale low carbon farming practices to Greenhouse Gas reduction policies and the role of quantitative soil carbon methodologies in creating compliance-grade offset credits. It will also provide a roadmap for aggregating landowners over large areas at low cost. We seek to demonstrate a model for marketing and monetizing the resulting carbon credits. This will be one of the largest land-based carbon projects to date.

We seek to achieve the following outcomes in this project:

- **Demonstrate the model at scale.** Our proposed project is broken into two phases: In Phase 1, we intend to develop a low-carbon agricultural partnership with landowners on 300,000 acres of Shepherd's Grain and surrounding land. In Phase 2, we intend to partner with landowners on over 1,000,000 acres across the Palouse and larger Columbia Plateau eco-region. This can be expanded at a much larger scale because the project can build off of the analytic and technical work we will have done (GIS mapping, stratification, soil sampling, model projections, etc.) at the eco-region scale.
- **Demonstrate a low-cost aggregation model**. Assembling landowners over large acreages at a relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. Through our planned work with landowners on 1 million acres, the AES/TEP team will develop, test, and refine a low-cost aggregation model. To this end, the AES/TEP team is building on significant existing experience in aggregating landowners, developing standard partnership structures, and streamlining landowner interactions and engagement.
- **Showcase a successful land-based carbon transaction.** While agricultural carbon credits cannot currently be monetized in the marketplace, this project seeks to ensure that credits derived from this project will be accepted by the CA Air Resources Board (ARB) under AB-32 or other emerging compliance markets, as well as voluntary markets like VCS and ACR. To this end, we have developed a unique partnership of farmers, project developers, carbon investors, scientists, and government.
- **Develop data, maps and templates that will inform policy and support further research.** We will utilize GIS landform and geomorphic modeling and mapping to design, evaluate, and implement a regional, on-the-ground baseline analysis of soil carbon levels across the Palouse and Columbia Plateau eco-region. The resulting data and maps will represent a type of integrated information that is lacking in the region, which will be useful for government agencies, scientists, universities, and other researchers.

SEMI-ANNUAL PROGRESS REPORT

1. USDA-NRCS CIG-GHG Project Number

69-3A75-11-131

2. Project Title

Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region

3. Project Director / Principal Investigator

Steven I. Apfelbaum, Chairman of the Board/Principal Ecologist, Applied Ecological Services, Inc.

4. Date of Report / Period Covered

January 31, 2012 for Report No. 1: August 13 – December 31, 2011

5. Executive Summary

Since signing the contract in August 2011, the Project Team focused primarily on the following tasks:

- Task 1 – Business Origination with Shepherd's Grain;
- Task 2 – Mapping, Screening and Stratification of the Palouse;
- Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region; and
- Task 8 – Reporting and Knowledge Dissemination.

In addition, some initial sub-tasks were completed on the following tasks:

- Task 4 – Analysis and Baseline Development; and
- Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members.

6. Accomplishments

Task 1 – Business Origination with Shepherd's Grain

AES and TEP have successfully kicked off the partnership with the Shepherd's Grain producers and the other parties involved in the CIG grant. Project activities to date include the following:

I. Project Kickoff

The project team had a project kickoff meeting on September 26, 2011 with all of the key project partners, including: AES, TEP, Shepherd's Grain, University of Missouri Soils Lab, and Informing Ecological Design (statisticians). The kickoff meeting provided the project team with an opportunity to review the discuss the overall project, while having a more detailed discussion on grant terms, project timeline, and next steps to kick off the project.

II. Learning Journey Listening Sessions

In November 2011, the project team traveled to Washington and held an initial learning journey with Shepherd's Grain producers. Team members attended the annual Shepherd's Grain producer meetings and presented the soil carbon project in a short presentation, which has been provided as **Appendix C**. The meetings were an opportunity to present the overall program, answer producer questions, and discuss any concerns that were raised. Soil sampling procedures, as well as other short-term next steps, were discussed. Follow-up, one-on-one meetings with interested producers were scheduled for January 2012 to begin learning about their farming practices and operations in a more detailed listening session / learning journey. See Appendix C for presentation slides from the November 2011 meetings.

III. Business Development and Enrollment Agreement

In December, the project team had a business partner meeting at AES's office in Brodhead, WI, in which TEP explained to the various parties business models and soil carbon accrual opportunities based on existing models developed from pre-sampling of soil carbon levels. These meetings have helped structure the program for engaging Palouse producers and other parties.

TEP developed a draft of the partnership enrollment agreement ("Contract") with Shepherd's Grain producers and the surrounding farmers. Since no template agreement exists for this type of project, the TEP team had to develop the Contract from scratch. It has undergone over ten iterations based on substantive feedback from the directors of Shepherd's Grain, team members from AES and EKO Asset Management, TEP's carbon lawyer Martin Gitlin, and local producers and contract experts in the Palouse region. The principles of the Contract will be presented to the core group of Shepherd's Grain producers for feedback during the listening sessions planned for January 2012.

Task 2 – Mapping, Screening and Stratification of the Palouse

I. Base Mapping

Basic data gathering and mapping has been conducted for the entire Columbia Plateau (USEPA L3 Eco-region) for visualization and regional context. These data themes include:

- Political Boundaries;
- Eco-regions (EPA);
- Road Infrastructure (ESRI Street Map);
- Surface Landform (30m USGS DEM);
- Surface Water and Watersheds (National Hydrologic Dataset);
- Average Precipitation And Temperature (PRISM);
- General Soil Associations (NRCS STATSCO);
- Land Cover (USGS NLCD and GAP);
- Geology (USGS – http://pubs.usgs.gov/sir/2010/5246/); and
- Aerial Photography (Bing Map Service and NAIP).

Advanced data gathering and preliminary stratification for soil sampling has been concentrated in the eastern counties of the Columbia Plateau, within which most of the Shepherd's Grain farm operations are located (See ***Appendix D***). In this area additional data has been gathered, including: Surface Landform (10m USGS DEM) and County Soil Surveys (NRCS SSURGO). Derivatives generated from the 10m DEMs include: Slope, Aspect, Shaded Relief and 20 foot contours. SSURGO soil map unit data has been aggregated by state (WA, OR, ID) and joined to the attributes supplied in the SSURGO table muaggatt.

II. Preliminary Analysis of Soils

Initial geospatial analysis is being used to filter or screen out soil map units that are the least homogeneous with regard to soil carbon and that are difficult to sample because of rock and shallowness. The ideal soils are the deep silt loams derived from loess parent materials that are typical of the Palouse Hills L4 eco-region within the Columbia Plateau. To aid screening, the NRCS Soil Data Viewer tool in ArcGIS was used to query each state's database for predominant surface texture and parent material by soil map unit. These attributes were reviewed and a preliminary subset of soil map units to be included in the soil sampling domain was developed. The best soils for inclusion are considered those with a parent material of simply loess and a surface texture of silt loam. Other combinations are still being investigated. The Soil Data Viewer did not return parent materials for numerous mapping units, including all those in Spokane County. In order to estimate these values, an analysis of parent material by soil series was conducted to infer parent material based upon other mapping units of the same series. In a few cases where the same soil series had multiple parent materials, the most dominant was usually chosen to be assigned to the unknown map units. Preliminary maps of Soil Series extracted from the map unit name and parent materials are shown in ***Appendix D***. The soil series map shows only those soils that are currently within the soil sampling domain. Additional research will be conducted to determine if any soil attributes will be used to generate sampling strata within the sampling domain thus far defined.

III. Preliminary Analysis of Topography

Since soil carbon is likely to vary with topographic characteristics, preliminary topographic analysis has been conducted to determine likely stratification for soil sampling. Two terrain characteristics have been investigated, aspect and topographic position. The aspect derivative from the 10m DEM has been reclassified into two categories along the northwest-southeast axis under the assumption that the northerly and easterly slopes will be cooler and wetter. An additional analysis using a slope position model developed by Jeff Jenness was conducted to develop a binary topographic position classification consisting of 'upper slopes and hilltops' and 'lower slopes and valleys'. The assumption is that the lower slopes will be wetter than the higher slopes. With these two binary classifications, there are currently 4 possible strata based on topography alone: 1) upper southwest facing, 2) lower southwest facing, 3) upper northeast facing and 4) lower northeast facing. Examples of these two classifications are shown in ***Appendix D***. Further testing of the Jenness topographic position index models will be conducted to determine if more refined positions (such as toe slope, foot slope, back slope, shoulder slope and summit can be generated consistently or if smaller variations in these can be determined. Also, a further refinement of categories based upon topographic position using the Topographic Wetness Index (TWI) model will be investigated. Further research will look at possible categories for temperature/precipitation/elevation which are highly correlated from lower to higher elevations across the plateau.

Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region

I. Literature and Data Review

A literature review was completed for the project to begin understanding the study area in more detail, with particular emphasis on the following: geologic history, pre-settlement ecological conditions, carbon-friendly farming /no-till practices, and related agricultural research that emphasized conservation of soil and water resources. Through the literature search and through discussions with the technical team members, the project team also began to understand the key soil scientists and agricultural researchers in the region, and their respective universities, that could provide insight into the topics of our research. Soil surveys from the counties in the study area were collected and reviewed. The statistical team analyzed the soil carbon dataset from the initial sampling of Shepherd's Grain farmer fields conducted in summer 2009. Initial stratification maps were reviewed to assist in developing a preliminary sampling plan for November 2011.

II. Preliminary Soil Sampling

During the November visit to the Palouse and Columbia Plateau eco-region, the project team conducted preliminary soil sampling at five Shepherd's Grain member farms and collected 45 soil cores. The goals of the sampling effort were:

- Test the physical sampling methods and determine sampling efficiency with new equipment;
- Gain insight into variation in carbon levels by slope position and aspect;
- Gain insight into variation in carbon levels by geographic region and land management practices; and
- Gain insight into changes in soil carbon levels throughout the 1m soil cores.

At each of the five sites, the sampling team included key members of the QA/QC technical team, including Dr. Tom Hunt, Dr. Richard Hammer and Steve Apfelbaum, as well as other key team members. The team surveyed the landscape to assess the geomorphic position in the landscape. The team then attempted to collect soil cores in a north-south transect (where feasible) that allowed soil cores to be collected at numerous slope positions (summit, shoulder, back, foot, toe) and aspects (north or south facing). It is expected that soil carbon levels on similar slope positions will vary depending on whether they are south facing (hot/dry) vs. north facing (cool/wet). At each sampling location, one core was collected for analysis by the University of Missouri Soils Lab. This core was collected, labeled and stored for later shipment. In two sample locations, a duplicate soil core was taken 12" from the first location for analysis in the lab to determine the level of variability of soil carbon and bulk density levels within a short distance in the same soils and the same slope position.

As time allowed, a second soil core was collected for detailed analysis and description on site by the sampling team. This description included: depth of genetic horizons, soil texture, soil structure, and soil color (wet and dry). If refusal was met due to a restrictive layer or bedrock, this depth was noted on the field sheet. Any unique features associated with the core were noted on the field sheet. Each location was geo-referenced with a sub-meter accuracy Trimble GPS unit. Additional information was documented in the GPS unit, including: farm name, time in no-till practice, soil core number, slope position, slope shape (convexity/concavity), and aspect. See **Appendix E** for graphic of slope position and a detailed list and maps of soil cores collected.

III. Laboratory Analysis of Soil Cores

The 45 soils cores collected during the November 2011 preliminary sampling trip were sent to the University of Missouri Soils Lab for analysis. Due to staff availability and current workloads at the lab, it is not anticipated that the soil cores will be described and samples analyzed until the first quarter of 2012.

Once available, the lab staff will conduct the following:

- Full description of soil cores, including genetic horizons, soil color, soil texture, and soil structure;
- Bulk density and soil carbon (total, inorganic and organic) levels at select increments through the 1m soil cores; and
- Full characterization of select soil cores.

Data from the November 2011 sampling will be analyzed by the project team and statistical consultants to help guide the development of the soil sampling plan that will be implemented in Spring 2012. With a limited schedule and budget for soil sampling and analysis in the CIG grant, it is critical that each and every sample be placed very strategically in the landscape to provide key information related to the variables that are presumed to influence soil carbon levels in the larger Palouse and Columbia Plateau eco-region.

Task 4 – Analysis and Business Development

Under this task, the project team has assembled its statistical team and began assembling the technical team to review the soil carbon projections, once completed. Initial discussions between the statistical team and the University of Missouri Soils Lab have been initiated to understand laboratory analysis procedures and potential for statistical variation during laboratory tests. No other activities occurred under this task. It is expected that this task will occur primarily in the second half of 2012 and will be reported on in the 3rd Bi-annual report.

Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers

No activities have occurred under this task. It is expected that this task will be initiated during the first half of 2012 and be completed during the first half of 2013.

Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members

No activities have occurred under this task. It is expected that this task will be initiated during the first half of 2013 and be completed during the second half of 2013.

Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

Under this task, the project team initiated the validation of the TEP Soil Carbon Methodology through the Verified Carbon Standard (VCS) process. Third-party verification is the core of quality assurance, and under the VCS Program, all projects must be validated and all emission reductions must be verified by approved validation / verification bodies. The methodologies verified by VCS have been used by over 600 projects quantifying emission reductions and issuing GHG credits in the voluntary markets.

After a 30 day public review that ended on November 3rd, no substantive comments debating the technical aspects of the TEP Soil Carbon Methodology were received. The TEP carbon team has addressed the comments that were received during the public review period. The methodology is currently undergoing third-party review by two independent external validators, per the VCS path to validation. The two external validators, Environmental Services Inc. (ESI) and Scientific Certification Services, Inc. (SCS), are near completion of their validation, and the carbon team is finalizing its responses to the two validators. The TEP carbon team is addressing the issues raised by the validators, and is continuing to engage VCS to ensure a timely validation of the methodology. It is anticipated that the review process will be completed in early 2012, at which time the Soil Carbon Methodology will be validated and ready for use in the soil carbon sampling of the Palouse and Columbia Plateau eco-region.

In addition, TEP has continued preliminary conversations with potential future carbon buyers so that they are aware of the status of the partnership with Shepherd's Grain producers and adjacent landowners and the potential for agricultural land based carbon credits through the project.

Beyond the subtasks described above, it is expected that this task will be initiated in 2013.

Task 8 – Reporting and Knowledge Dissemination

To begin the project, initial communication were made with USDA administrative contacts Gregorio Cruz and Dan Lukash to ensure all administrative, budget and payment procedures were well-understood for the

CIG grant. Project team members also initiated communications with Steve Campbell, NRCS Technical Contact, to understand his expertise and potential contributions to the project. The project team shared the highlights of its technical approach with Steve for any feedback or comments that he may have and clarified how he would prefer to remain apprised of project progress and updates. The project team scheduled time for an in-person meeting with Steve Campbell during the January 2012 travels to Washington. It was agreed that the team would meet with Steve about the project and he would attend the listening session meetings with farmers that followed.

Upon request of Greg Johnson, NRCS West Technology Support Center in Portland, Oregon, team members scheduled and presented at the Coalition on Agricultural Greenhouse Gases (C-AGG) meeting in Washington DC on November 8, 2011. David Tepper, CEO of TEP, presented on a moderated roundtable discussion with other CIG Greenhouse Gas (GHG) project representatives.

Next Steps

During the first half of 2012, the following activities will be undertaken by the project team:

I. Task 1 – Business Origination with Shepherd's Grain

In late January 2012, the project team will travel to Washington and Idaho to implement the detailed listening sessions / learning journey with Shepherd's Grain producers. At this time, the team will present the main components of the enrollment agreement (contract) to producers and receive feedback. This feedback will be incorporated into the final enrollment agreement, which will be provided to each producer for official signature and sign-up in the program. The project team will initiate the remaining sub-tasks under this task, including: create graphics showing benefits of no-till farming to soil carbon levels; and develop website for producers to document annual practices (tillage, fertilizer, yields, residue mgmt., etc.).

II. Task 2 – Mapping Screening and Stratification of the Palouse

During the first quarter of 2012, it is expected that the project team will complete the GIS stratification mapping of the Palouse ecosystem, at which point the project team will hold and technical meeting to review and refine the stratification mapping.

III. Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region

It is expected that the majority of the sampling will take place during the second quarter of 2012. All tasks under Task 3 will be initiated during the first half of 2012. The laboratory analysis and sample archiving will not be completed during the first half of 2012 and will continue to the second half of 2012.

IV. Task 4 – Analysis and Baseline Development

As data becomes available from the sampling process, the statistical team will begin building the predictive model of soil carbon levels in the Palouse region. It is expected that this work will not be completed until the second half of 2012.

V. Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers

Once the enrollment agreements are signed and the sampling begins, the project team will begin to outline the Project Design Document (PDD). The majority of the PDD work will follow the completion of the activities in Task 4, in late 2012 or early 2013.

VI. Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

The independent, third-party review of the TEP Soil Carbon Methodology will be completed during the first quarter of 2012. At this point, the method will be validated and verified and ready for use in soil sampling.

VII. Reporting and Knowledge Dissemination

Regular reporting with Steve Campbell (monthly update) and with the NRCS administrative contacts (as needed) will continue through the first half of 2012.

7. Cost Status

See ***Appendix A – SF 425 Federal Financial Reports*** for the financials for this period.

8. Schedule/Milestone Status

During the first bi-annual report period, the project is progressing according to schedule. Based on the progress to date, some tasks may be completed ahead of schedule. A project schedule with milestones (*updated since contract signing*) is presented in ***Appendix B – Project Schedule with Milestones***.

APPENDICES

Appendix A – SF425 Federal Financial Reports for August – December 2011
Appendix B – Project Schedule with Milestones
Appendix C – November Shepherd's Grain Meeting Presentation Slides
Appendix D – Example Maps from Stratification Process
Appendix E – November Pre-sampling Approach and Locations
Appendix F – Coalition on Agricultural Greenhouse Gases (C-AGG) Meeting, Washington DC

FEDERAL FINANCIAL REPORT
(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page of pages
USDA-NRCS, Washington DC	**69-3A75-11-131**	1 of 1

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	**39-1611274**		☑ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☑ Cash ☐ Accrual

8. Project/Grant Period (Month, Day, Year)		9. Reporting Period End Date (Month, Day, Year)
From: **August 13, 2011**	To: **September 30, 2011**	**September 30, 2011**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0**
b. Cash Disbursements	**26,219.18**
c. Cash on Hand (line a minus b)	**0**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000**
e. Federal share of expenditures	**23,627.55**
f. Federal share of unliquidated obligations	**0**
g. Total Federal share (sum of lines e and f)	**23,627.55**
h. Unobligated balance of Federal funds (line d minus g)	**526,372.45**
Recipient Share:	
i. Total recipient share required	**550,000**
j. Recipient share of expenditures	**2,591.63**
k. Remaining recipient share to be provided (line i minus j)	**547,408.37**
Program Income:	
l. Total Federal program income earned	**0**
m. Program income expended in accordance with the deduction alternative	**0**
n. Program income expended in accordance with the addition alternative	**0**
o. Unexpended program income (line l minus line m or line n)	**0**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. *Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:*

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number, and extension)
Ry Thompson, Ecologist/Project Manager **Applied Ecological Services, Inc.**	**(608) 897-8641 ext. 57**
	d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **Nov 8, 2011 (Partial Qtr-1st report)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted USDA-NRCS, Washington DC	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment) 69-3A75-11-131	Page 1 of 1 pages

3. Recipient Organization (Name and complete address including Zip code)
Applied Ecological Services, 17921 Smith Road / PO Box 256, Brodhead, WI 53520

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	39-1611274		☒ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☒ Cash ☐ Accrual

8. Project/Grant Period From: (Month, Day, Year)	To: (Month, Day, Year)	9. Reporting Period End Date (Month, Day, Year)
October 1, 2011	December 31, 2011	December 31, 2011

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	0
b. Cash Disbursements	228,218.37
c. Cash on Hand (line a minus b)	0
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	550,000
e. Federal share of expenditures	174,683.61
f. Federal share of unliquidated obligations	0
g. Total Federal share (sum of lines e and f)	174,683.61
h. Unobligated balance of Federal funds (line d minus g)	375,316.39
Recipient Share:	
i. Total recipient share required	550,000
j. Recipient share of expenditures	53,534.76
k. Remaining recipient share to be provided (line i minus j)	496,465.24
Program Income:	
l. Total Federal program income earned	0
m. Program income expended in accordance with the deduction alternative	0
n. Program income expended in accordance with the addition alternative	0
o. Unexpended program income (line l minus line m or line n)	0

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:			

12. *Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:*

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official Ry Thompson, Ecologist / Project Manager	c. Telephone (Area code, number and extension) 608-897-8641 x57
	d. Email address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official [signature]	e. Date Report Submitted (Month, Day, Year) 1/31/12 (through 2nd quarter)
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

	Year 1				Year 2				Year 3			
	Q1 Aug 13 - Sep 30, 2011	Q2 Oct 1 - Dec 31, 2011	Q3 Jan 1 - Mar 31, 2012	Q4 Apr 1 - Jun 30, 2012	Q1 Jul 1 - Sep 30, 2012	Q2 Oct 1 - Dec 31, 2012	Q3 Jan 1 - Mar 31, 2013	Q4 Apr 1 - Jun 30, 2013	Q1 Jul 1 - Sep 30, 2013	Q2 Oct 1 - Dec 31, 2013	Q3 Jan 1 - Mar 31, 2014	Q4 Apr 1 - Jun 30, 2014
Project organization and set-up	■											
Introductory meetings	■											
Partnership with Shepherd's Grain (SG) and surrounding landowners		■	■									
Partnership agreement finalized with farmers			◆									
Development and dissemination of educational materials		■	■	■								
Development of live farm field activity web site			■	■								
Mapping, screening, and stratification of the Palouse	■	■	■									
Mapping and stratification completed			◆									
Preparation for sampling		■	■									
Sampling across Palouse region			■	■								
Laboratory analysis of samples			■	■	■							
Statistical analysis and baseline development				■	■	■						
Review of analysis by experts and technical team				■	■	■						
Baseline developed for carbon project						◆						
Finalize soil method validation through VCS or other body	■	■	■									
Soil carbon methodology validated			◆									
PDD drafting and review for SG and surrounding landowners (300,000 ac)				■	■	■	■	■				
Formal submittal of PDD to independent validator								■				
PDD delivered to market									◆			
Aggregation beyond SG and surrounding landowners (1 million ac)						■	■	■	■	■		
Partnership agreement finalized (1 million ac)										◆		
Host meetings and discussions with high potential carbon buyers								■	■	■		
Drafting of deal structures to monetize credits										■	■	
Carbon deal structured (1 million ac)											◆	
Engage ARB or other emerging compliance markets					■	■	■	■	■	■	■	■
USDA communications	■	■	■	■	■	■	■	■	■	■	■	■
Bi-annual report		◆				◆				◆		
Annual report				◆				◆				
Final Report												◆

Agricultural Soil Carbon in the Palouse Region: "Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region"

USDA-NRCS Conservation Innovation Grant (CIG) – 2011 Greenhouse Gas (GHG) Program

APPLIED ECOLOGICAL SERVICES, INC.

theearthpartners

Project History

1. (2008) AES / SFL Packard foundation grant
   - Evaluated literature and pre-sampled soil carbon levels in representative fields of Shepherd's Grain members
   - Developed preliminary carbon business models
   - We learned that real soil carbon improvements are occurring among Shepard's Grain farmers.

2. (2011-2015) USDA CIG Grant: "Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region"
   - This is what we are here to discuss

Introduction to the project

- No market for carbon credits, especially agriculture-based soil carbon
- Purpose of this project is "measure and verify" soil carbon from sustainable agricultural practices
- When carbon markets develop or buyers emerge, landowner can claim these carbon credits
- TEP will market the credits, but landowner chooses when to sell the credits, and at what price

This project allows landowners to begin "banking" their carbon with no risk

Soil carbon: beyond just carbon credits

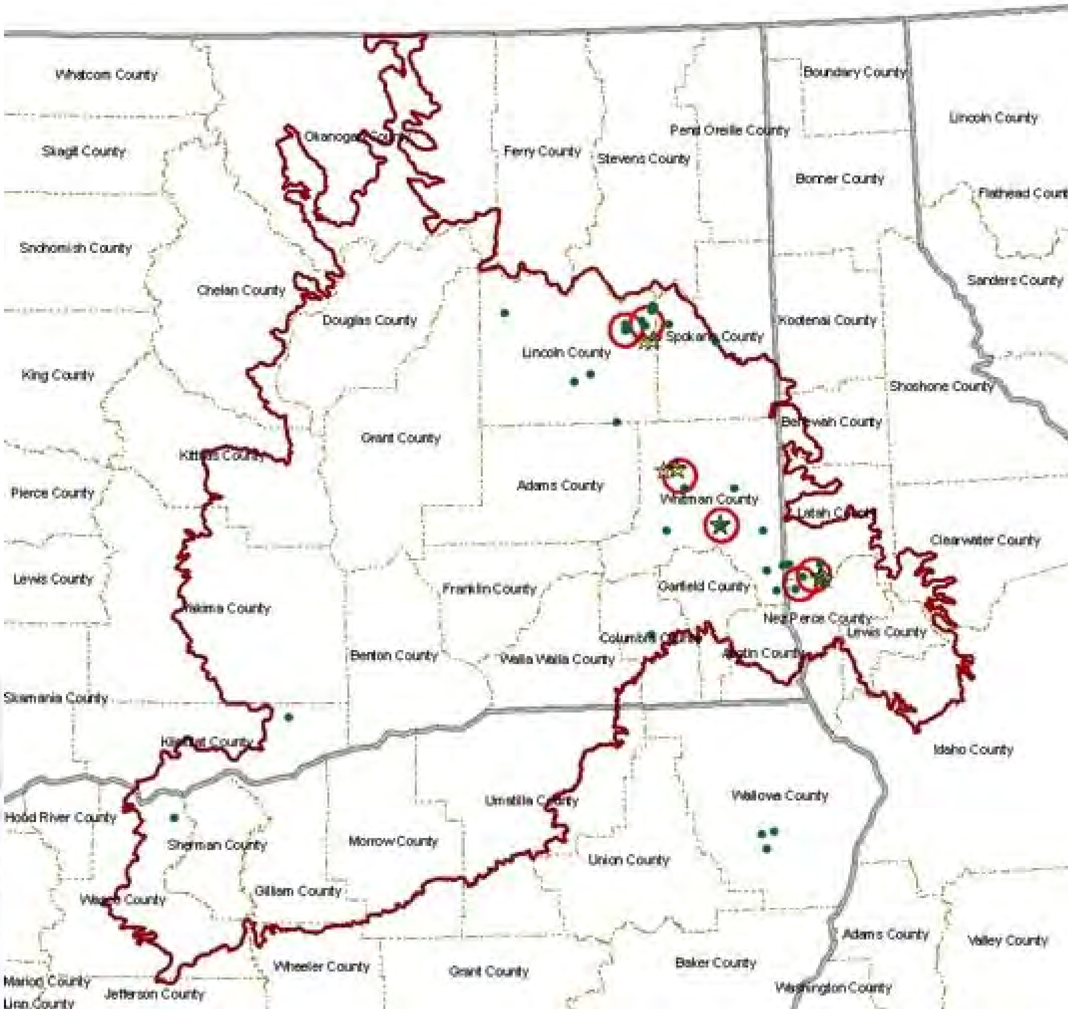
- Improved yields
- Increased soil fertility
- Reduced erosion risk
- Water retention and efficiency
- Lower operational costs
- Long term land value

Increased value of production

Project Partners

- USDA NRCS – grant funding, technical support
- Applied Ecological Services, Inc. – grant recipient/science lead
- Shepherd's Grain – farm aggregation facilitator
- The Earth Partners, LP – business lead
- University of Missouri – technical team / soils
- EKO Asset Management – cash carbon buyer/investor
- Sustainable Food Lab – advisor

Project Area



See more detailed maps that we brought

APPLIED ECOLOGICAL SERVICES, INC.

theearthpartners

What Are The Major Goals Of The Project?

Demonstrate the first large-scale agricultural soil carbon model at scale

– In Phase 1, develop a soil carbon partnership with landowners on 300,000 acres

– In Phase 2, extend partnership to over 1,000,000 acres

About the TEP Soil Carbon Quantification Method

- Actual measurement – not defaults or assumptions
- Tested/confirmed in North America: WI, VT, WA, OR, CA, South/Central America; NZ, AUS, and Western Europe as cost effective, and a practical and robust technical methodology.
- Now being validated by VCS, awaiting finalization of public comment period (ends 3rd Nov).
- Selected by USDA for this grant, supported by many experts and organizations

Where We Are At In The Process?

1. Signed USDA contract mid-August and began mapping/stratification

2. VCS validation of method in process—should be done before end of year

3. Learning journey with SG farmers and preliminary sampling at subset of SG farms to further refine sampling plan for 2012.

1. An enrollment term sheet is being discussed with SG

2. Organizing for working with SG to start farmer aggregation process.

3. Working with SG farmers to get locations and aerial photos with field numbering of their farms.

4. Organizing for full sampling in 2012

This Week—Preliminary Soil Sampling Plans

This week we will:

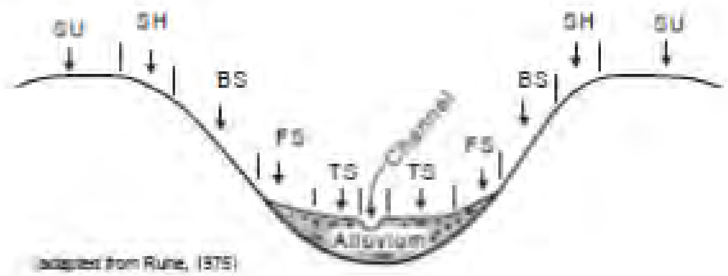
1. Test/shakedown the soil survey equipment to streamline sampling.

2. Clarify soil carbon variations with slope position.

3. Meet with the farmers who have expressed interest and to learn about their farms in preparation for sampling in 2012.

Hillslope - Profile Position (Hillslope Position in PDP) - Two-dimensional descriptors of parts of line segments (i.e., slope position) along a transect that runs up and down the slope; e.g., *backslope* or *BS*. This is best applied to transects or points, not areas.

Position	Code
summit	SU
shoulder	SH
backslope	BS
footslope	FS
toeslope	TS



(adapted from Ruhe, 1975)

USDA-NRCS *1-6* *September 2002*

- Sites for today?

Giddings Soil Sampler on JD Gator

Work so far

The enrollment agreement

- TEP and partners are investing over $1 million in this project grant
- No risk to landowner, and no cash required
- This project requires an enrollment agreement with the landowners
- The enrollment agreement describes the process, economics, and responsibilities of TEP and the landowner
- The partnership requires a commitment to sustainable agricultural practices for a certain period

Partnership economics

- 1st 5 years, landowner owns 80% of carbon
- 2nd 5 years, landowner owns 85% of carbon
- After this, landowner owns 95% of carbon
- First 300,000 acres to sign up ("early movers") get a 10% share of TEP's carbon on lands beyond these first 300,000 acres
- Some carbon goes into a "Buffer" which acts as an insurance mechanism for the project
- The cash investors require a minimum of 300,000 tons for carbon during the first 5 years

Illustrative economics

- Landowner with 3,000 acres enrolled

- Conservative carbon increase of 1 ton CO2e/acre/yr (net after buffer and economics sharing)

Scenarios once carbon markets develop or buyers emerge

($5/ton; $10/ton; $20/ton)

- Payment per year:
  $15,000; $30,000; $60,000
- Over 15 years:
  $225,000; $450,000; $900,000

Soil carbon: beyond just carbon credits

- Improved yields
- Increased soil fertility
- Reduced erosion risk
- Water retention and efficiency
- Lower operational costs
- Long term land value

Increased value of production

How to get your soils sampled in 2012?

1) You let us know if you want to enroll. Earlier is better!

2) We'll need an NRCS aerial photograph showing your land boundaries and field numbering by early Dec 2011

3) We'll talk with you about the practices in each field, so that we can fill out an information form about the history in each field.

4) We'll then arrange scheduling with you and other farmers.

5) We'll begin sampling in early 2012.

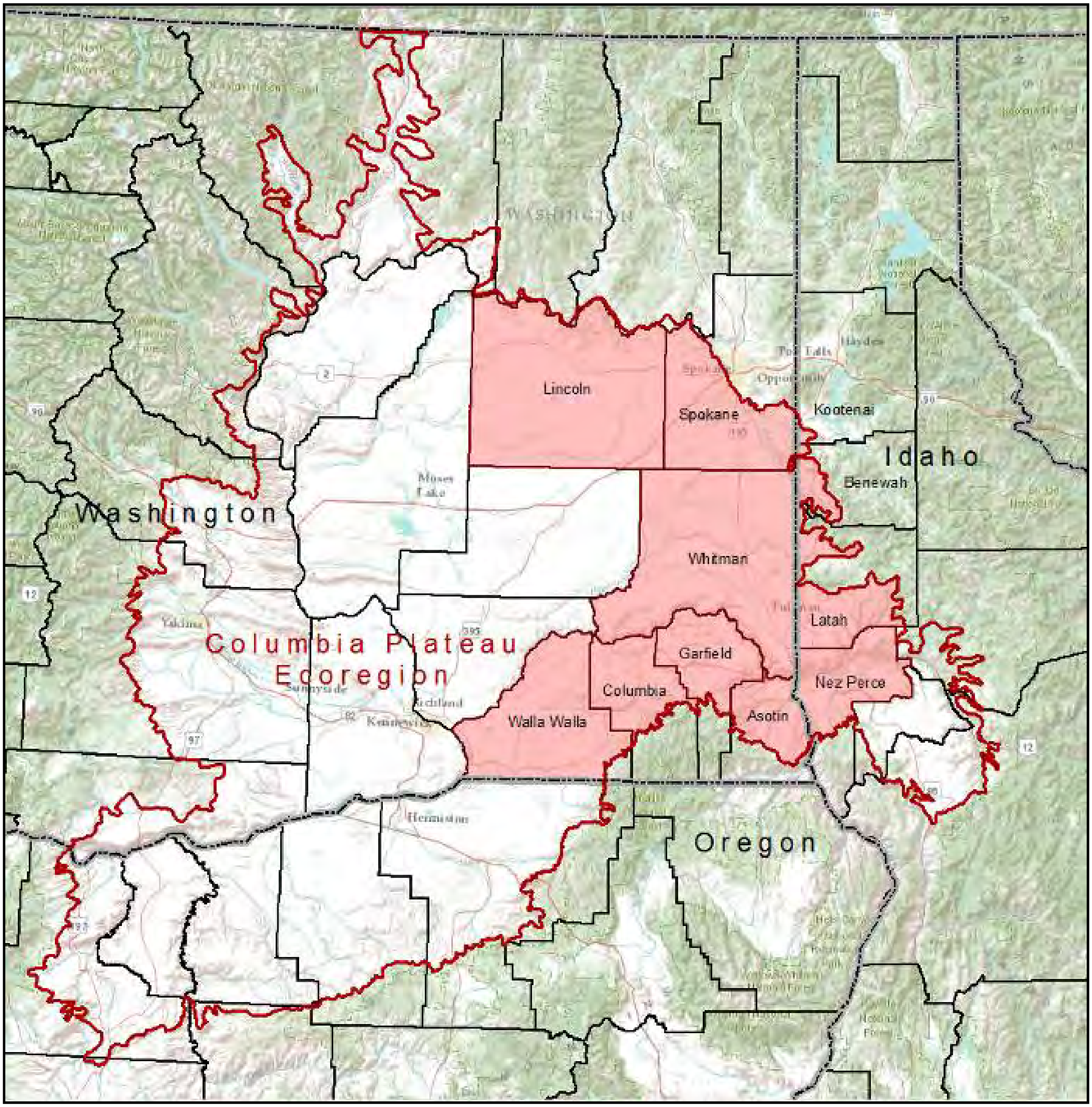
6) Core samples will then be analyzed and we'll report back findings.

Thank You

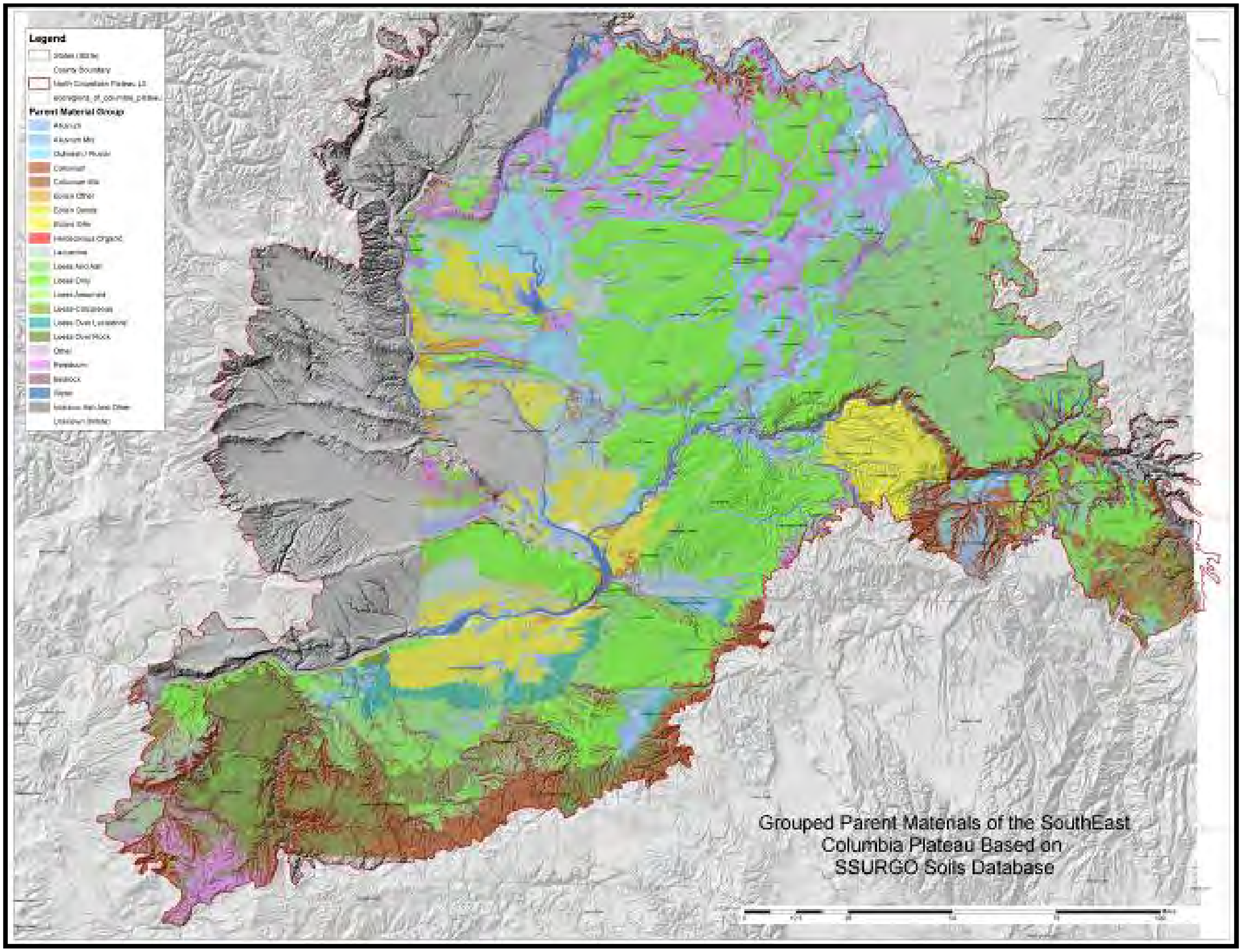
Please talk to us after the meeting, or contact:

- Chas Taylor (chas@theearthpartners.com)
- Steve Apfelbaum (steve@appliedeco.com)

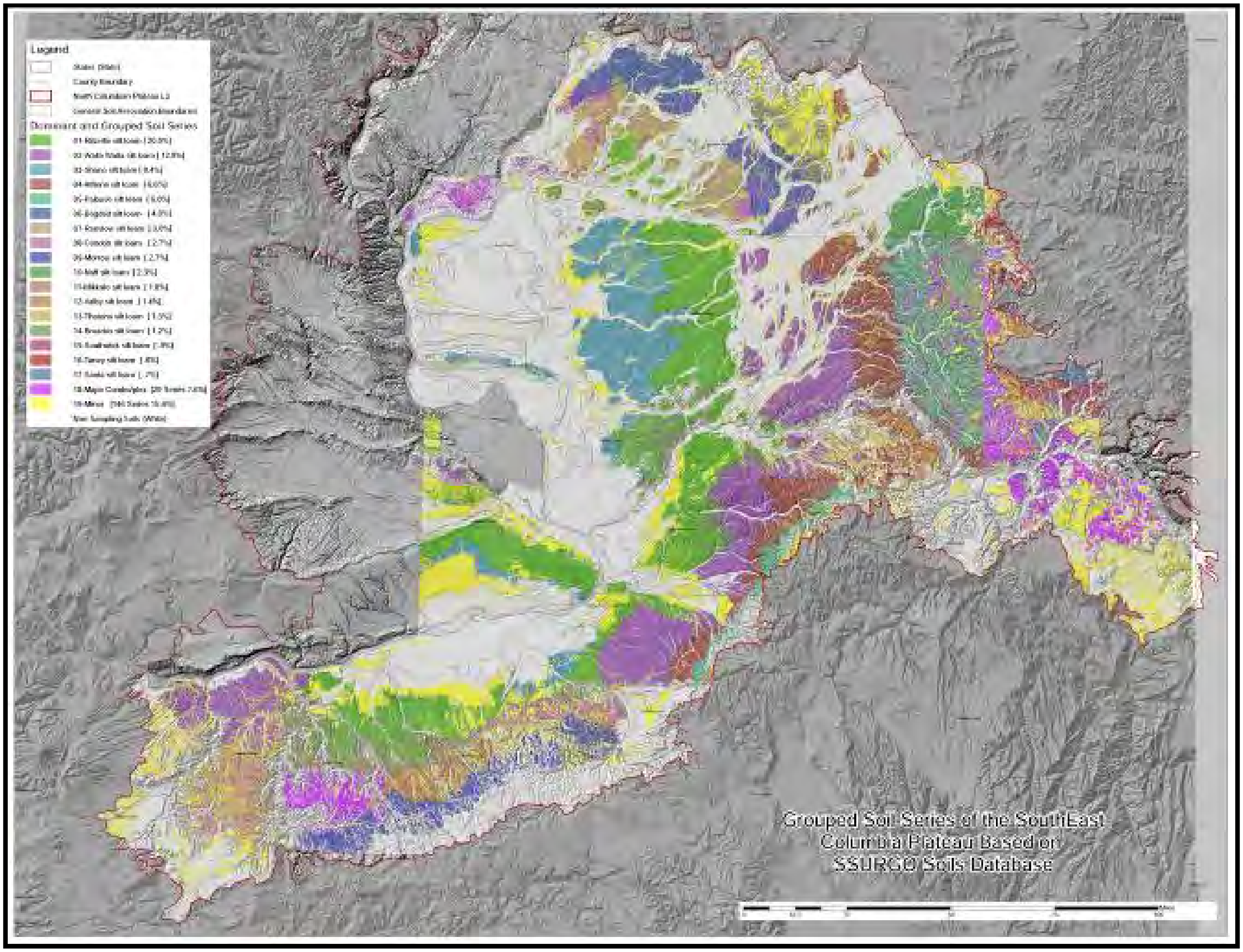
Appendix D-1. Counties of Eastern Columbia Plateau



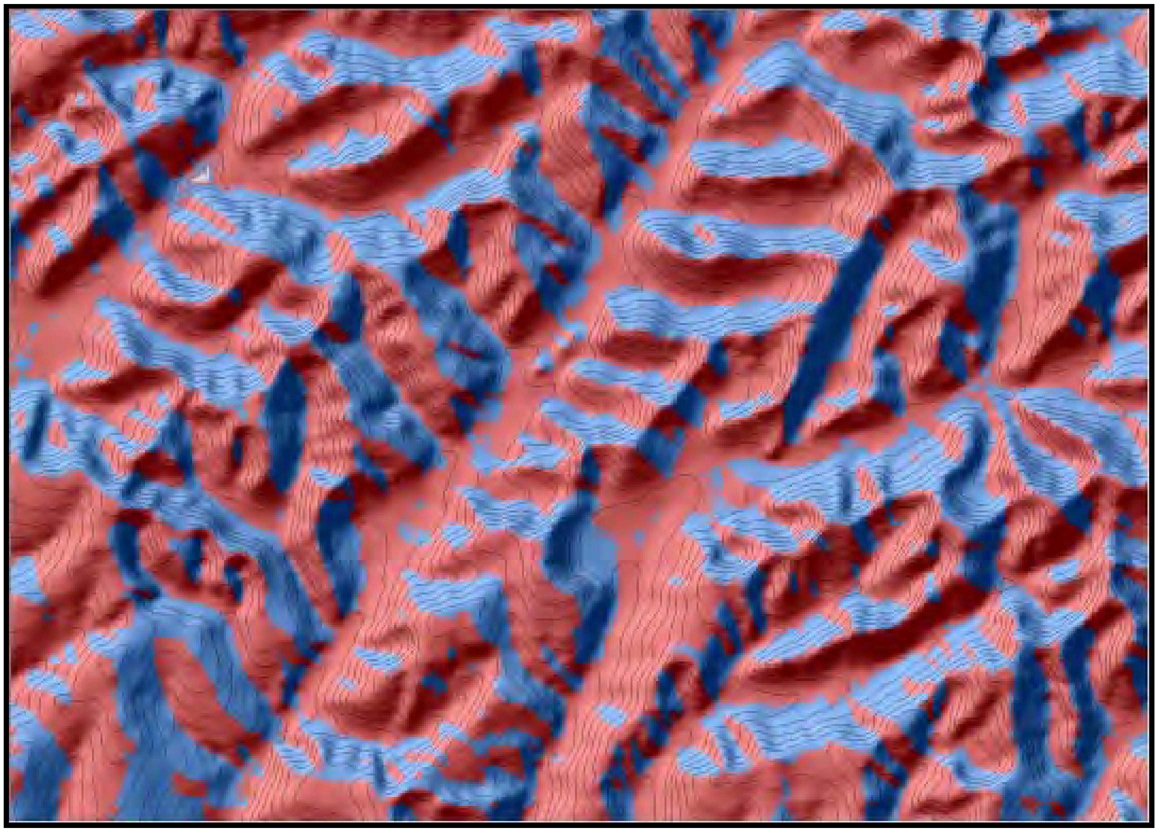
Appendix D-2. Grouped Parent Materials of the Southeast Columbia Plateau



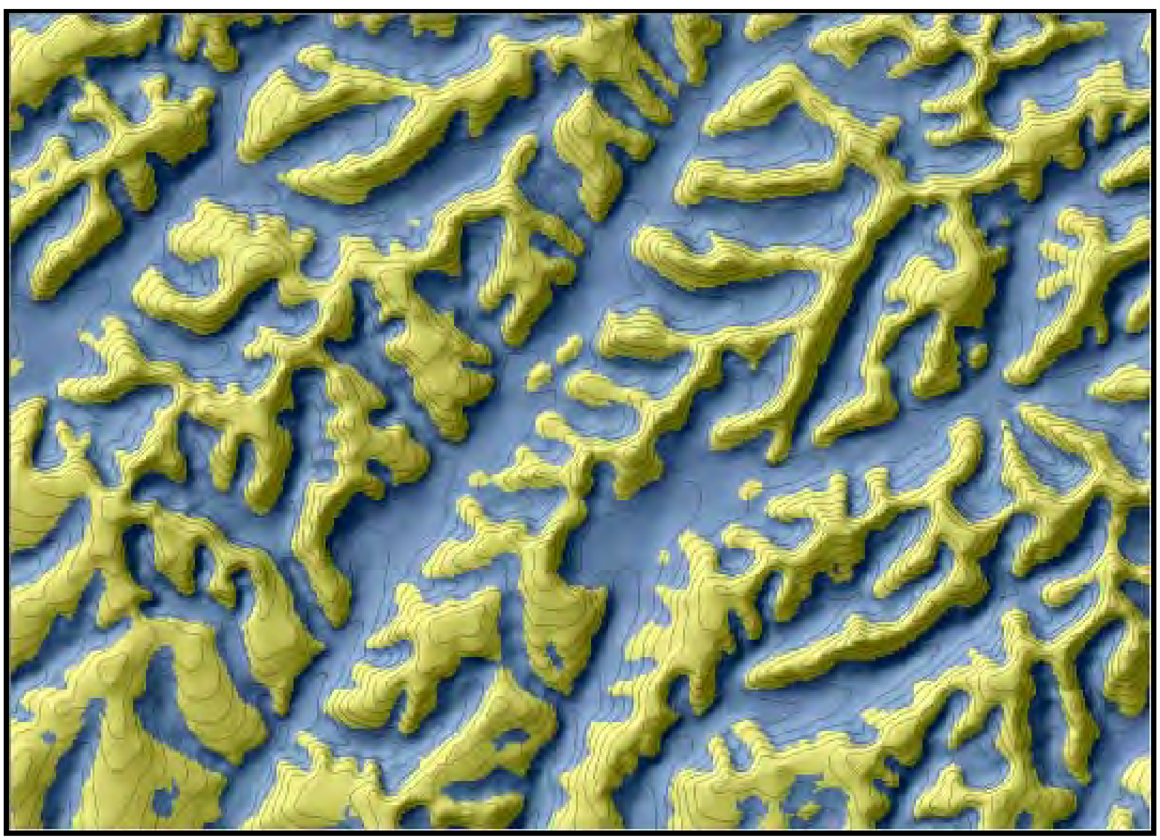
Appendix D-3. Dominant and Grouped Soil Series of the Southeast Columbia Plateau within Current Sampling Domain



Appendix D-4. Aspect (grouped Along NW-SE Axis (upper image)) and Slope Position Index (grouped into Upper And Lower Slopes (lower image)) [Both with 20 foot contours]



Red=SouthWesterly Aspects, Blue=NorthEasterly Aspects

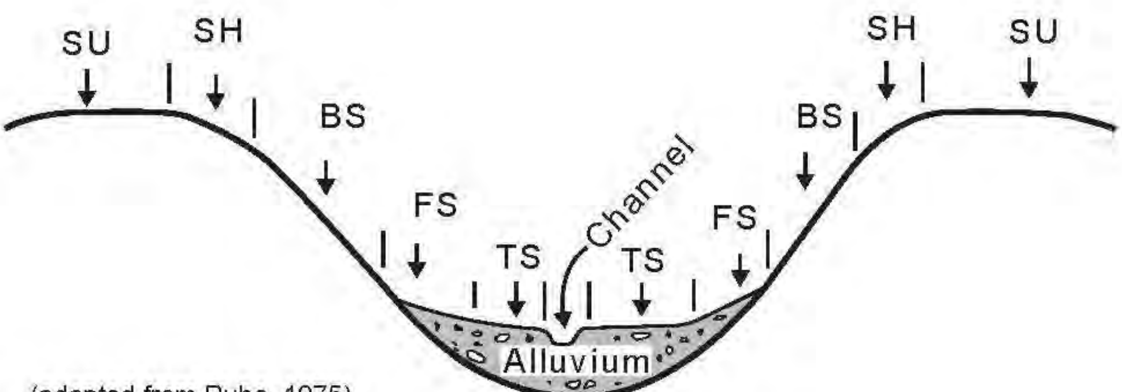


Yellow=Upper Slope, Blue=Lower Slope

Appendix E-1. Hillslope – Profile Position Diagram (from USDA-NRCS Field Book for Describing and Sampling Soils, Version 2.0, September 2002)

Hillslope - Profile Position (Hillslope Position in PDP) - Two-dimensional descriptors of parts of line segments (i.e., slope position) along a transect that runs up and down the slope; e.g., *backslope* or *BS*. This is best applied to transects or points, not areas.

Position	Code
summit	SU
shoulder	SH
backslope	BS
footslope	FS
toeslope	TS

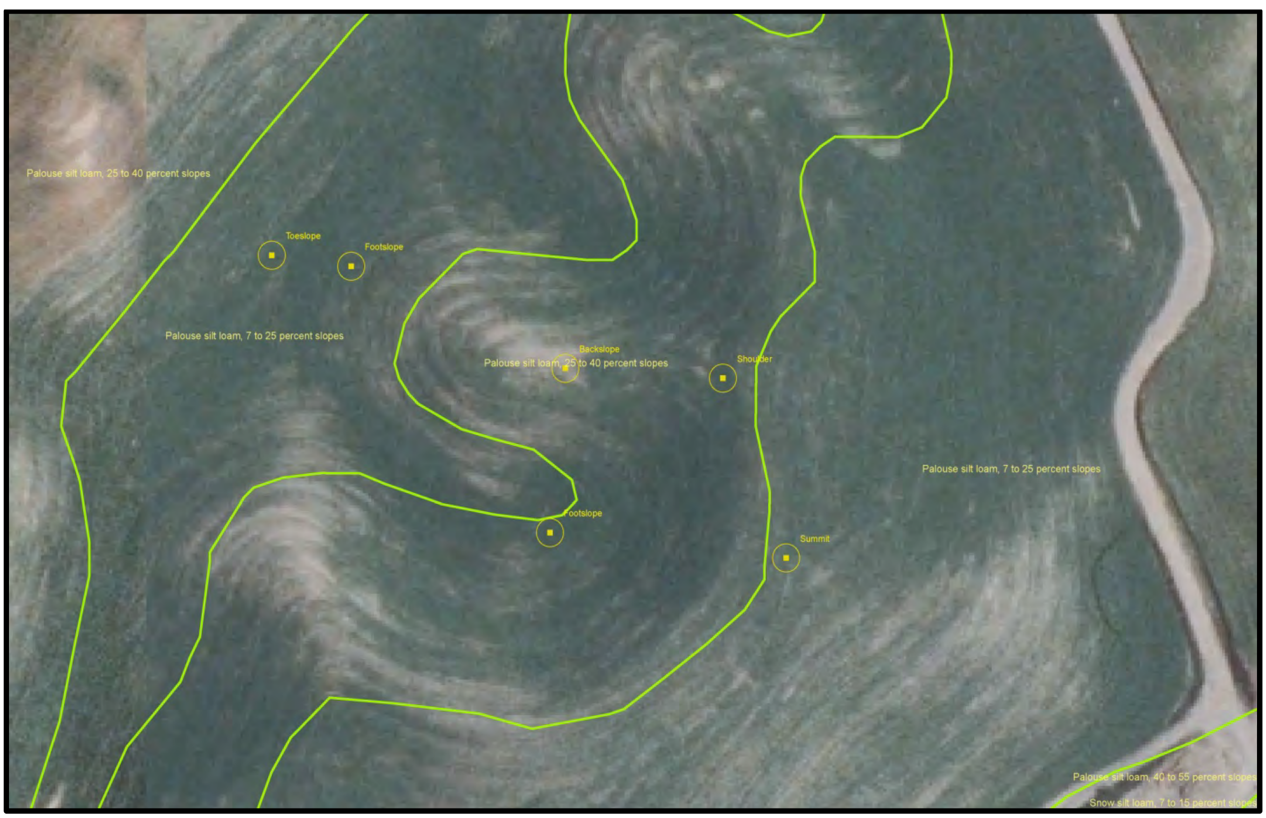


(adapted from Ruhe, 1975)

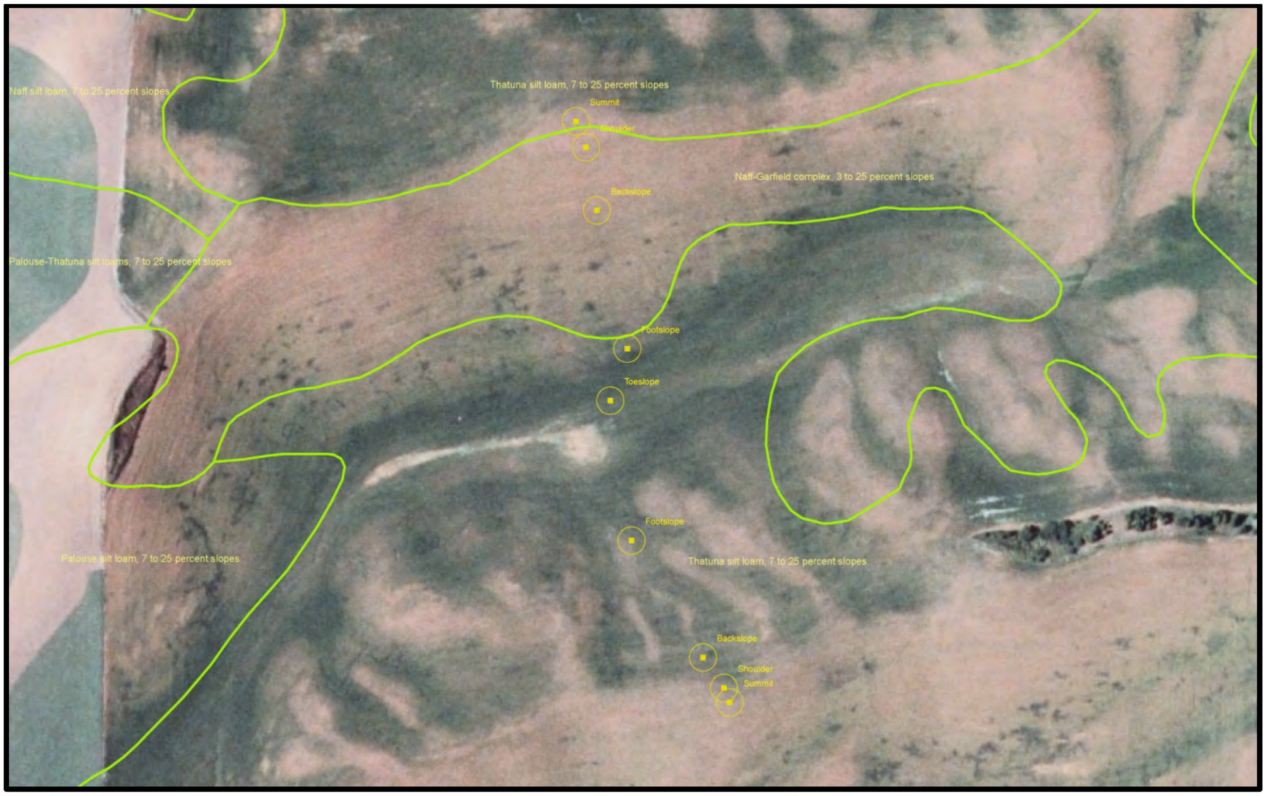
Appendix E-2. Preliminary Sampling Sites (with Profile Position and Mapped Soil Series)

Date	Farmer Name	Sample #	Slope Position	Notes	Mapped OSD
11/1/2011	Landreth	01	toe slope	native reference transect	Dragoon silt loam, 25 to 40% slopes
11/1/2011	Landreth	02	back slope	native reference transect	Dragoon silt loam, 25 to 40% slopes
11/1/2011	Landreth	03	shoulder slope	native reference transect	Dragoon silt loam, 25 to 40% slopes
11/1/2011	Landreth	04	summit (micro)	native reference transect	Dragoon silt loam, 25 to 40% slopes
11/1/2011	Landreth	05	back slope	native reference transect	Dragoon silt loam, 25 to 40% slopes
11/1/2011	Landreth	06	toe slope	native reference transect	Dragoon silt loam, 25 to 40% slopes
11/1/2011	Landreth	07	back slope	native reference transect	Dragoon silt loam, 25 to 40% slopes
11/1/2011	Landreth	08	summit	native reference transect	Dragoon silt loam, 25 to 40% slopes
11/1/2011	Landreth	09	back slope	native reference transect	Dragoon silt loam, 25 to 40% slopes
11/1/2011	Landreth	10	toe slope	native reference transect	Dragoon silt loam, 25 to 40% slopes
11/5/2011	Landreth	11	summit	native reference transect	Dragoon silt loam, 7 to 25% slopes
11/2/2011	Aeschliman	01	summit	35 year no-till transect	Palouse silt loam, 7 to 25% slopes
11/2/2011	Aeschliman	02	shoulder slope	35 year no-till transect	Palouse silt loam, 25 to 40% slopes
11/2/2011	Aeschliman	03	back slope	35 year no-till transect	Palouse silt loam, 25 to 40% slopes
11/2/2011	Aeschliman	04	foot slope	35 year no-till transect	Palouse silt loam, 25 to 40% slopes
11/2/2011	Aeschliman	05	foot slope	35 year no-till transect	Palouse silt loam, 7 to 25% slopes
11/2/2011	Aeschliman	06	toe slope	35 year no-till transect	Palouse silt loam, 7 to 25% slopes
11/3/2011	Druffel	01	summit	15 year no-till transect	Thatuna silt loam, 7 to 25% slopes
11/3/2011	Druffel	02	shoulder slope	15 year no-till transect	Thatuna silt loam, 7 to 25% slopes
11/3/2011	Druffel	03	back slope	15 year no-till transect	Thatuna silt loam, 7 to 25% slopes
11/3/2011	Druffel	04	foot slope	15 year no-till transect	Thatuna silt loam, 7 to 25% slopes
11/3/2011	Druffel	05	toe slope	15 year no-till transect	Thatuna silt loam, 7 to 25% slopes
11/3/2011	Druffel	06	foot slope	15 year no-till transect	Thatuna silt loam, 7 to 25% slopes
11/3/2011	Druffel	07	back slope	15 year no-till transect	Naff-Garfield complex, 3 to 25% slopes
11/3/2011	Druffel	08	shoulder slope	15 year no-till transect	Naff-Garfield complex, 3 to 25% slopes
11/3/2011	Druffel	09	summit	15 year no-till transect	Thatuna silt loam, 7 to 25% slopes
11/4/2011	Thorn	01	back slope	10 year no-till transect	Palouse silt loam, 8 to 25% slopes
11/4/2011	Thorn	02	summit	10 year no-till transect	Athena silt loam, 0 to 8% slopes
11/4/2011	Thorn	03	back slope	10 year no-till transect	Athena silt loam, 8 to 25% slopes
11/5/2011	Landreth	01	foot slope	25 year no-till transect	Reardan silt loam, 7 to 25% slopes
11/5/2011	Landreth	02	foot slope (duplicate)	25 year no-till transect	Reardan silt loam, 7 to 25% slopes
11/5/2011	Landreth	03	shoulder slope	25 year no-till transect	Broadax silt loam, 7 to 25% slopes
11/5/2011	Landreth	04	summit (micro)	25 year no-till transect	Broadax silt loam, 7 to 25% slopes
11/5/2011	Landreth	05	shoulder slope	25 year no-till transect	Broadax silt loam, 7 to 25% slopes
11/5/2011	Landreth	06	back slope	25 year no-till transect	Broadax silt loam, 7 to 25% slopes
11/5/2011	Landreth	07	foot slope	25 year no-till transect	Broadax silt loam, 7 to 25% slopes
11/5/2011	Landreth	08	toe slope	25 year no-till transect	Reardan silt loam, 7 to 25% slopes
11/5/2011	Landreth	09	foot slope	25 year no-till transect	Reardan silt loam, 7 to 25% slopes
11/5/2011	Landreth	10	back slope	25 year no-till transect	Reardan silt loam, 7 to 25% slopes
11/5/2011	Landreth	11	shoulder slope	25 year no-till transect	Reardan silt loam, 7 to 25% slopes
11/5/2011	Landreth	12	summit	25 year no-till transect	Reardan silt loam, 7 to 25% slopes
11/5/2011	Landreth	13	shoulder slope	25 year no-till transect	Reardan silt loam, 7 to 25% slopes
11/5/2011	Landreth	14	shoulder slope (duplicate)	25 year no-till transect	Reardan silt loam, 7 to 25% slopes
11/5/2011	Landreth	15	summit	25 year no-till transect	Dragoon silt loam, 25 to 40% slopes
11/5/2011	Landreth	16	back slope	25 year no-till transect	Reardan silt loam, 7 to 25% slopes

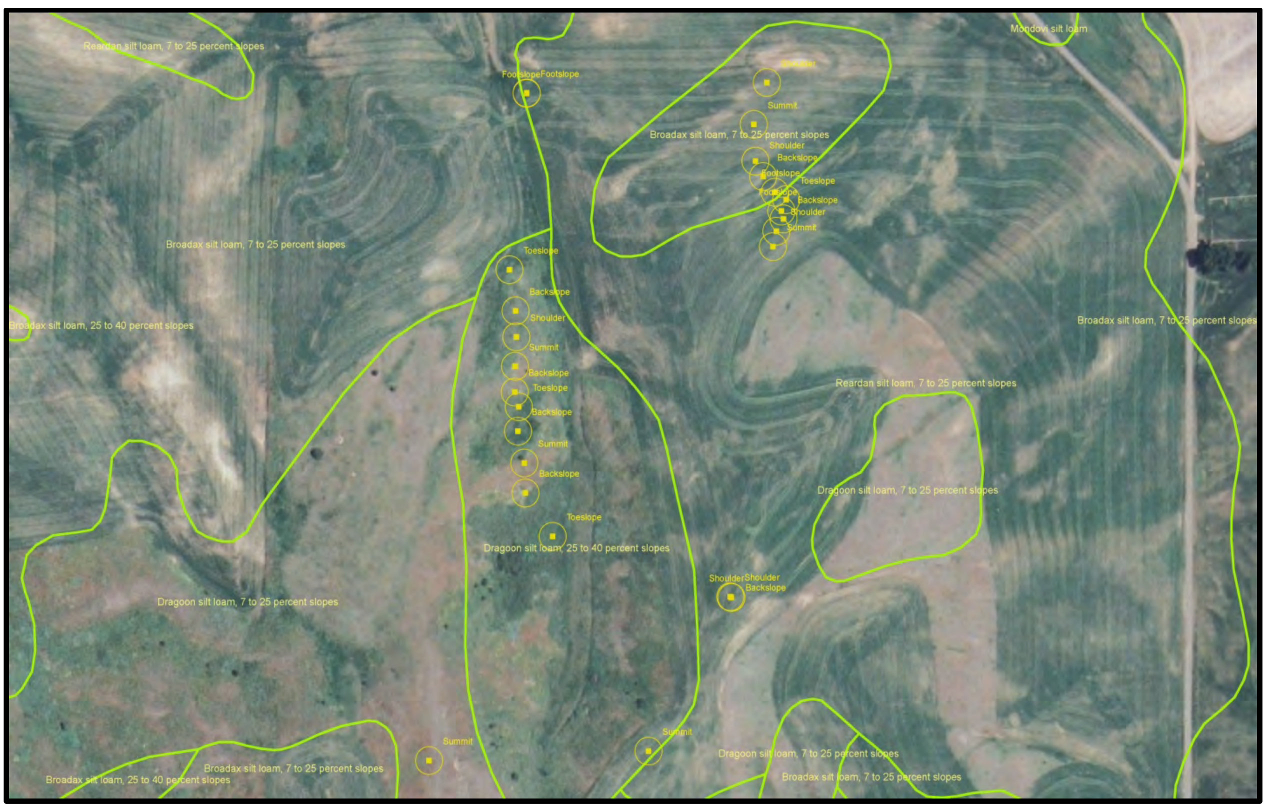
Shepherd's Grain farm in Columbia County, WA (10 year no-till)



Shepherd's Grain farm in Whitman County, WA (35 year no-till)



Shepherd's Grain farm in Whitman County, WA (15 year no-till)



Reference Natural Area (never tilled) and Shepherd's Grain farm in Lincoln County, WA (25 year no-till)

C-AGG
Coalition on Agricultural Greenhouse Gases

C-AGG Meeting Agenda

Wednesday-Thursday, November 2-3, 2011
The Dupont Circle Hotel
1500 New Hampshire Avenue, NW
Washington, DC - USA

Wednesday, November 2, 2011

8:30 am **Breakfast**

9:00 am *Welcome and Introductions*
C-AGG Overview and Background
Debbie Reed, C-AGG Executive Director

Objectives:
- Welcome new and past participants of C-AGG;
- Provide context of C-AGG's past and current activities, goals and objectives, to aid in participant understanding of C-AGG's multi-stakeholder forum and purpose, and to enhance participants' abilities to participate and contribute.

Format:
- Allow participants to introduce themselves (10 minutes);
- Introduce C-AGG staff and governance structure (10 minutes); and
- Describe C-AGG organizational goals and objectives, review past activities, and review meeting agenda, goals and objectives (10 minutes).

9:30 am *Update from USDA on Relevant GHG and Environmental Services Activities*
Bill Hohenstein, Director, USDA Climate Change Program Office

Objectives:
- Gain understanding of USDA's activities to integrate environmental services opportunities, including developing consistent data requirements and user interfaces for producers; and
- Learn about USDA's efforts to develop landowner/land manager tools for estimating environmental services.

Format:
- Presentation from USDA (40 minutes),
- Followed by Q&A and facilitated group discussion (20 minutes).

10:30 am **Coffee Break and Networking Opportunity**

Coalition on Agricultural Greenhouse Gases

11:00 am *The Global Research Alliance on Agricultural Greenhouse Gases*
Steven Shafer, Deputy Administrator
Natural Resources and Sustainable Agricultural Systems
USDA Agricultural Research Service

Objectives:

- To learn about the Global Research Alliance on Agricultural Greenhouse Gases, progress to date, and future plans.
- To learn more about the Alliances' activities under the Croplands Research Group, and including:
  - Quantification of net GHG emissions in cropland management systems, agricultural peatlands and wetlands;
  - standardized research datasets and data management protocols, and harmonized methods and guidelines for possible international collaboration/utilization of experimental sites; and
  - modeling of nitrous oxide (N_2O) emissions and soil organic carbon stocks and changes, and evaluations of models for each.

Format:

- An overview presentation on the Alliance, and some specific efforts of the Croplands Research Group (see 3rd bullet item, below), will be delivered (40 minutes);
- Followed by questions and answers and facilitated group discussion (20 minutes).
- ***NOTE:*** it is highly recommended that participants review the summary document describing the Croplands Research Group Action Plan prior to this discussion. The Action Plan is posted with other background documents for the C-AGG meeting at: http://www.c-agg.org/docs/resources/Global%20Research%20Alliance%20on%20Agricultural%20Greenhouse%20Gases_Croplands%20Research%20Group%20Action%20Plan.pdf

12:00 pm **Lunch and Networking Opportunity**

1:00 pm *Carbon Disclosure Project Report on CDP Agriculture Supply Chain Pilot 2011, and Future Plans*
Betty Cremmins, Supply Chain Project Officer
Carbon Disclosure Project (CDP)

Objectives:

- To learn about CDP's experience testing their Agriculture Supply Chain Pilot with members and members' growers, including recruitment and

participation issues, participants' experiences, data collected, and members' future ambitions for agricultural supplier engagement;
- To consider remaining issues and future actions and how CDP intends to drive action in the sector; and
- To derive and discuss lessons and implications for agricultural producer participation in supply chain initiatives, offset projects, or other activities with a GHG quantification component.

Format:
- A presentation on CDP's Agriculture Supply Chain Pilot 2011, based on the forthcoming report, will be provided (40 minutes);
- Followed by questions and answers and facilitated group discussion (20 minutes).

2:00 pm *National Cattlemen's Beef Association Sustainability Initiative Program*
Tamara McCann Thies, Chief Counsel for Environment & Sustainability
National Cattlemen's Beef Association (NCBA)

Objectives:
- To learn about NCBA's Sustainability Initiative Program

Format:
- A presentation on NCBA's Sustainability Initiative Program, which includes a carbon-footprint analysis, will be provided (45 minutes);
- Followed by questions and answers and facilitated group discussion (15 minutes).

3:00 pm *Presentation and Discussion of C-AGG White Paper (Final Draft):*
The Role of Biogeochemical Process Models for Agricultural Offset Projects: An Approach for Capturing Uncertainty
Bill Salas, Applied GeoSolutions, LLC

Objectives:
- To assess and evaluate the sources of uncertainty from the use of GHG models in agricultural offset projects, and to determine how to capture and account for this uncertainty in the development of offset protocols.

Format:
- A final draft of the white paper, first presented and discussed at the July, 2011 C-AGG meeting, will be presented. The authors will summarize the paper and use a concrete example of how the approach would work with an agricultural GHG mitigation project (30 minutes);
- Followed by facilitated group discussions and feedback to the authors (30 minutes).

4:00 pm **Coffee Break and Networking Opportunity**

4:30 pm *C-AGG Facilitated Discussion:*
Feedback, suggestions, next steps

Objectives:
- To allow more thorough discussion of topics discussed or suggested during the course of the day, whether parked issues, discussions that were not concluded due to time constraints, or to air new thoughts; and
- To allow for dialogue on new topics relevant to the day's discussions, or to suggest topics or activities for future C-AGG meetings.

Format:
- Discussion topics from the day that were parked or not concluded will be revisited; and
- C-AGG participants can suggest relevant issues for discussion by the group.

6:00 pm **Wine and Cheese Reception**

7:30 pm **Dinner on your own**

Thursday, November 3, 2011

8:30 am **Breakfast**

9:00 am *Welcome new participants*
Summary of Wednesday, overview of Thursday's agenda
Debbie Reed, C-AGG Executive Director

Objectives:
- Welcome new participants;
- Provide context for previous day and goals and objectives of current day's agenda, to enhance participants' abilities to participate and contribute to discussions.

Format:
- Allow new participants to introduce themselves (5 minutes); and
- Briefly summarize Wednesday's outcomes, and describe Thursday's agenda, goals and objectives (10 minutes).

9:20 am *Overview of November 4 EPRI Workshop on N_2O Emissions Offsets*
Adam Diamant, Senior Project Manager
Electric Power Research Institute (EPRI)

9:30 am *Agricultural Protocol Development:*
Update from Voluntary Carbon Registries ACR, CAR, and VCS

C-AGG
Coalition on Agricultural Greenhouse Gases

Objectives:

- Gain understanding of agricultural GHG protocol development, approval, and implementation within voluntary GHG registries; and
- Provide opportunity to engage C-AGG participants, CIG GHG project representatives, and voluntary GHG registries on an ongoing basis.

Format:

- Each representative will have 20 minutes to provide an update on the development and approval of agricultural GHG protocols (60 minutes)
- followed by facilitated group discussion (30 minutes).

Presenters:
Carolyn Ching, Senior Program Officer, Verified Carbon Standard (VCS)
Nick Martin, Chief Technical Officer, American Carbon Registry (ACR)
Kathryn Goldman, Senior Policy Manager, Climate Action Reserve (CAR)

11:00 am — ***Presentation and Discussion of C-AGG White Paper:***
Additionality in Agricultural Offset Protocols
Rob Janzen, Vice President, ClimateCHECK

Objectives:

- To understand how the concept of additionality, a key component in the development of agricultural GHG reduction quantification protocols, is crucial to the engagement of the agricultural sector in carbon offset projects;
- To learn about additionality criteria of various GHG registries and initiatives, and applications for agricultural offsets and activities; and
- To discuss innovate approaches to additionality for agricultural offsets, propose criteria for discussion, and describe a case study comparing conventional and proposed innovative additionality approach.

Format:

- A white paper drafted for C-AGG based on previous discussions will be presented (30 minutes); the author will explain the concept of the paper, propose some innovative approaches for additionality, and apply it to concrete examples of agricultural GHG mitigation projects;
- Followed by facilitated group discussions and feedback to the author (30 minutes).

12:00 pm — **Lunch and Networking Opportunity**

1:00 pm — **Moderated Roundtable Discussion:**
USDA Conservation Innovation Grant (CIG) Greenhouse Gas (GHG) Project Representatives

C-AGG
Coalition on Agricultural Greenhouse Gases

Objectives:

- Learn about unique and shared challenges and successes to date during planning phase of the CIG GHG projects, including responses to specific questions posed to project representatives; and
- provide a shareholder forum for grant awardees to share plans, progress, and challenges and seek suggestions and input from C-AGG throughout the planning and implementation phases of the projects.

Format:

- Interactive facilitated panel discussion (75 minutes)

Panelists/CIG GHG Project Representatives:

- *Bringing Greenhouse Gas Benefits to Market: Nutrient Management for Nitrous Oxide Reductions*
  - **Ryan Anderson, Delta Institute, and Eliav Bitan, National Wildlife Federation**
- *Smart Nitrogen Application Program (SNAP) Demonstration Project*
  - **Rob Janzen, ClimateCHECK**
- *Bovine Innovative Greenhouse Gas Solutions (BIGGS)*
  - **Matt Sutton Vermeulen, Unison Resource**
- *Dairy Farm Stewardship Toolkit*
  - **Matt Welch, Innovation Center for U.S. Dairy**
- *Ducks Unlimited Avoided Grassland Conversion Carbon Project*
  - **representative TBD**
- *Agricultural Soil Carbon in the Palouse Region: Developing a Large-scale Agricultural Soil carbon Transaction in the Palouse Region*
  - **David Tepper or Chas Taylor, Applied Ecological Services**
- *Demonstrating Greenhouse Gas Emissions Reductions in California and Midsouth Rice Production*
  - **Belinda Morris, Environmental Defense Fund**
- *Estimating N2O Reductions from Nutrient Management in the Chesapeake Watershed*
  - **Beth McGee, Chesapeake Bay Foundation**

Moderator: TBD

2:30 pm ***Capitol Hill Update: US Farm Policy***
Chris Adamo, Staff Director
US Senate Committee on Agriculture, Nutrition & Forestry

3:30 pm *C-AGG Facilitated Discussion:*
Feedback, suggestions, next steps

Objectives:

- To allow more thorough discussion of topics discussed or suggested during the course of the day, whether parked issues, discussions that were not concluded due to time constraints, or to air new thoughts; and
- to allow for dialogue on new topics relevant to the day's discussions, or to suggest topics or activities for future C-AGG meetings.

Format:

- Discussion topics from the day that were parked or not concluded will be revisited; and
- C-AGG participants can suggest relevant issues for discussion by the group.

4:30 pm *Wrap-up and Conclusions and Input from Participants*
Debbie Reed, C-AGG Executive Director

5:00 pm *Meeting adjourns*

Appendix D – Semi-Annual Report #2

Applied Ecological Services, Inc. (AES)
Semi-Annual Progress Report No. 2: January 1 – June 30th, 2012
USDA-NRCS CIG-GHG Project No. 69-3A75-11-131
August 7, 2012

PROJECT DESCRIPTION / ABSTRACT

Applied Ecological Services, Inc. (AES), in partnership with The Earth Partners, LP (TEP), and a consortium of secondary partners (the AES/TEP Team) seek to develop a large-scale agricultural carbon project in partnership with Shepherd's Grain members and surrounding farmers in the loess hills of the Palouse and Columbia Plateau region. Intensive farming across the region has resulted in the near extinction of the native grasslands, and the exhaustion of the soil and hydrological resources of the region. The introduction and widespread application of sustainable, low-carbon farming practices have the potential to restore the fertility and ensure the longevity of one of the United States' most important breadbaskets. Demonstrating the value to landowners of increased soil carbon stemming from these improved agricultural practices is a critical component in facilitating the large-scale adoption of such practices. To this end, this project seeks to provide a roadmap for developing large-scale, high-quality, and low-cost soil carbon transactions.

Building off literature reviews and preliminary sampling completed in 2009, we propose to further develop and extrapolate these models at a larger, landscape scale across the entire Columbia Plateau eco-region. Utilizing TEP's Soil Carbon Quantification Methodology, we seek to measure, monitor, validate, and monetize carbon credits stemming from low carbon agricultural practices such as no-till, direct seeding, crop rotation, and improved soil management. We believe that this project demonstrates both the importance of large-scale low carbon farming practices to Greenhouse Gas reduction policies and the role of quantitative soil carbon methodologies in creating compliance-grade offset credits. It will also provide a roadmap for aggregating landowners over large areas at low cost. We seek to demonstrate a model for marketing and monetizing the resulting carbon credits. This will be one of the largest land-based carbon projects to date.

We seek to achieve the following outcomes in this project:

- **Demonstrate the model at scale.** Our proposed project is broken into two phases: In Phase 1, we intend to develop a low-carbon agricultural partnership with landowners on 300,000 acres (*to be revised*) of Shepherd's Grain land. In Phase 2, we intend to partner with landowners on over 1,000,000 acres (*to be revised*) across the Palouse and larger Columbia Plateau eco-region. This can be expanded at a much larger scale because the project can build off of the analytic and technical work we will have done (GIS mapping, stratification, soil sampling, model projections, etc.).
- **Demonstrate a low-cost aggregation model**. Assembling landowners over large acreages at a relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. Through our planned work with landowners on 1 million acres, the AES/TEP team will develop, test, and refine a low-cost aggregation model. To this end, the AES/TEP team is building on significant existing experience in aggregating landowners, developing standard partnership structures, and streamlining landowner interactions and engagement.
- **Showcase a successful land-based carbon transaction.** While agricultural carbon credits cannot currently be monetized in the marketplace, this project seeks to ensure that credits derived from this project will be accepted by the CA Air Resources Board (ARB) under AB-32 or other emerging compliance markets, as well as voluntary markets like VCS and ACR. To this end, we have developed a unique partnership of farmers, project developers, carbon investors, scientists, and government.
- **Develop data, maps and templates that will inform policy and support further research.** We will utilize GIS landform and geomorphic modeling and mapping to design, evaluate, and implement a regional, on-the-ground baseline analysis of soil carbon levels across the Palouse and Columbia Plateau eco-region. The resulting data and maps will represent a type of integrated information that is lacking in the region, which will be useful for government agencies, scientists, universities, and other researchers.

FIRST ANNUAL PROGRESS REPORT

1. USDA-NRCS CIG-GHG Project Number and Contract Period

69-3A75-11-131 – August 1, 2011 to July 31, 2014

2. Project Title

Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region

Project Director / Principal Investigator

Steven I. Apfelbaum, Chairman of the Board/Principal Ecologist, Applied Ecological Services, Inc.

3. Date of Report / Period Covered

July 31, 2012 for Report No. 2: January 1 – June 30, 2012

4. Executive Summary

During the first half of 2012, the Project Team focused primarily on the following tasks:

- Task 1 – Business Origination with Shepherd's Grain –The team focused on building relationships with Shepherd's Grain producers, developing the enrollment agreement, implementing the learning journey and collecting detailed field histories from producers.
- Task 2 – Mapping, Screening and Stratification of the Palouse – The GIS analysts completed the mapping, screening, and stratification process. Additionally, they allocated sample points in a stratified random fashion and created maps and field data for the sampling teams.
- Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region – The soil sampling teams collected over 700 cores this spring to drive an initial statistical model that relates land history, slope, aspect, and precipitation to soil carbon. Two crews, composed of a crew leader and a crew member each, collected the cores with a hydraulic Giddings probe from conventional, no-till, CRP and reference area fields. Crews collected GPS and hardcopy data in the field.
- Task 4 – Analysis and Baseline Development – Soil cores were labeled in the field, temporarily stored and then shipped via freight to University of Missouri Soils Lab for analysis (expected August, 2012).
- Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers – No activities were completed under this task.
- Task 6 – Aggregration and Farmer Engagement beyond Shepherd's Grain and Surrounding Members – Relationship building described in Task 1 above led to some farmer engagement beyond Shepherd's Grain. This will be a major focus of the next reporting period.
- Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members – The Soil Carbon methodology went through the third party validation process and was expected to be complete by the end of July 2012.
- Task 8 – Reporting and Knowledge Dissemination – Regular communication with NRCS administrative and technical contacts was ongoing throughout the reporting period.

5. Proposed Changes requiring Prior Approval

In accordance with the Prior Approval Requirements outlined in Section IV of CIG Contract #69-3A75-11-131, the project team proposed the following modifications to the project scope.

- Proposed Modification #1 – The team is providing an update to USDA-NRCS on the enrollment targets under the grant for reasons described in the Justification section below.
  - During Phase One, we proposed target enrollment acreage of 300,000 acres. During Phase Two, we proposed target enrollment acreage of 1,000,000 acres in the grant.
  - We will continue to work towards the original targets, but it is likely that the originals are unattainable. Future reports will quantify planned versus actual.
- Justification for Modification #1 – The original acreage and producer targets were provided in the grant in Section B. Project Objectives and Section D. Location and Size of Project Area. These were established as targets for the project during the proposal stage, however, it is likely that these targets may be unattainable for a few reasons. These include:
  - Acreage estimates provided for Shepherd's Grain producers, our core aggregate group, included a percentage of land that will not be included in the program due to complex ownership structures and landlord/tenant relationships (more detail in Task 1 below).
  - Several of the core aggregate group members are not interested in participating in a carbon credit offset program for reasons of personal values.
  - Scaling up beyond the Shepherd's Grain producers is more difficult, time consuming and expensive than originally thought. Without a robust carbon offset credit market in place (in California or elsewhere), producers are more cautious about signing up land in a program that does not have clear, immediate economic benefit.
  - With the complexities of the landlord/tenant relationships across the Palouse and the aging population of farmers, many are cautious about tying up their land with long-term commitments.

  The larger scope of the project has not changed, though we expect the overall scale of the project will be smaller than originally proposed. We are committed to developing a scientifically robust and cost-effective carbon program with a smaller aggregate group in the Palouse. As described in Task 1 below, we will continue to work towards the targets we've set over the next 12-18 months.

6. Accomplishments

Task 1 – Business Origination with Shepherd's Grain

Applied Ecological Services and The Earth Partners, LP have had success in originating this project over its first year. A successful set of meetings in November 2011 was followed up with ongoing communications and planning for a late January learning journey where the AES/TEP project team would meet one on one with as many Shepherd's Grain farmers as possible during a solid week of meetings.

I. Learning Journey

During this learning journey, the team had a series of excellent meetings with producers in Washington and Idaho. The team had a chance to build relationships, which is the most important thing when developing a long-term partnership. As such, the team approached meetings with producers as "learning journeys" rather than as a pitch presentation — which was effective in understanding producer concerns and cementing support for the program. Some of the key learnings included:

- Current agricultural practices, economics, risks and challenges
- Structure and of the Shepherd's Grain organization and marketing function
- Climate, soil, and topographical variation among producers in the Palouse
- Cultural practices, land ethic, and views on sustainability and climate change
- Participation in CSP, CRP, and other USDA programs
- Existing university and government extension activities and initiatives in the region

- Land tenure and landlord/tenant dynamics, and the implications on the contract structure

Prior to and during this learning journey, the team received completed data release forms that allowed AES to collect geospatial and related data directly from USDA FSA for the stratification of the landscape and preparation for soil sampling. This data release also stated the intention of the producer to allow soil sampling on their fields during the 2012 soil sampling season. In total, geospatial data was received for almost 145,000 acres, which included almost all of the producers in the Shepherd's Grain group.

Table 1. Total Acreage of Shepherd's Grain Producers who signed data release, grouped by state and county

State / County Name	Acres	% of total
16 Idaho	**18,061**	**13%**
057 Latah County	9,403	
069 Nez Perce County	8,658	
41 Oregon	**5,855**	**4%**
063 Wallowa County	2,366	
065 Wasco County	3,488	
53 Washington	**120,264**	**83%**
001 Adams County	3,291	
013 Columbia County	4,499	
039 Klickitat County	10,031	
043 Lincoln County	47,543	
063 Spokane County	20,898	
071 Walla Walla County	516	
075 Whitman County	33,486	
Grand Total	**144,180**	**100%**

II. Producer Enrollment Agreement

The team developed a first-of-its kind contractual structure for enrolling producers in this land-based carbon project. There were very few problems around the economic distribution of any future carbon credits — which all parties found fair. Even if carbon markets did not develop, the producers remained interested in the useful scientific data and analysis that would come out of the implementation of the methodology. Producers were also eager to be the innovators and first-movers that could help define and shape emerging policy around land-based carbon markets and their ability to reward producers for implementing sustainable agricultural practices in a scientifically rigorous way.

However, this process of developing an acceptable contract to all parties was more challenging than expected due to the following complexities:

- **Needing a contract before knowing the terms of the carbon deal.** It became clear that producers needed to understand the potential carbon accruals under different land use histories and agricultural practices before signing any binding contract related to this project. As a result, we developed a three-phase program: first, a data release to allow us to collect GIS data and associated information from FSA and do soil sampling on the producer's land; second, an enrollment agreement, which commits the producer to the program, lays out the economic terms, and lays out the roles and responsibilities of each party; and third, the Project Design Document (PDD), which will be developed after the methodology has been implemented, which requires completion of the mapping and stratification, on–the-ground soil sampling, laboratory analysis of soil cores, statistical analysis, baseline development, and development of a predictive model. Once the PDD has been developed, producers that signed the enrollment contract would understand the potential carbon accruals under their land use histories and agricultural practices. They would review the PDD and decide whether or not to commit to the agricultural practices required for a carbon project, which also would require the sign-off of landlords, where applicable (described in the next section).

- **Landowner/tenant relationships.** At the beginning of the project, the AES/TEP team did not fully understand the complexities of the landlord/tenant relationship in the region. During the learning journey meetings and discussion with individual producers in January, it became clear that almost every producer was renting land from one or more landlords, in addition to farming land they own outright or with several family members. Very few producers farm only what they own. The terms of the landlord/tenant relationships varied by producer. Some were handshake deals, some were simple rental payments, and some were crop share arrangements. The duration of each of the lease agreements vary as well. This created complexity in the development of the enrollment agreement ("contract") because it was not clear when the landowner versus the producer had the authority to sign. As a result, we revised the contract several times, coming to the conclusion that we should structure it such that only the producer had to sign (and not each of the respective landlords). As a result, this contract could not bind the landowner to any obligations, and could not run with the land. Rather, it laid out the structure of the program, the economic terms of a potential carbon deal, exclusivity principles, and the responsibilities of the producer and the carbon developer. The producer has a responsibility under the contract to inform the landowner of the program, and use their best effort to get the landowner to sign off on the binding PDD, which would run with the land and involve commitment to certain agricultural practices.

Each set of comments and proposed amendments to the contract from the producers, the lawyers, the investors, and the carbon development team required an additional round of discussion and feedback. This was a long but important process that was necessary to develop a strong contract structure which all parties were committed to and comfortable with. Since the contract was finalized in spring 2012, the team has been successful in getting producers to sign the enrollment contract described. As of June 30, 2012, we have received signed enrollment contracts with producers representing almost 70,000 acres (see Table 2 below).

Table 2. Shepherd's Grain Producers who have signed Enrollment Agreement (as of June 30, 2012)

Operator Name	**Acres****	**Signed**	**Acreage**
Cargrain Farms Inc	1,364	YES	1,364
Lazy YJ Farms JV	2,422	YES	2,422
Spokane Hutterian Brothers	9,325	YES	9,325
Mondovi Corner Farm Inc	2,446	YES	2,446
Nordic Hills Farm Inc	2,551		
Northface Farms	1,117	YES	1,117
Hill View Farms JV	4,765	YES	4,765
Steve Camp	2,880		
Diamond-S Farms Inc	1,523	YES	1,523
Wolf Corporate Farms	1,536	YES	1,523
JenCrops Inc	4,661	YES	4,661
Kunz Farms JV	8,911		
Kurt Blume	1,714	YES	1,714
Thorn Inc	4,499		
DOC-Correctional Industries WA State	516	YES	516
Emerson Dell Farms	3,488		
Bar Star Inc	1,858		
RattleSnake Ranches	2,266	YES	2,266
Steve Matsen	10,031		
Tim Melville	2,366	YES	2,366
Nollmeyer Farms JV	6,442	YES	6,442

Odberg Farms Inc	3,833	YES	3,833
Mark Richter	4,381		
Timm-Rush Inc	2,374	YES	2,374
Sheffels Co	9,120	YES	9,120
West Hills JV	5,110		
Read Smith	8,345		
NW Farms Inc	950	YES	950
Lester Wolf Farms	2,429	YES	2,429
Russ Zenner	3,272		
Wheathills Ranch Inc	1,166		
Gary Esser Farms	1,466		
Greg Lucht (Coulee Hite Enterprises, Inc.)	2,309	YES	2,309
Huntley Family JV	4,887		
Dewald Farms	6,385		
Swannack Enterprises Inc	3,073	YES	3,073
Z&Z Farms Inc	3,423		
R&RFarms Inc	2,093		
Butte Boys LLC	165		
Donald Hyslop	650	YES	650
Loren Ensor	2,067	YES	2,067
Grand Total	**144,180**	**Signed**	**69,255**

III. Challenges and Proposed Changes to Acreage Targets

During the enrollment process, it became clear that there was a misrepresentation of the total acreage available for aggregation amongst the Shepherd's Grain producers, which was informally reported as 300,000 acres in the CIG grant application:

Figure 1: Acreage Table from CIG Grant Application

City	State	Estimated Acres	City	State	Estimated Acres
Colfax	WA	4,500	Bickleton	WA	2,500
Genesee	ID	2,000	Enterprise	OR	N/A
The Dalles	OR	2,500	Enterprise	OR	3,000
Lacrosse	WA	2,500	Joseph	OR	N/A
Reardan	WA	N/A	Reardan	WA	6,000
Colfax	WA	3,000	Genesee	ID	3,000
Colton	WA	4,500	Endicott	WA	6,000
Reardan	WA	N/A	Harrington	WA	5,000
Reardan	WA	4,200	Colton	WA	2,000
Reardan	WA	10,000	Wilbur	WA	7,000
Genesee	ID	2,500	Sprague	WA	5,000
Genesee	ID	3,000	Spokane	WA	7,000
Davenport	WA	7,000	Dayton	WA	5,000
Davenport	WA	8,000	Davenport	WA	N/A
Harrington	WA	N/A	Uniontown	WA	3,000
Reardan	WA	4,000	Genesee	ID	2,500
Pullman	WA	10-12,000	Reardan	WA	4,500

These turned out to be anecdotal estimates, as the actual acreage where the team acquired geospatial data was about 150,000 acres, or half of what was projected in the grant. There may be a few reasons for this: 1) acreages were estimated for grant purposes; 2) producers chose not to include acreage of landlords that were not or wouldn't be interested in the program; 3) some producers were not interested in the participating themselves; and 4) some field data may not have been acquired through the FSA data release process.

In addition, the actual amount of land in wheat production (which would be included in the PDD and subsequent carbon project) is only about 2/3 of the total acreage owned or rented by each of the producers. The remaining acreage is composed of CRP, pasture, other cropland, etc—some of which may go back into crop production over time. So in total, there is about 100,000 acres of cropland among the Shepherd's Grain producers.

As a result of these on-the-ground learnings over the last reporting period, the team is notifying USDA-NRCS that the original enrollment targets set forth in the grant may be unattainable. During Phase One, we will continue to enroll as close to the 300,000 acres as possible. During Phase two, we will engage producers beyond Shepherd's Grain, and seek to scale up the project to a much larger project. Future reports will quantify planned versus actuals.

We anticipate that this scaling-up process will be aided by the first phase of the sampling work, a validated methodology and establishment of carbon accrual projections that will be shared with the producers in the form of a PDD. In addition, the scale up will be supported if the team is able to develop a voluntary carbon deal in which producers receive a share of the revenue, as described under Task 7.

Despite the challenge in the achieving the original acreage targets, this program will still be one of the largest, if not the largest, land-based carbon projects with private producers in the world.

Task 2 – Mapping, Screening and Stratification of the Palouse

I. Base Mapping

Since January 2012, data gathering and base mapping expanded both in geographic scope and type of content in order to meet the needs of soil sampling throughout the Columbia Plateau. USGS 10m DEMs were obtained for the entire region and mosaiced together. Derivative rasters from these DEMS included slope, aspect and shaded relief to be used for screening, stratification and field survey maps. Contours with 20 foot intervals were generated for 26 counties where field survey maps would be needed. Additional SSURGO soils data were obtained and generalized for a total of 29 counties. 2011 NAIP aerial photography was obtained for 25 counties where soil sampling would occur.

II. Screening

The screening process eliminated certain areas from consideration for soil sampling using the factors of 1) access permission and field land use, 2) soils, and 3) terrain. Using GIS, the majority of 2012 soil sample locations were allocated randomly before sampling began within the areas known to be accessible and appropriate for sampling. The following describes the 4 screening factors in greater detail:

<u>Screening Factor 1 – Access Permission and Field Land Use</u>

GIS polygon 'common land unit' data from the USDA Farm Services Agency (FSA) was obtained with permission from participating operators and used to focus initial plot allocation on fields under no till / direct seed practices. Field identification attributes (County, Farm, Tract, Field #, and FSA classification) were submitted to each operator in spreadsheet format for validation. Within the spreadsheet, operators provided corrections and/or detailed descriptions of farming practices, including the year no till practices began for each field. Information from the operators was standardized and added to the field use polygons. The screening process classified each field into one of the following groups relevant to sampling:

NOTILL CROPLAND – continuous no till cultivation since the reported 'year direct seed began' with no indication that anything other than conventional tillage had been used for a substantial time before that year. These are INCLUDED in the Tillage History strata grouped by years in direct seed (from 2012). [93,906 acres]

NOTILL-0 CROPLAND – no till to begin in 2012 with previous conventional. These are INCLUDED in the Tillage History strata with the value CONVENTIONAL. [789 acres]

CRP CROPLAND – under CRP contract. The number of years in CRP was requested but only a small number of operators provided this information. These were EXCLUDED in the initial stratification due to their very mixed and often unknown history. However, sample plots were allocated separately as part of the study. [11,242 acres]

GRASS CROPLAND – non-CRP areas that are not being cultivated. These were EXCLUDED from the Tillage History strata and all sampling. [3,009 acres]

OTHER CROPLAND – these are fields that have 'non-standard' or mixed tillage histories including irrigated cropland, unknown number of years in direct seed or rotational cultivation between direct seed and some cultivation (e.g. fallow maintained with tillage, every 5th year in potatoes, etc.). These were EXCLUDED from the Tillage History strata but some samples were taken in irrigated fields. [8,225 acres]

REFERENCE – this includes an area reported by an operator as never having been under cultivation. These were EXCLUDED from the automated sample allocation because of very low acreage, but these and other reference areas are considered part of the Tillage History continuum for modeling purposes. [60 acres]

Approximately 4,000 separate fields were processed this way. A quick visual comparison was conducted between the final classification and the 2011 NAIP (or BING Maps) photography to look for obvious errors. About 1 dozen changes were made based on the photos, mostly from no till to grassland for small fields overlooked by the operators.

After sampling began, additional boundary data for reference natural areas was obtained from public agencies and private conservation organizations in Oregon, Washington and Idaho. [31,000+ acres] Once this data was processed and the appropriate permits were obtained from the agencies, the field crews manually selected sample locations in these areas. Crews also networked with local operators to find areas of conventional tillage practices for additional sampling.

Screening Factor 2 – Soils

The Semi-annual Report (January 2012) describes the generalization of soil map units by parent material, surface texture and soil series. The initial analysis focused on the most uniform and easiest to sample soils; those largely from loess parent material with silt-loam surface textures. As it turns out, very few of the accessible no till fields were screened out because of soils. Of the approximately 107,000 acres of 'cropland" fields available for sampling 93 percent were generally silt-loams formed from loess. It was decided to add an additional 4,700 acres of alluvial silt-loams to the sampling domain for a total of 104,322 or 97 percent. The 3 percent screened out were largely rocky complexes, or from colluvial or outwash parent materials. In the future, this factor could probably be eliminated altogether. Soils were not used to screen out areas when pre-allocating sample locations to CRP croplands, even though a much lower percentage of those areas met the original criteria. It was thought that to do so would unnecessarily restrict the opportunity for sampling. The better loess/silt-loam soils were given a priority for crew-allocated samples in natural or reference areas, but were not restricted to them.

Screening Factor 3 – Topography

The only use of topography for screening was to remove areas of greater than 25 percent slope from pre-allocation of samples in the no till and CRP fields. This was done to ensure safe operation of the soil sampling equipment. Sampling in reference areas used hand-carried tools so steep slopes were not necessarily a limiting factor for these crew-allocated plots.

III. Stratification For Sample Plot Allocation

The initial steps at stratification cited in the Semi-annual Report (January 2012) were completed using four discrete variables that would ensure an adequate distribution of samples in the initial 2012 sampling effort. While these may only generally harness the expected variation in soil carbon, it was necessary to use highly simplified categories considering the complexity of the terrain, the large area under consideration and the requirements for carbon modeling*. The four variables include 1) Slope Position (2 categories), 2) Aspect (2 categories), 3) Precipitation Zone (5 categories) and 4) Tillage History (7 categories) for a total of 2 x 2 x 5 x 7 = 140 unique combinations or strata. Each of these is described below.

[*Note: See Section IV for a discussion on sampling requirements for modeling that is different from the initial TEP protocol.]

Stratification Factor 1 – Topographic Slope Position

The Jenness topographic model described in the January report was used to classify two categories of Upper Slope and Lower Slope.

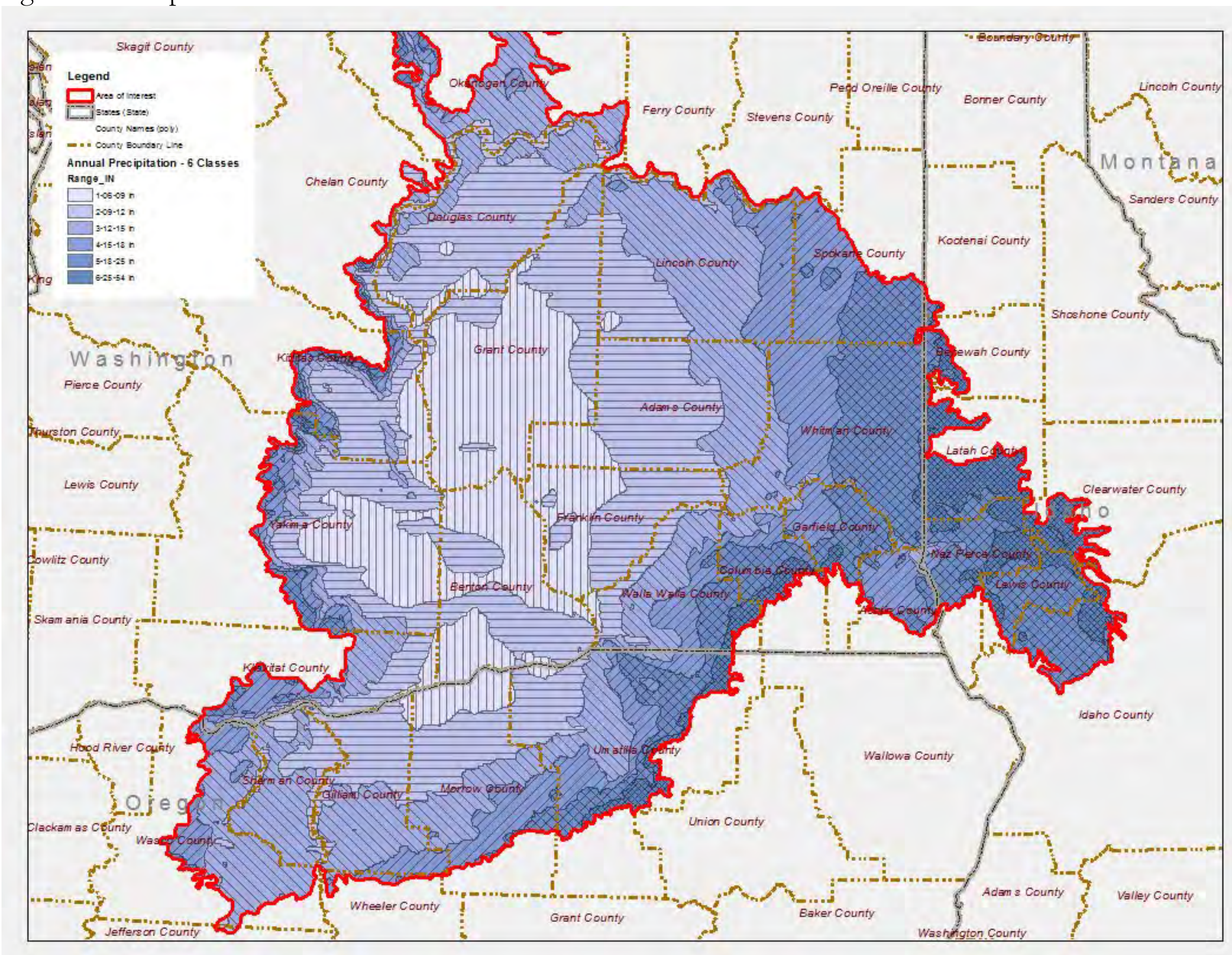
Stratification Factor 2 – Topographic Aspect

The initial aspect categories described in the January report were used in the final stratification. They are Southwest, between 135 and 315 degrees azimuth, and Northeast, between 315 and 135 degrees azimuth. A very small amount of the area was modeled by the GIS as flat and was almost always coincident with the Lower Slope topographic position. Because there was not enough of this area to create a distinct category for modeling, these were arbitrarily assigned an aspect of Northeast to keep them in the sampling domain.

Stratification Factor 3 – Precipitation Zone

This is a new variable not discussed in the January report. Average Annual Precipitation data based on the PRISM model developed by Oregon State University was used to develop precipitation zones as recommended by Steve Campbell, the project Technical Contact for NRCS. According to the PRISM data, the entire Columbia Plateau ranges from 6 inches per year in the central lower elevations to over 28 inches in the highest mountains. The PRISM model utilizes elevation models along with point measurements of precipitation to interpolate values to each cell. The PRISM data, as obtained directly from Oregon State University, is a continuous raster with a cell size of 90 meters and values modeled to many decimals. These were re-classed into 6 categories recommended by Steve Campbell as follows: Less than 9 in, 9-12 in, 12-15 in, 15-18 in, 18-25 in and 25+ in. The project had accessible sampling area in the 5 highest categories which were used for the final stratification. The boundaries of these categories were smoothed a bit by converting to polygon with minor smoothing and then re-rasterizing at 10m cell size to match the other raster data used in the stratification. The final strata are shown below in Figure 2.

Figure 2. Precipitation Zones from PRISM data.



Stratification Factor 4 – Tillage History

This is new since the January report and is the primary independent variable of interest to the business side of this project. Foundational to the modeling effort is the expected continuum of the dependent variable, soil carbon, from a low value for conventional tillage, through increasing values for length of time in direct seed, to reference or natural areas with the highest values. The operator-reported history data provided areas that ranged from 0 years in direct seed (considered conventional for this year's sampling) to over 30 years, with the vast majority between 6 and 20 years. Based on earlier interviews, it was decided that for plot allocation the histories would be grouped as follows: 0 Years/Conventional (789 ac), 1-5 Years Direct Seed (17,175 ac), 6-12 Years Direct Seed (36,173 ac), 13-20 Years Direct Seed (38,435 ac), 21+ Years Direct Seed (2,122 ac), Natural/Reference Area (60 ac known). While less is known about areas in CRP (11,242 ac) and with expected higher variability, this area could be considered another category in this strata and was sampled as such in 2012.

IV. Sample Plot Allocation For Soil Carbon Modeling

After discussions with the project statistician, Dr. Kevin Little of Informing Ecological Design, it was determined that the purpose of predictive model building for this project warranted a different sampling approach than the stratified random sampling proposed in the TEP methodology. The stratified random sampling approach, which allocates samples proportional to the area of various "strata" that have lower within-strata variability, is more appropriate for estimating the total amount of something within the area of interest. Plot allocation for predictive model building allocates samples in equal number across all factor levels or strata combinations. Including CRP, which is not necessarily part of a continuum, these make up the 140 factor combinations described in Section II.

Do to various factors, it was decided to conduct only half of the total sampling planned for the project in 2012. A target number of 5 samples per factor combination was established, yielding a total sampling target of 140 x 5 = 700 samples. An important issue for this type of sampling is having enough sampling area to reasonably capture the variation within the area to which the prediction will be applied. Related to this is keeping the samples separated enough to minimize spatial autocorrelation and not concentrating the disruptive effects of sampling on a single field or operatorship. As shown in Table 3, these factors were significantly limiting in the pre-survey sample allocation for strata combinations in the driest and wettest precipitation zones and at both ends of the cultivation history continuum. Only 428 of the 700 desired samples were pre-allocated using GIS. The field crews were responsible for determining sample locations in the correct strata combination for unallocated samples and for any plots that needed to be moved because of operator concerns, access problems or productivity issues. To facilitate this, the crews were provided general maps and georeferenced image maps of the strata combinations that could be loaded into the GPS receivers for precision locating in the field. For conventional tillage fields that were totally discovered by the field crews, they had the capability to create their own image maps for local areas from GIS data provided on a laptop. An example of one of these maps is shown in Figure 4. Crews were also given a GPS file of all pre-allocated plots for navigation to the sampling sites. Figure 5 shows an example of plot location photo maps with FSA field numbers and tillage histories that can be used for final validation by operators.

Table 3. Sample Locations Pre-Allocated Using GIS by Strata Combinations [Target of 5 per cell]

			Direct Seed History							
			2012 or None	2007-2011	2000-2006	1992-1999	1991 or earlier			
Precip	Slope		Conventional	1-5 Yrs	6-12 Yrs	13-20 Yrs	21 + Yrs	CRP	REFERENCE	
Zone	Position	Aspect	H1	H2	H3	H4	H5	H6	H9	
P2	UP	SW			5	1		5		
P2	UP	NE			5	1		5		
P2	LO	SW			5	1		5		
P2	LO	NE			5	1		5		
P3	UP	SW	1	5	5	5	1	5		
P3	UP	NE	1	5	5	5	1	5		
P3	LO	SW	1	5	5	5	5	5		
P3	LO	NE	1	5	5	5	5	5		
P4	UP	SW	2	5	5	5	5	5		
P4	UP	NE	2	5	5	5	5	5		
P4	LO	SW	2	5	5	5	5	5		
P4	LO	NE	2	5	5	5	5	5		
P5	UP	SW		5	5	5	5	5		
P5	UP	NE		5	5	5	5	5		
P5	LO	SW		5	5	5	5	5		
P5	LO	NE		5	5	5	5	5		
P6	UP	SW		5	5	5		5		
P6	UP	NE		5	5	5		5		
P6	LO	SW		5	5	5		5		
P6	LO	NE		5	5	5		5		Totals
	Pre-Allocated Plots		12	80	100	84	52	100	0	428
	Target # of Plots		100	100	100	100	100	100	100	0
Allocation Needed By Field Crew			88	20	0	16	48	0	100	272
										700

Figure 4. Example of Sample Location Map Provided To Crews

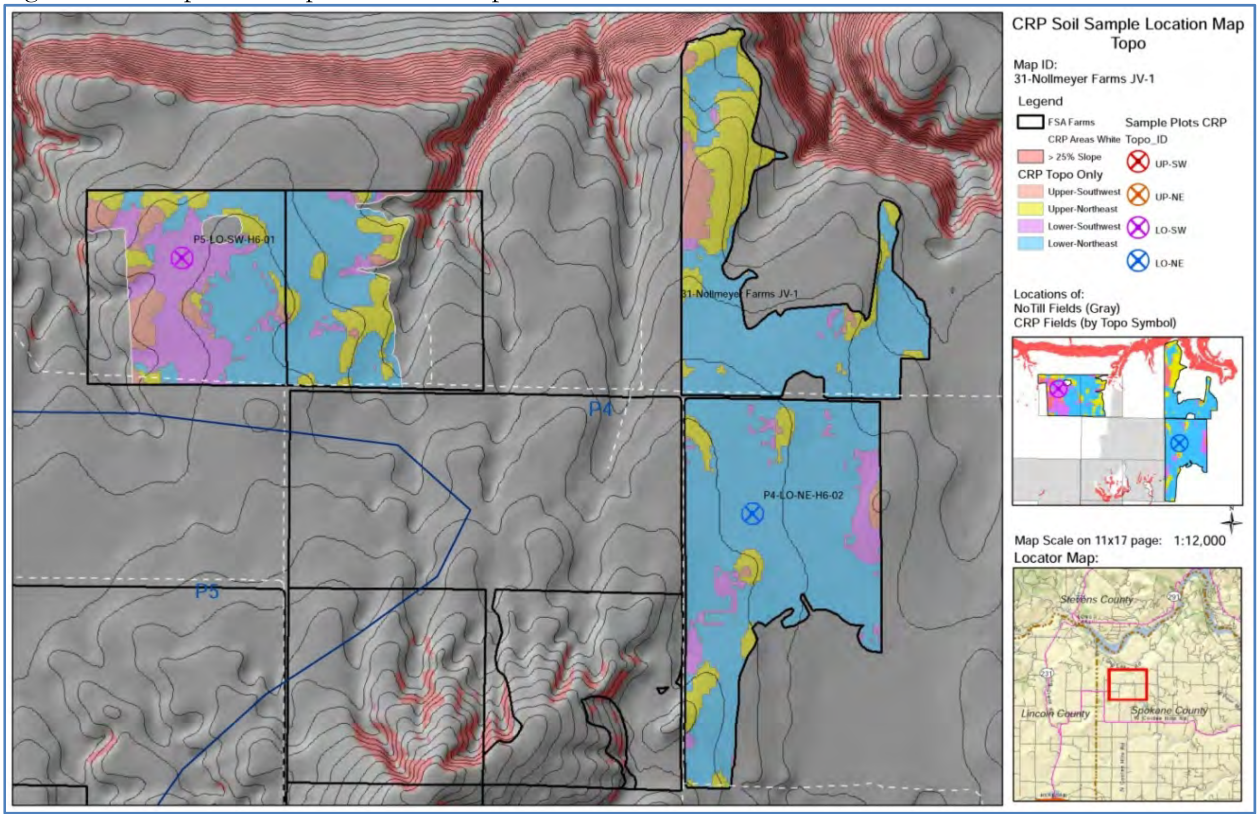
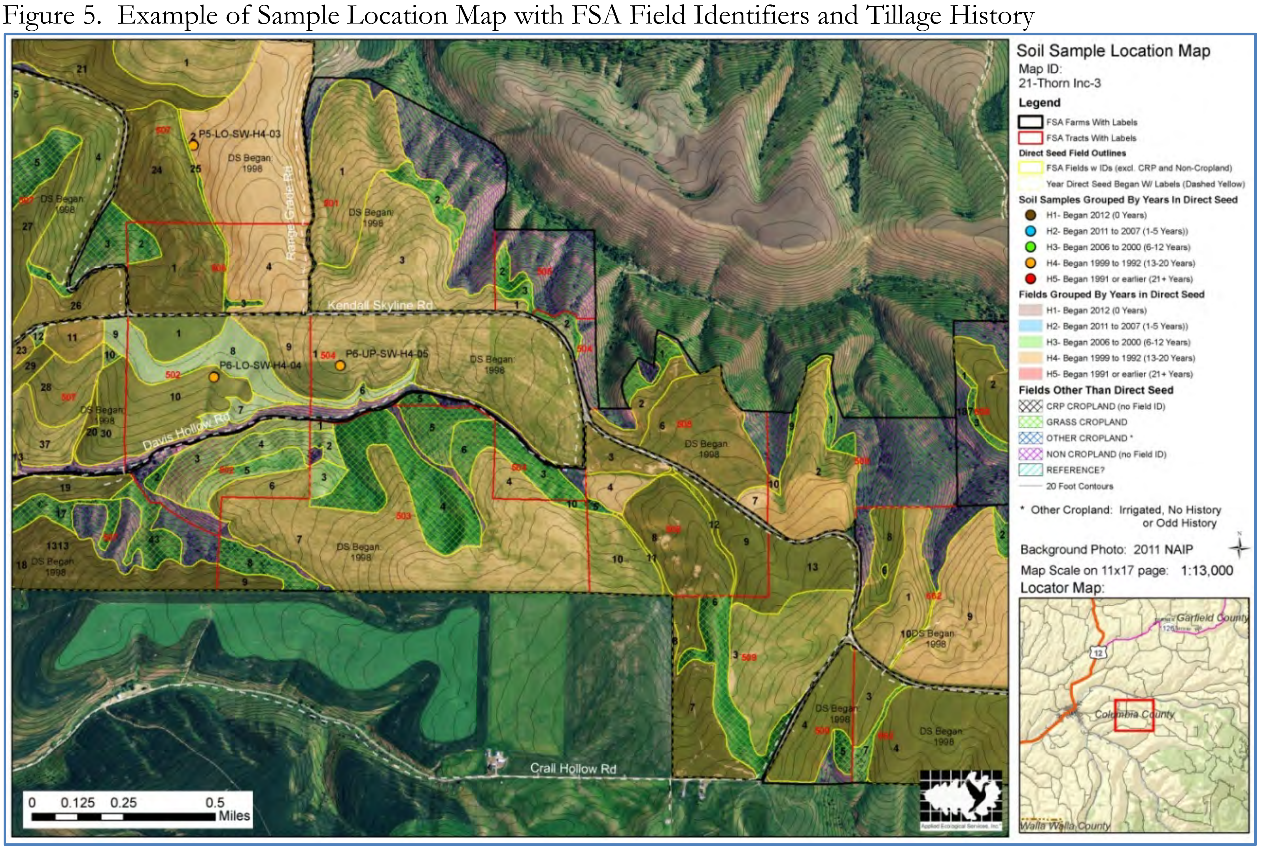


Figure 5. Example of Sample Location Map with FSA Field Identifiers and Tillage History



Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region

Due to the reduction in total acreage available and enrolled for Phase One of the program, as described in Task 1 above, the project team adapted the field portion of the project accordingly. Based on the acreage available for sampling in Phase One, the team chose to split the sampling season between 2012 and 2013. Assuming 1,500 soil cores will be collected for the entire project, the revised goal for 2012 was 700 soil cores from a mix of conventional tillage, no till, CRP, Reference Natural Areas and miscellaneous sites. With the 45 samples collected during the pre-sampling trip in November 2011, that brought the first year total to ~750 samples.

I. Soil Sampling Field Season – Preparation

Much of the preparation for the field season began during winter 2012 and included completion of the stratification process and allocation of samples across the available producer fields, as described in Task 2 above. Extensive planning to ensure all logistics were in place to ensure a safe and successful field season was proceeding on a parallel track. Logistics included securing and preparing field sampling equipment, purchasing supplies and safety equipment, hiring and training crew members, securing permission to fields with standing crops, and so on. Due to a number of factors, the stratification and the field season preparation prevented the team from getting soil sampling crews into the field until early May 7, a full month to six weeks later than anticipated. This created some challenges for field access, as described below in the "Finalizing Access and Permissions" section.

In early spring, AES hired two soil sampling crew leaders and two soil sampling crew members to comprise the two soil sampling crews. One crew member was hired from the AES Contracting crew, while the other was a local from Genesee, ID and grew up on a wheat farm in the area. One crew leader was hired from Iowa, while the other was a local from Moscow, ID who will be starting a master's program in soil science in the fall. Each team was comprised of one local and one Midwesterner, ensuring familiarity with local roads and customs. The crews were provided with accommodation in Genesee, ID and Reardan, WA to serve as a home base and office during the two-month soil sampling season.

Both crews were provided with nearly identical sampling equipment, allowing them to work independently in the region. Where feasible, they tried to stay in fairly close proximity and work on adjacent farms and fields for safety reasons. They started and ended their day at the home base / office and carefully planned their week to ensure both efficiency and safe operation was achieved.

Each crew was provided with a truck, trailer and John Deere Gator with a Giddings hydraulic soil probe. One crew had an older (Jan 2000) Giddings hydraulic soil sampler with a 54" mast and the standard manual anchoring system, while the second crew had a newer (Oct 2011) Giddings hydraulic soil sampler with the standard 48" mast and a newly installed hydraulic (automatic) anchoring system. In addition, each crew had a Trimble GeoXT GPS unit to collect sub-meter accuracy GPS data for each soil sample location. This allows future soil sampling crews to relocate the precise location of the soil sample for verification of soil carbon accrual levels over time, as described in the TEP Soil Carbon Methodology. Each crew also had a Canon point and shoot digital camera for use in the field to photograph the soil core, the cardinal directions at each sample point and anything else of interest.

Equipment and Field Safety

At AES, workplace safety is a critical component of the culture for both office and field based crews and at the forefront of planning for all projects. A detailed safety plan and job hazard analysis assessment was developed for the project to address standard safety procedures and protocols, and numerous detailed safety measures to address potential risks associated with the fieldwork in the Palouse (equipment, steep slopes, heat, biological hazards, etc). The project safety plan was provided to each crew member ahead of the orientation and training week.

During the week of May 7th and 14th, the crews received extensive training from AES staff on the equipment and field sampling protocols. Equipment training was provided by Jeremy Bennett, AES Grounds and Equipment Manager, and included specific training on the Gator, truck, and trailer. Giddings operation and safety training was provided by Ry Thompson and Tom Hunt. After the training, each crew member was required to complete a test to ensure they were fully competent with the equipment, driving protocols, trailer operation, and so on.

Additional training was completed by Tom Hunt and Ry Thompson and focused on the following topics:

- reading the landscape – geomorphology, slope aspect, concavity/convexity;
- navigating with topographic maps and Trimble GPS units to a sample point;
- collecting detailed field data with GPS, field data sheet and camera;
- understanding soils of the region – soil structure, texture, color, organic matter/soil carbon, etc; and
- using ArcGIS and Pathfinder office to upload GPS points, create image layers for use in field, etc.

We are proud to report that no reportable injuries were recorded and no work days were lost due to injury during the two plus months of field work in the region. This is a testament to the importance of having a program and plan in place, training the employees on the plan and instilling in them the importance of safety to the AES way.

II. Soil Sampling Field Season – Sampling in Shepherd's Grain No till and CRP Fields

Once soil sample locations were allocated across the strata, as described in Task 2 above, the team provided maps to every Shepherd's Grain producer by email and followed up with a phone call to ensure there were no concerns with the sample locations. In the spring 2012 producer group, many had viewed the maps of their land with the designated sample locations that had been emailed previously. Many of the producers who had already looked at the maps permitted the crews to go ahead and sample without further communication. The vast majority of the points were acceptable to the Shepherd's Grain producers and the crews were ok to access fields after the phone call. Several producers preferred to meet in person to review the maps and provide additional information on field access and field history.

With the exception of one producer, all of the participants in spring 2012 were receptive to the sampling process, though there was a range of desired involvement from the producers', which the crews were able to accommodate. Some producers asked to be notified the exact day that the sampling would occur, and some requested that the crew meet them in person. In some instances where many sample locations were in maturing (winter) crop fields, it was helpful to meet with the producer to look at the maps together, in person, to determine access points that would reduce crop damage, or to move points into fields that were planted in spring crop or that were in summer fallow. If producers were not comfortable with initial sample locations, a compromise was easily achieved by moving sample locations using the strata maps. In talking with producers, it was also helpful to ask for any access tips to the specific fields we were sampling. Speaking with the producers often proved to be beneficial to the crew, and helped to further develop the relationship between AES and the producers and increase general interest in the project.

As shown in Table 3 in Task 2 above, the sampling approximately 700 samples total, with the vast majority occurring in the no till and CRP fields managed by the Shepherd's Grain producers. As stated above, the teams were able to access nearly every sample on every field, with the exception of one producer who preferred to not have any sampling completed on his field that late in the spring. Numerous points were moved out of winter crop fields as well.

III. Soil Sampling Field Season – Sampling on Conventional Tillage Fields

In addition to the primary task of sampling in no till, soil sampling crews were tasked with securing samples from conventional tillage and minimum tillage fields to incorporate into the predictive model. Since all Shepherd's Grain farmers primarily utilized no till cultivation methods, this additional land had be to secured during the field season. One of the more effective ways of finding new producers to add to the sample base, particularly conventional till farmers, was to ask the Shepherd's Grain producers for recommendations. At times they would make a call themselves, or otherwise put the crews in contact with neighbors, or other producer's in the area that they thought would be interested in participating in the study.

With the already established relationships with the Shepherd's Grain producers, it became much easier to find new producers that would allow us to sample their fields. This is expected to be a primary approach for expanding the project and securing additional acreage for sampling and enrollment during the second half of 2012. Additionally, the AES team developed a flier that was used to advertise the program with NRCS offices and Conservation Districts. Several staff members even sent the flyer out to producers that were on their email lists. To date, this has not yet yielded much success. As expected, it will be much easier to spread the word and build the program through established relationships and networks in the local communities throughout the region.

IV. Soil Sampling Field Season – Reference Natural Areas

Once field season began, the AES project manager and GIS analyst began identifying potential reference natural areas that could be sampled throughout the region once sampling in time-sensitive crop fields was completed. Through extensive research of existing plans and reports and discussion with expert ecologists in the region, we developed a preferred list of sites to consider in more detail in Oregon, Washington and Idaho. The majority of the sites considered were owned by Washington Department of Natural Resources or The Nature Conservancy (Oregon or Washington chapters). We also identified a number of smaller sites owned by individuals (prairie remnants) and small conservation organizations. Once boundaries of the site were acquired, a more detailed screening and stratification process was completed to identify sites within our target precipitation zones that had suitable soils for sampling (per Task 2 above).

It's no surprise that it is difficult in this region to find reference natural areas that have deep loess soils that would be suitable for agriculture – those were converted long ago. General characteristic of these natural areas included the following: thin, rocky soils, steep slopes, shallow bedrock, dry precipitation zones, rare plant species, etc. Maps were provided to the field crews of the sites chosen for sampling and the crews collected samples from a diversity of the strata combinations on the site, with a preference toward areas of the site with more suitable soils.

Due to the ecological sensitivity of these sites, a crew member designed and fabricated a manual soil sampler that allowed for utilization of existing plastic soil sleeves and collection of an identical 2" diameter x 1m long soil core for analysis (though at most sites refusal was met prior to reaching 1m). This ensured the data would generally be comparable between the cultivated fields, CRP and reference natural areas. In total, approximately 100 samples were collected from reference natural areas throughout the region. The manual soil sampling protocol is described in more detail in the following section on Sampling Protocols.

V. Soil Sampling Field Season – Sampling Protocols

Navigating to the Sample Location

Utilizing a combination of the map sets provided by AES GIS staff and the Benchmark Maps state road atlases the field crew located the designated fields and navigated to them. When time permitted, field locations were drawn into the road atlases for easier planning and navigation on the road. Upon arriving at the designated field for sampling, a safe parking place was found in a pull off area in the field or alongside the low-traffic county road. Often, parking was available at the producer's shop or home. At all parking locations, there was ample space to unload the sampling equipment safely without the threat of traffic.

The hardcopy aerial / topographic maps, in combination with the Trimble GPS units, were used to locate the sample points. The topographic maps were allowed for navigation through the fields (around steep slopes and mature crop fields) to get within close range of the sample locations. The Trimble GPS units were essential to navigate to the approximate sample location, then the precise sample point. The crew would drive within 10 meters of the sample location, and then often the crew member who was not driving would walk to the precise sample location to minimize any unnecessary driving on the crops.

When parking the Gator to collect a soil sample, the Gator was pointed in the downslope position with the emergency brake fully engaged. A set of wheel chocks were inserted in front of the wheels as an additional safety precaution. All crew activities took place on the upslope side (rear) of the vehicle, providing an additional measure of safety in the event that the brake and the wheel chocks fail.

It was critical to be courteous to the producer while driving through the crop fields by making an effort to minimize tire tracks left through production crops. Often this was achieved by driving along crop edges where there is typically a narrow uncultivated area, following any tire tracks already visible in the field (when appropriate), and retracing the same route in and out of the field. The general rule of thumb is to avoid driving through production crops whenever possible. Making an effort to choose direct routes to the sample locations whenever possible is also important.

Collection / Extraction of Soil Core with Giddings Sampler

Upon arriving at a sample location, the crew followed a specific step-by-step process for extracting a soil core, as detailed below. In general, one crew member collected the sample and the other recorded data, including collecting the GPS point and associated data, completing the hardcopy data sheet, taking photos (cardinal directions and soil core), then capping, packing and labeling the soil core. The other member operates the Giddings and took the sample. However, there were times during the Giddings soil core extraction process that required both crew members. Personal protective equipment (ear plugs, safety goggles and steel-toed boots) were worn at all times while operating the Giddings Soil probe. Safety goggles and seat belts were worn at all times while driving or riding in the Gator.

Giddings Soil Sampling Protocol:

1. Remove anchors, metal soil tube, and Kelly bar from the gator. (Attach anchors to hydraulic system).
2. Turn on Giddings motor and bring the mast to the vertical position. Check the level and adjust the probe to be as level as possible in the vertical position. On steep slopes, vertical 'level' is difficult to achieve.
3. Secure anchors. Follow methods for *hydraulic anchoring system* OR *manual anchors*.
4. Adjust the Giddings probe so that it is level in the lateral direction to to ensure the probe is going straight down into the ground rather than entering the ground at a slight angle.
5. Insert Kelly bar into rotary head. Insert plastic tube into metal soil tube and attach to the Kelly bar with the adapter.
6. Lower the foot until it firm on the ground to stabilize the Giddings (with manual anchor system, chains should be very tight at this point). Lower the probe smoothly into the soil to obtain a full 1m soil core. If the probe

encounters bedrock layer, or another restrictive layer that it cannot penetrate, raise the probe with less than a 100cm soil core. In much of the cultivated land in the Palouse, a full soil core should be achieved.

7. Raise the probe as smoothly as possible. Cover the bottom of the soil core with one hand as soon as it is above the top of the soil. Note: If the first sample core is less than 90 centimeters in length, rotate the probe to one side of the first attempt and try again. The probe may need to be adjusted laterally to be level. If after the third attempt, none of the cores are above 90 centimeters, keep the longest of the cores and discard the others.
8. If the plastic tube does not slide out from the metal tube easily, use a flat head screwdriver to gently push the bottom edge of the plastic tube.
9. Cap the bottom of the soil core with a black cap immediately upon removal from the metal tube. If the tube is not full, insert paper towels into the top to fill the gap, taking care not to compact the soil core. Cap the top with a red cap. Apply the bar code label to the soil core. Measure the hole left by the soil probe and the length of the soil core in centimeters.
10. Remove anchors from the soil. Raise the foot on the probe. Remove Kelly bar. Adjust the lateral position back to center. Lower the mast until it rests in the cradle. Turn off Giddings motor.
11. Store all equipment and tools securely in the Gator for transport. Fill in or stamp-down any obvious holes or disturbed soil. Leave sample site as undisturbed as possible, within reason.
12. IMPORTANT: Mark the sample location point on the topographic map with an 'X', and record the soil core ID number that was applied to it.

Collection of Duplicate Soil Core

To ensure that a duplicate soil core is taken for each of the strata combinations, a duplicate sample should be taken at all sample locations with a sequential number of '01'. To take a duplicate soil core, rotate the probe about one foot to either side (of center), then collect another soil core. Collect a new GPS point and record all the necessary data for this duplicate soil core in the GPS and on a data sheet, including length, UTM, etc. Put a barcode sticker on the sample (all duplicates should be consecutive numbers, logically). Duplicate samples can be recorded on the same data sheet, as most of the information is identical. It is recorded with the same site location name as the original. Make note on the data sheet that it is a duplicate.

Manual Soil Sampling Protocol (for Reference Natural Area Sampling)

1. Insert plastic tube into metal tube. Insert metal plug into the top of the metal tube. Holding metal tube in the vertical position, push or slam the bottom into the ground where sample is to be taken so that tube will stand vertical without other support.
2. Place trex board flat on the top of the metal plug/metal tube. Use sledgehammer to pound metal tube into the ground, using the trex board as a buffer between the hammer and metal plug/top of tube. Ensure metal tube remains in the upright, vertical position. After the first 6 inches, the metal tube should be snug in the ground, requiring less stabilization.
3. Carefully pound the metal tube into the ground 100 cm deep, if possible, using the trex board as a buffer. At its deepest point, be sure to leave enough space between the ground and the metal lip on the top end of the metal tube so that a chain can be wrapped around the tube.
4. To extract the core, wrap the chain around the metal tube, securing it under the top lip. Attach the other end of the chain to the lever on the jack. Apply downward pressure to the jack lever to lift the metal tube. Re-adjust the chain on the metal tube as needed as it is lifted from the ground. Steady the metal tube as it rises, and cover the bottom of the tube as soon as it is lifted out of the hole to avoid losing any soil from the core.
5. Remove soil core from metal tube. Cap and label the soil core according to the same procedure as the hydraulic sampling methods (red cap top, black cap bottom, barcode label, soil core length, etc.). Note: Due to the rock and adverse soil conditions that often exist in areas where the manual sampling method is used, it is rather common to meet refusal before a 100 cm depth is reached with the manual sampler.

VI. Soil Sampling Field Season – Data Collection at Soil Core Locations

Once the soil core has been collected, hold the Trimble GPS unit one meter above the hole / sample location to take the GPS point. Have a clipboard with data sheet nearby to enter the relevant site attribute information into the Trimble. Designate whether the sample is: Original (no change from map), New (crew allocated point), or Moved (adjusted in the field to accommodate crops, access, etc.). Use the site location code to fill in the rest of the fields. Check the box for duplicate if it is a duplicate sample.

Fill in the data sheet using the soil sample location code listed on the producer map (topo map). Note the shape of the slope by visually assessing the location as best as possible. Record the length of the soil core/depth of the hole in centimeters. Record the UTM coordinates of the sample location. Including any typical information for the General Notes section of the data sheet such as:

- Type of crop currently growing (or fallow),
- Any clarifications to indicate slope position (or other attributes) being observed in the field may differ from what GPS designated it (include a cross-section sketch of the slope showing the sample location),
- If the probe hit bedrock or restrictive layer, record "met refusal",
- Anything unusual about the core or site that should be noted,
- Any notes about the history of the field or sample location obtained from the producer or from observing the site can also be noted.

Finally, take a photo facing each of the four cardinal directions (north, east, south, and west) while standing near the sample location. Use a compass to be as accurate as possible. Walk around the Gator to get a better view of the surrounding landscape/topography. Take a photo of the soil core and include the barcode label for future reference. Record the photo numbers of each image on the data sheet. Take additional photos that may be of interest to the project team in the office documenting crops, interesting features, scenic beauty, etc.

VII. Soil Sampling Field Season – Sample Labeling, Processing and Shipment

In the sections below, information has been included highlighting specific details regarding the proper handling and care of soil cores.

<u>Soil Core Labeling</u>
Once the soil core is extracted from the soil tube, immediately cap the bottom of the soil tube with a black cap. To ensure minimal movement of the soil core within the plastic tube, sheets of paper towels should be included to fill any remaining space. The top should then be capped with a red cap. For extra security, a piece of duct tape should be applied to the interface between the cap and the soil tube to ensure caps remain in place during handling, storage and shipping. Apply a barcode label. With a Sharpie, write the length of the soil core, measured in centimeters, on the soil core.

<u>Soil Core Handling</u>
Handling of soil cores was kept to a minimum. A cylindrical soil tube holder was installed on the Gator for safe, upright transport of the soil cores in the field. Soil cores were then stored upright in the truck, then transferred to a temporary storage location at the rental house.

<u>Soil Core Storage</u>
Soil cores were store until a sufficient quantity were collected and a large crate were ready for shipment to the University of Missouri Soils Lab. When a shipment is anticipated, a crew leader coordinated with the project manager for shipping details.

Soil Core Shipping
About 575 soil cores can be shipped in a 48" x 48" heavy-duty wood crate, supplied by Uline. The crate with ¾ inch plywood sides was the sturdiest option found for the fragile cargo. The box was modified with 2 x 2's screwed on the interior of the box in all of the seams/edges (vertical and horizontal) for reinforcement. Styrofoam was cut to fit the box and placed on top of the soil cores for padding and extra stabilization.

When the crate was full and all sides securely fastened with the provided metal clamps, the crate was wrapped in plastic wrap and also bound with the metal banding running vertically around the box in both directions (imaging a present wrapped with ribbon). Both the plastic and the banding were added for extra strength to secure the crate to the pallet, and were provided by the shipping company. Being sure these extra precautions are taken is highly recommended. When a shipping box is filled, the shipment should be loaded into a truck or trailer and delivered to a freight shipment location for drop-off. In 2012, YRC Freight, located in Spokane Valley, WA, was the shipping company used.

Task 4 – Analysis and Baseline Development

As reported in the last semi-annual report, the November visit to the Palouse and Columbia Plateau eco-region, the project team conducted preliminary soil sampling at five Shepherd's Grain member farms and collected 45 soil cores. The goals of the sampling effort were:

- Test the physical sampling methods and determine sampling efficiency with new equipment;
- Gain insight into variation in carbon levels by slope position and aspect;
- Gain insight into variation in carbon levels by geographic region and land management practices; and
- Gain insight into changes in soil carbon levels throughout the 1m soil cores.

At each sampling location, one core was collected for analysis by the University of Missouri Soils Lab. This core was collected, labeled and stored for later shipment. In two sample locations, a duplicate soil core was taken 12" from the first location for analysis in the lab to determine the level of variability of soil carbon and bulk density levels within a short distance in the same soils and the same slope position.

The 45 soils cores collected during the November 2011 preliminary sampling trip were sent to the University of Missouri Soils Lab for analysis. Laboratory analysis of the initial 45 soil samples collected in November 2011 was completed in spring 2012 and analyzed by statistician on the team, Dr. Kevin Little of Informing Ecological Design, and were used to inform the soil sampling field season and future laboratory analyses. Though the dataset was very small, some of the initial findings that have informed our future work include:

- The sampling confirmed our model for stratification, and the reconnaissance sampling verified our understanding of the importance of landscape/slope position, aspect, precipitation, etc. on soil carbon values.
- Our predictive model matches well with other models in widespread use, such as the Topographic Wetness Index (TWI) – an important cross-convergence of data in our work and research – and confirms our spatial distribution and number of samples.

Soil cores from the Spring 2012 were shipped to the University of Missouri Soils Lab in mid-July and will be analyzed once they arrive. It is expected that initial baseline development and modeling will begin in the second half of 2012 and will be reported on in the 3rd bi-annual report.

Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers

No activities have occurred under this task. It is expected that this task will be initiated during the second half of 2012 and be completed during the first half of 2013.

Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members

Building relationships with Shepherd's Grain farmers has been the primary focus of the aggregation work to date. By establishing and building on a foundation of mutual trust and understanding, our efforts for further aggregation work beyond Shepherd's Grain will be much easier. As described above, we began the relationship building last fall during our meeting in November and then again during our learning journey in late January, described above. Since that time, we've continued to communicate as we sought information on farm and field history and during the sampling coordination.

During the field season, our sampling crews regularly interacted with the Shepherd's Grain producers to verify that sampling points were acceptable and our assumed access points would minimize negative impacts to crops. Our sampling crews also queried the producers about additional producers in the area (both conventional and no-till) that may allow soil sampling in their fields. Through this farmer to farmer and community-based approach, we were able to access and sample at least a dozen additional farms.

We will continue to build on the relationship we've developed with the Shepherd's Grain producers and expect to have some in-roads to other producers in the communities through this relationship. We will begin developing our outreach strategy during the next quarter (beginning July 1, 2012). The recruitment is ongoing and we'll begin implementing our outreach strategy in the latter half of the year once the harvest is complete and producers are more accessible. This task won't end during the grant phase, even if we are able to meet our targets - we'd like to continue recruiting into the program beyond the grant period.

Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

Third-party verification is the core of quality assurance, and under the Verified Carbon Standard (VCS) Program, all projects must be validated and all emission reductions must be verified by approved validation / verification bodies. The methodologies verified by VCS have been used by over 600 projects quantifying emission reductions and issuing GHG credits in the voluntary markets.

The Earth Partners have developed the first modular soil carbon quantification methodology to be validated under the Verified Carbon Standard (VCS). The Methodology can be used to quantify the emission reduction and carbon sequestration benefits of projects such as this project. In order to create carbon offset credits certified under the VCS, the methodology had to undergo a public review process as well as a double validation process by two separate accredited independent validators/certification bodies.

The process was kicked off on October 5, 2011 with the public comment period and followed by the subsequent first and second validation. The first validation was executed by a team of Environmental Services Inc. (ESI) which included a soil science expert. The method has been reviewed to be scientifically correct and in compliance with the VCS guidelines and rules. Revisions were made along the way to ensure the method was in compliance with the VCS standard version 3.2. The second validating team was sourced from Scientific Certification Systems (SCS).

The methodology will be officially validated in July 2012 under the VCS standard Version 3.2 and can be used by projects that would like to quantify and monetize the GHG benefit their project cause. The formal announcement of the TEP Soil Carbon Methodology will be announced with a press release in August. We anticipate that this will provide momentum in the enrollment process as well as the cultivation of potential voluntary buyers.

TEP has continued preliminary conversations with The Climate Trust, a potential voluntary carbon buyer in Oregon. They are very interested in our enrollment progress, scientific rigor of our methodology, and the fact that the producers are based in their regional areas of interest: the Pacific Northwest, and specifically Oregon. The team is actively working with The Climate Trust to develop a term sheet for a purchase of carbon credits from the program, as well as a strategy for getting these credits accepted into the California market through the California Air Resources Board.

Task 8 – Reporting and Knowledge Dissemination

Ongoing communications with USDA administrative contacts Gregorio Cruz and Ralph Jones continue to ensure all administrative and budget questions and issues are addressed for the CIG grant.

Project team members regularly communicate with Steve Campbell, NRCS Technical Contact, to keep him informed of project progress and invite any contributions he may make to the project. Last fall, the project team shared the highlights of its technical approach with Steve for any feedback or comments that he may have and clarified how he would prefer to remain apprised of project progress and updates. In January, the project team scheduled an in-person meeting with Steve Campbell during the learning journey meetings in Colfax, Washington. The learning journey team met with Steve in person, while additional team members called in to the meeting. Steve then attended two of the listening session meetings with farmers that followed.

Upon request of Greg Johnson and Adam Chambers, NRCS West Technology Support Center in Portland, Oregon, team members scheduled and presented at the Coalition on Agricultural Greenhouse Gases (C-AGG) meeting in Sacramento, CA in late February, 2012. Frederik Vroom, Carbon Analyst with TEP, presented on a moderated roundtable discussion with other CIG Greenhouse Gas (GHG) project representatives.

After learning of the EQIP funding for CIG associated producers, Tom Hunt and Ry Thompson participated in several conference calls with Steve Campbell, Adam Chambers and Todd Peplin to learn about and discuss the opportunity and strategize for the CIG Palouse project. This is anticipated to be an ongoing collaborative process between the project team and NRCS staff.

During the sampling period in May and June, field team staff interacted with several NRCS and Conservation District staff with the hopes of recruiting conventional producers to allow soil sampling on their fields.

The July C-AGG meeting in Chicago, IL will be attended by Steve Apfelbaum, Tom Hunt, and Ry Thompson. Ry and Tom will present a project overview at a CIG grant recipient dinner prior to the start of the C-AGG meetings, as well as present during two CIG related panel discussions at C-AGG on carbon markets and EQIP funding.

7. Next Steps

During the second half of 2012, the following activities will be undertaken by the project team:

Task 1 – Business Origination with Shepherd's Grain

During the second half of 2012, the project team will travel to the Palouse region to update farmers on the progress of the project through the field season that was completed in early July. The team will follow-up individually with any Shepherd's Grain producers who have not already signed the enrollment agreement to expedite that process, if they are interested in the program. It is expected that not every farmer will participate.

Task 2 – Mapping Screening and Stratification of the Palouse

During the second half of 2012, it is expected that the project team will begin applying the stratification mapping to any new acreage that is secured for enrollment and a second sampling season. It is expected that this acreage will primarily come from producers outside of the Shepherd's Grain group.

Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region

The laboratory analysis and sample archiving will be completed during the second half of 2012 and will be completed during that period. A second sampling season is expected for the first half of 2013.

Task 4 – Analysis and Baseline Development

As data becomes available from laboratory analysis during the second half of 2012, the statistical team will begin building the predictive model of soil carbon levels in the Palouse region. It is expected that the initial phase of this work will be completed during the second half of 2012.

Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers

During the second half of 2012, the project team will begin to outline the Project Design Document (PDD). The majority of the PDD work will begin following the completion of the activities in Task 4 early 2013. With a split field season and laboratory analysis period, it is expected that the PDD will not be completed until late 2013, when the total number of soil samples have been collected and analyzed and the predictive model calibrated and validated.

Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members

It is expected that this task will be initiated during the second half of 2012 and be completed during the second half of 2013. This will be a major focus of the AES/TEP team in fall and winter 2012. An outreach plan will be developed during late summer 2012.

Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

A press release will be issued in August 2012 announcing the TEP soil method has been validated and verified and is ready for use in soil sampling. Discussions with potential carbon buyers in the voluntary market will continue during the second half of 2012. Further discussions regarding getting Palouse carbon credit offsets into the California ARB market will be ongoing.

Task 8 – Reporting and Knowledge Dissemination

Regular reporting with Steve Campbell (monthly update) and with the NRCS administrative contacts (as needed) will continue through the second half of 2012.

8. Cost Status

See ***Appendix A – SF 425 Federal Financial Reports*** for the financials for this period.

9. Schedule/Milestone Status

During the second bi-annual report period, the project is generally progressing according to schedule. A second field season in spring 2013 was added to accommodate the additional acreage to be signed up in late 2012. We do not believe this will materially affect or delay any major milestones in the Schedule. A project schedule with milestones is presented in ***Appendix B – Updated Project Schedule with Milestones***.

APPENDICES

Appendix A – SF425 Federal Financial Reports for January – June 2012
Appendix B – Updated Project Schedule with Milestones
Appendix C – Spring 2012 Soil Sample Locations

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted USDA-NRCS, Washington DC	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment) 69-3A75-11-131	Page 1 of 1 pages

3. Recipient Organization (Name and complete address including Zip code)
Applied Ecological Services, 17921 Smith Road / PO Box 256, Brodhead, WI 53520

4a. DUNS Number 614663276	4b. EIN 39-1611274	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type ☒ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	7. Basis of Accounting ☒ Cash ☐ Accrual

8. Project/Grant Period From: (Month, Day, Year) January 1, 2012	To: (Month, Day, Year) March 31, 2012	9. Reporting Period End Date (Month, Day, Year) March 31, 2012

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	0
b. Cash Disbursements	350,201.20
c. Cash on Hand (line a minus b)	0
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	550,000
e. Federal share of expenditures	268,447.69
f. Federal share of unliquidated obligations	0
g. Total Federal share (sum of lines e and f)	268,447.69
h. Unobligated balance of Federal funds (line d minus g)	281,552.31
Recipient Share:	
i. Total recipient share required	550,000
j. Recipient share of expenditures	81,753.51
k. Remaining recipient share to be provided (line i minus j)	468,246.49
Program Income:	
l. Total Federal program income earned	0
m. Program income expended in accordance with the deduction alternative	0
n. Program income expended in accordance with the addition alternative	0
o. Unexpended program income (line l minus line m or line n)	0

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:			

12. Remarks: *Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:*

13. **Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)**

a. Typed or Printed Name and Title of Authorized Certifying Official Ry Thompson, Ecologist / Project Manager	c. Telephone (Area code, number and extension) 608-897-8641 x57
	d. Email address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official [signature]	e. Date Report Submitted (Month, Day, Year) 4/30/12 (through 3rd quarter)
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted USDA-NRCS, Washington DC	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment) 69-3A75-11-131	Page 1 of 1 pages

3. Recipient Organization (Name and complete address including Zip code)
Applied Ecological Services, 17921 Smith Road / PO Box 256, Brodhead, WI 53520

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	39-1611274		☒ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☒ Cash ☐ Accrual

8. Project/Grant Period From: (Month, Day, Year)	To: (Month, Day, Year)	9. Reporting Period End Date (Month, Day, Year)
April 1, 2012	June 30, 2012	July 31, 2012

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	0
b. Cash Disbursements	586,124.20
c. Cash on Hand (line a minus b)	0
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	550,000
e. Federal share of expenditures	411,785.06
f. Federal share of unliquidated obligations	0
g. Total Federal share (sum of lines e and f)	411,785.06
h. Unobligated balance of Federal funds (line d minus g)	138,214.94
Recipient Share:	
i. Total recipient share required	550,000
j. Recipient share of expenditures	174,339.1
k. Remaining recipient share to be provided (line i minus j)	375,660.86
Program Income:	
l. Total Federal program income earned	0
m. Program income expended in accordance with the deduction alternative	0
n. Program income expended in accordance with the addition alternative	0
o. Unexpended program income (line l minus line m or line n)	0

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:			

12. *Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:*

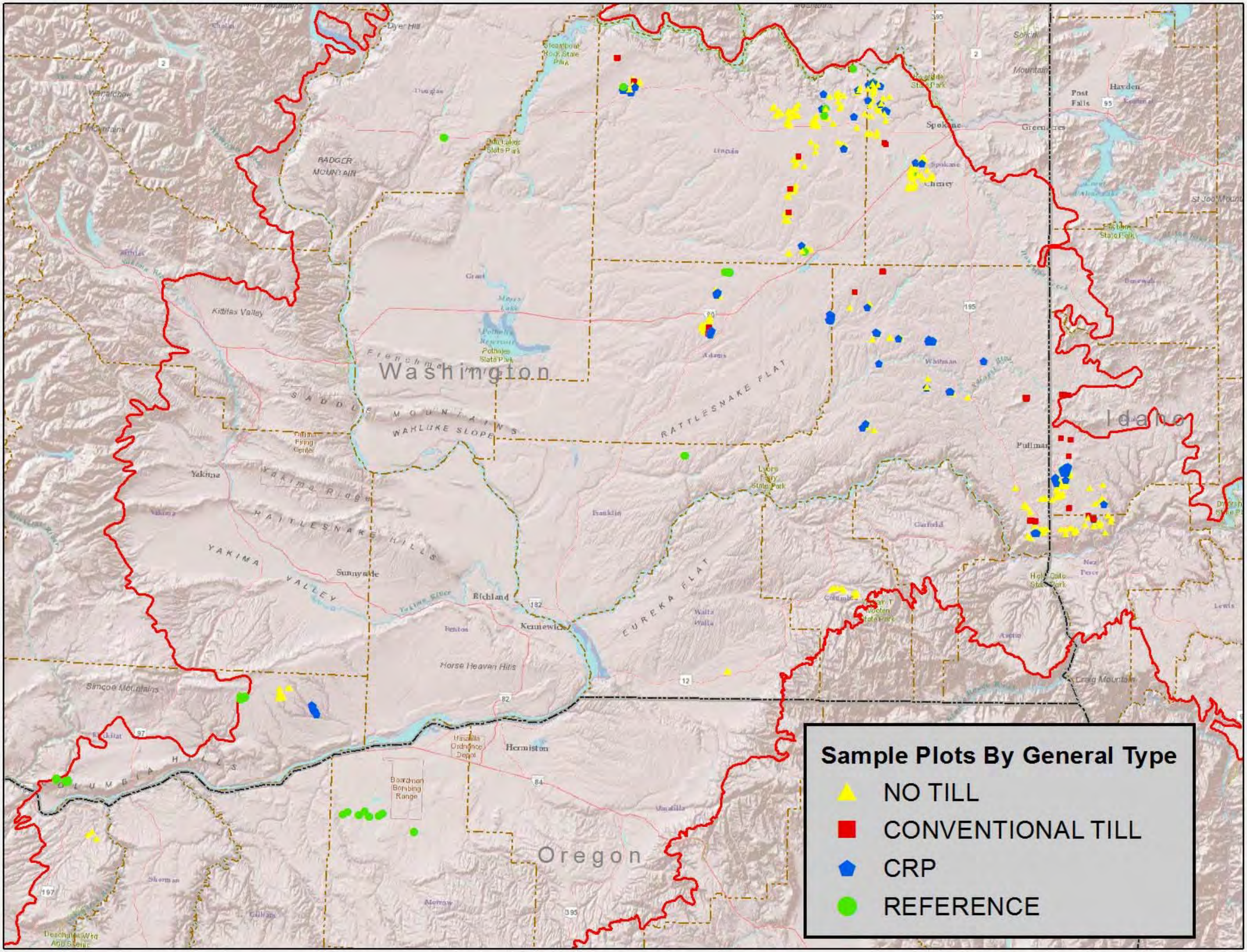
13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official [signature] Project Manager	c. Telephone (Area code, number and extension) 608-897-8641 x57
	d. Email address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) 7/31/12 (through 4th quarter)
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

	Year 1 Q1 Aug 13 - Sep 30, 2011	Year 1 Q2 Oct 1 - Dec 31, 2011	Year 1 Q3 Jan 1 - Mar 31, 2012	Year 1 Q4 Apr 1 - Jun 30, 2012	Year 2 Q1 Jul 1 - Sep 30, 2012	Year 2 Q2 Oct 1 - Dec 31, 2012	Year 2 Q3 Jan 1 - Mar 31, 2013	Year 2 Q4 Apr 1 - Jun 30, 2013	Year 3 Q1 Jul 1 - Sep 30, 2013	Year 3 Q2 Oct 1 - Dec 31, 2013	Year 3 Q3 Jan 1 - Mar 31, 2014	Year 3 Q4 Apr 1 - Jun 30, 2014
Project organization and set-up	■											
Introductory meetings	■											
Partnership with Shepherd's Grain (SG) and surrounding landowners		■	■									
Partnership agreement finalized with farmers			◆									
Development and dissemination of educational materials		■	■	■								
Development of live farm field activity web site			■	■								
Mapping, screening, and stratification of the Palouse	■	■	■									
Mapping and stratification completed			◆									
Preparation for sampling		■	■									
Sampling across Palouse region			■	■								
Laboratory analysis of samples			■	■	■							
Statistical analysis and baseline development				■	■	■						
Review of analysis by experts and technical team				■	■	■						
Baseline developed for carbon project						◆						
Finalize soil method validation through VCS or other body	■	■	■									
Soil carbon methodology validated			◆									
PDD drafting and review for SG and surrounding landowners (300,000 ac)				■	■	■	■	■				
Formal submittal of PDD to independent validator								■				
PDD delivered to market									◆			
Aggregation beyond SG and surrounding landowners (1 million ac)						■	■	■	■	■		
Partnership agreement finalized (1 million ac)										◆		
Host meetings and discussions with high potential carbon buyers								■	■	■		
Drafting of deal structures to monetize credits										■	■	
Carbon deal structured (1 million ac)											◆	
Engage ARB or other emerging compliance markets					■	■	■	■	■	■	■	■
USDA communications	■	■	■	■	■	■	■	■	■	■	■	■
Bi-annual report		◆				◆				◆		
Annual report				◆				◆				
Final Report												◆



Sample Plots By General Type
NO TILL
CONVENTIONAL TILL
CRP
REFERENCE
Washington
Oregon
Idaho
Spokane
Cheney
Pullman
Yakima
Sunnyside
Richland
Kennewick
Hermiston
Post Falls
Hayden
SADDLE MOUNTAINS
WAHLUKE SLOPE
RATTLESNAKE FLAT
RATTLESNAKE HILLS
YAKIMA VALLEY
EUREKA FLAT
COLUMBIA HILLS
Horse Heaven Hills
Simcoe Mountains
Kittitas Valley
BADGER MOUNTAIN
Craig Mountain

Appendix E – Semi-Annual Report #3

Applied Ecological Services, Inc. (AES)
Semi-Annual Progress Report No. 3: July 1 – December 31st, 2012
USDA-NRCS CIG-GHG Project No. 69-3A75-11-131
July 3, 2013

PROJECT DESCRIPTION / ABSTRACT

Applied Ecological Services, Inc. (AES), in partnership with The Earth Partners, LP (TEP), and a consortium of secondary partners (the AES/TEP Team) seek to develop a large-scale agricultural carbon project in partnership with Shepherd's Grain members and surrounding farmers in the loess hills of the Palouse and Columbia Plateau region. Intensive farming across the region has resulted in the near extinction of the native grasslands, and the exhaustion of the soil and hydrological resources of the region. The introduction and widespread application of sustainable, low-carbon farming practices have the potential to restore the fertility and ensure the longevity of one of the United States' most important breadbaskets. Demonstrating the value to landowners of increased soil carbon stemming from these improved agricultural practices is a critical component in facilitating the large-scale adoption of such practices. To this end, this project seeks to provide a roadmap for developing large-scale, high-quality, and low-cost soil carbon transactions.

Building off literature reviews and preliminary sampling completed in 2009, we propose to further develop and extrapolate these models at a larger, landscape scale across the entire Columbia Plateau eco-region. Utilizing TEP's Soil Carbon Quantification Methodology, we seek to measure, monitor, validate, and monetize carbon credits stemming from low carbon agricultural practices such as no-till, direct seeding, crop rotation, and improved soil management. We believe that this project demonstrates both the importance of large-scale low carbon farming practices to Greenhouse Gas reduction policies and the role of quantitative soil carbon methodologies in creating compliance-grade offset credits. It will also provide a roadmap for aggregating landowners over large areas at low cost. We seek to demonstrate a model for marketing and monetizing the resulting carbon credits. This will be one of the largest land-based carbon projects to date.

We seek to achieve the following outcomes in this project:

- **Demonstrate the model at scale.** Our proposed project is broken into two phases: In Phase 1, we intend to develop a low-carbon agricultural partnership with landowners on 300,000 acres (*to be revised*) of Shepherd's Grain land. In Phase 2, we intend to partner with landowners on over 1,000,000 acres (*to be revised*) across the Palouse and larger Columbia Plateau eco-region. This can be expanded at a much larger scale because the project can build off of the analytic and technical work we will have done (GIS mapping, stratification, soil sampling, model projections, etc.).
- **Demonstrate a low-cost aggregation model**. Assembling landowners over large acreages at a relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. Through our planned work with landowners on 1 million acres, the AES/TEP team will develop, test, and refine a low-cost aggregation model. To this end, the AES/TEP team is building on significant existing experience in aggregating landowners, developing standard partnership structures, and streamlining landowner interactions and engagement.
- **Showcase a successful land-based carbon transaction.** While agricultural carbon credits cannot currently be monetized in the marketplace, this project seeks to ensure that credits derived from this project will be accepted by the CA Air Resources Board (ARB) under AB-32 or other emerging compliance markets, as well as voluntary markets like VCS and ACR. To this end, we have developed a unique partnership of farmers, project developers, carbon investors, scientists, and government.
- **Develop data, maps and templates that will inform policy and support further research.** We will utilize GIS landform and geomorphic modeling and mapping to design, evaluate, and implement a regional, on-the-ground baseline analysis of soil carbon levels across the Palouse and Columbia Plateau eco-region. The resulting data and maps will represent a type of integrated information that is lacking in the region, which will be useful for government agencies, scientists, universities, and other researchers.

SECOND SEMI-ANNUAL PROGRESS REPORT

1. USDA-NRCS CIG-GHG Project Number and Contract Period

69-3A75-11-131 – August 1, 2011 to July 31, 2014

2. Project Title

Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region

Project Director / Principal Investigator

Steven I. Apfelbaum, Chairman of the Board/Principal Ecologist, Applied Ecological Services, Inc.

3. Date of Report / Period Covered

June 13, 2013 for Report No. 3: July 1 – December 31, 2012

4. Executive Summary

During the second half of 2012, the Project Team focused primarily on the following tasks:

- Task 1 – Business Origination with Shepherd's Grain –The team continued developing relationships with Shepherd's Grain producers and continued the enrollment process with producers.
- Task 2 – Mapping, Screening and Stratification of the Palouse – No major activities were completed under this task. Data was compiled and provided to the team statisticians for statistical analysis.
- Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region – Final samples were collected in early July. Over 700 soil cores were shipped via freight to the University of Missouri Soils Lab for analysis. Ongoing data QA/QC continued as batches of data were made available.
- Task 4 – Analysis and Baseline Development – Team statisticians began analyzing data as it became available to begin developing baseline soil carbon levels for the strata.
- Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers – An early draft PDD outline was developed for the project.
- Task 6 – Aggregration and Farmer Engagement beyond Shepherd's Grain and Surrounding Members – Relationship building described in Task 1 above led to some farmer engagement beyond Shepherd's Grain. This will be a major focus of the next reporting period.
- Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members– The Earth Partners Soil Carbon methodology was validated by VCS in November 2012.
- Task 8 – Reporting and Knowledge Dissemination – Regular communication with NRCS administrative and technical contacts was ongoing throughout the reporting period. Attendance at the C-AGG meetings in Chicago, IL and Washington, DC occurred during this reporting period.

5. Proposed Changes requiring Prior Approval (*July 3, 2013 Clarification*)

In the previous semi-annual report, the project team requested a modification to the enrollment targets for the project covered under CIG Contract #69-A375-11-131, as described below. Further clarification has been provided in this semi-annual report on the existing acreage available to the project, as described below.

- To clarify our language and provide additional detail on this previously requested modification, the acreage that is available to us at this time includes 100,588 acres.

- The total acreage could increase in the coming months based on the outreach being conducted by the project team in early 2013 and the potential recruitment opportunities that could come with the EQIP opportunities in the future, as described below in Section 7: Next Steps.
- We will continue to put forth a good faith effort to commit to and carry out what was originally forecast and expected for the project.

The following includes the original modification language provided in semi-annual report #2 (submitted on July 31, 2012):

- *In accordance with the Prior Approval Requirements outlined in Section IV of CIG Contract #69-3A75-11-131, the project team proposed the following modifications to the project scope.*
  - *Proposed Modification #1 – The team is providing an update to USDA-NRCS on the enrollment targets under the grant for reasons described in the Justification section below.*
    - *During Phase One, we proposed target enrollment acreage of 300,000 acres. During Phase Two, we proposed target enrollment acreage of 1,000,000 acres in the grant.*
    - *We will continue to work towards the original targets, but it is likely that the originals are unattainable. Future reports will quantify planned versus actual.*
  - *Justification for Modification #1 – The original acreage and producer targets were provided in the grant in Section B. Project Objectives and Section D. Location and Size of Project Area. These were established as targets for the project during the proposal stage, however, it is likely that these targets may be unattainable for a few reasons. These include:*
    - *Acreage estimates provided for Shepherd's Grain producers, our core aggregate group, included a percentage of land that will not be included in the program due to complex ownership structures and landlord/tenant relationships (more detail in Task 1 below).*
    - *Several of the core aggregate group members are not interested in participating in a carbon credit offset program for reasons of personal values.*
    - *Scaling up beyond the Shepherd's Grain producers is more difficult, time consuming and expensive than originally thought. Without a robust carbon offset credit market in place (in California or elsewhere), producers are more cautious about signing up land in a program that does not have clear, immediate economic benefit.*
    - *With the complexities of the landlord/tenant relationships across the Palouse and the aging population of farmers, many are cautious about tying up their land with long-term commitments.*

  The larger scope of the project has not changed, though we expect the overall scale of the project will be smaller than originally proposed. We are committed to developing a scientifically robust and cost-effective carbon program with a smaller aggregate group in the Palouse. As described in Task 1 below, we will continue to work towards the targets we've set over the next 12-18 months.

6. Accomplishments

Task 1 – Business Origination with Shepherd's Grain

TEP and AES continued to build on the relationships developed with Shepherd's Grain producers and neighboring producers. TEP has developed a working relationship with Pacific Northwest Direct Seeding Association (PNDSA), one of the largest producer groups in the Palouse region, and was invited to speak at their upcoming annual conference about the project. TEP and AES have also worked with local conservation districts, universities, and NRCS to build support around the program and find ways to leverage other conservation initiatives in the region.

Task 2 – Mapping, Screening and Stratification of the Palouse

TEP and AES have continued the QA/QC process on the data points collected during the 2012 field sampling season.

Data from the stratification process characterizing each sample point has been provided to the statisticians for use in the statistical analysis and modeling process. The primary sample point attributes being analyzed for fit in the model development phase include: slope position, aspect, precipitation, curvature, and years in no-till.

No other mapping or stratification activities were completed during this project period.

Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region

At the completion of the sampling period, two field crews had collected 710 total cores. The goal was to collect a full 1m core, but this was not possible at every location. The 710 cores reflected 608 unique sampling locations and include 102 duplicates (2nd core collected ~0.5m away) collected during the 2012 field sampling season. Samples were collected from a wide variety of field histories, as shown in Table 1 below, and included the following:

- H1 – Conventional Tillage (81 samples)
- H2 – 1-5 years in no-till (73 samples)
- H3 – 6-12 years in no-till (100 samples)
- H4 – 13-20 years in no-till (84 samples)
- H5 – 21+ yrs in no-till (52 samples)
- H6 – Conservation Reserve Program (CRP) (101 samples)
- H7 – Miscellaneous (Irrigated) (8 samples)
- H9 – Reference Natural Areas (109 samples)
- *The samples were then further allocated by several strata categories, including: slope position, aspect, precipitation zone, etc.*

Table 1: Soil Sample Locations by Strata

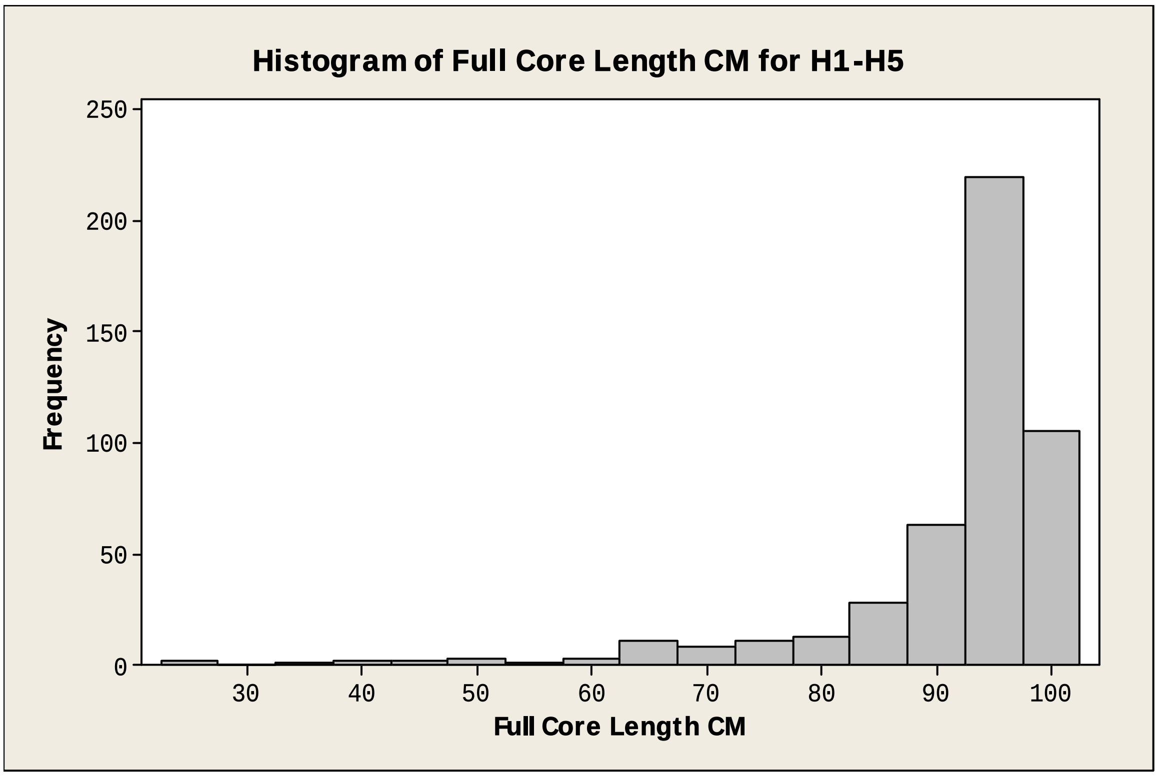
			Direct Seed History													
			2011 or None Conventional H1		2007-2010 1-5 Yrs H2		2000-2006 6-12 Yrs H3		1992-1999 13-20 Yrs H4		1990 or earlier 21 + Yrs H5		CRP Any H6		MISC (Irrigated) H7	REFERENCE H9
Precip Zone	Slope Position	Aspect	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Sampled	Sampled
P2	UP	SW		4			5	5	1	1			5	6		1
P2	UP	NE					5	5	1	1			5	5		3
P2	LO	SW		2			5	5	1	1			5	6		7
P2	LO	NE		2			5	5	1	1			5	5		11
P3	UP	SW	1	3	5	5	5	5	5	5	1	1	5	3		3
P3	UP	NE	1	5	5	5	5	5	5	5	1	1	5	5		2
P3	LO	SW	1	8	5	5	5	5	5	5	5	5	5	4		9
P3	LO	NE	1	5	5	5	5	5	5	5	5	5	5	5		8
P4	UP	SW	2	2	5	4	5	5	5	5	5	5	5	4	1	4
P4	UP	NE	2	4	5	2	5	5	5	5	5	5	5	6	1	8
P4	LO	SW	2	5	5	3	5	5	5	5	5	5	5	6	5	5
P4	LO	NE	2	3	5	4	5	5	5	5	5	5	5	5	1	4
P5	UP	SW		3	5	5	5	5	5	5	5	5	5	5		6
P5	UP	NE		7	5	5	5	5	5	5	5	5	5	7		4
P5	LO	SW		2	5	5	5	5	5	6	5	5	5	4		6
P5	LO	NE		4	5	5	5	5	5	5	5	5	5	4		7
P6	UP	SW		4	5	5	5	5	5	5			5	5		5
P6	UP	NE		6	5	5	5	5	5	5			5	5		5
P6	LO	SW		7	5	5	5	5	5	4			5	6		7
P6	LO	NE		5	5	5	5	5	5	5			5	5		4
Pre-Allocated or Sampled Plots			12	81	80	73	100	100	84	84	52	52	100	101	8	109
Target # of Plots			100		100		100		100		100		100			100

During the second half of 2012, cores were shipped to the University of Missouri Soils Characterization Lab for sample analysis. To begin, laboratory staff extracted the cores from the sample casing. Each soil core was described by a PhD soil pedologist and split into native soil horizons (A, Ap, AB, Bt, etc.) for more detailed physical and chemical analysis. After they were split and described, the soil pedologist recorded notes of

Standard calculations of soil carbon include an adjustment for large coarse fragments (e.g. USDA Soil Survey Laboratory Information Manual (2011), p. 251, reference [1]). The soil scientist on the project team confirmed that for this study, we will treat the percent of large coarse fragments as zero.

The field teams aimed to retrieve 100 cm of core for each sample. This was not possible for a variety of reasons, including shallow soils or wet cores such that the full core length could not be retained. Figure 6 shows the distribution of core lengths for the H1-H5 subset. 5% of cores were less than 67 cm and 10% of the cores were less than or equal to 80 cm. 50% of the cores were 95 cm or longer.

Figure 6: Distribution of Core Lengths for the H1-H5 subset. 90% of the samples are >80cm in length.



Due to the higher than expected costs associated with mobilizing two crews for the sampling season and dispatching the teams throughout the region for 3 months to collect the above-described soil cores, we do not anticipate proceeding with an early 2013 sampling season as originally anticipated. With the acreage available for sampling and the comprehensive stratification method employed, we are confident that the soil cores collected during the 2012 field season will allow us to develop initial baseline baseline conditions in the fields. The dataset will be statistically analyzed and recommendations will be made by the statisticians on where to focus additional sampling efforts (e.g. within which strata), should the opportunity arise for additional sampling.

Task 4 – Analysis and Baseline Development

Due to the volume of each soil core and the need to dry the entire soil core for bulk density measurements, the Soil Characterization Lab was limited on the number of soil cores that could be processed each week. On average, they were able to process approximately 60-70 soil cores weekly. As the analyses were completed and data became available from the lab, an intensive process of data review and QA/QC was completed by the project statisticians to ensure any issues that arose with data could be addressed as soon as possible. This unusual structure or evidence of erosion and took a digital photo, as shown in Figures 1-4. In sum, 2062 laboratory samples were analyzed from the 710 cores (~3 horizons/core). The analyses completed on each soil core included the following:

- Core Description and Splitting by Horizon
- Course Fragments
- Bulk Density
- % Total Carbon
- % Organic Carbon
- % Inorganic Carbon

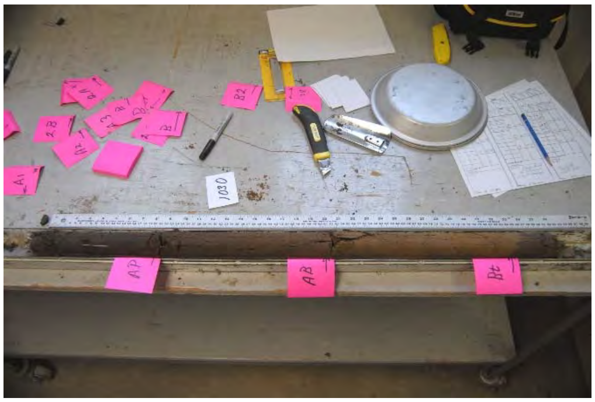


Figure 1: Soil core #1000

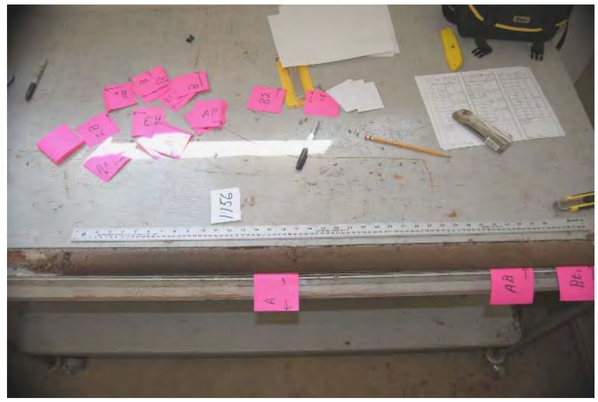


Figure 2: Soil core #1156


Figure 3: Soil core #1261

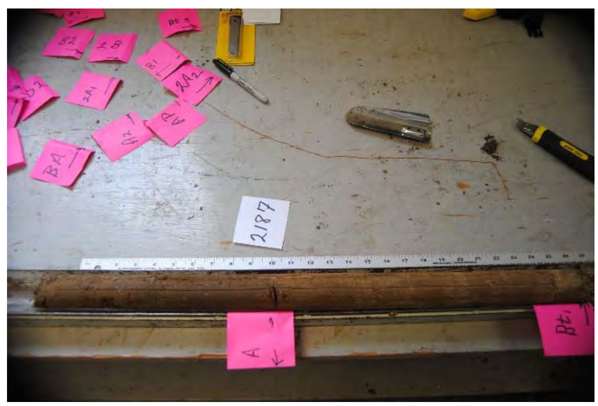


Figure 4: Soil core #2187

For each horizon, bulk density and percent carbon were calculated as shown in Figure 3. The soil carbon for a core is the sum of the soil carbon estimated for each horizon.

Figure 5: calculation of bulk density and soil carbon

Calculation of Carbon mass for each horizon (defined by positions Core Bottom and Core Top)

1. Bulk Density:

('Oven Dry Wt. (g)'-'Small Coarse Fragments (g)')/(3.1416*2.1^2*('Core Bottom (cm)'-'Core Top (cm)')).
The units of bulk density are **g/cm^3.**

2. Carbon calculation (organic carbon):

'% Organic C'*'Bulk Density (**g/cm3**)'*('Core Bottom (**cm**)'-'Core Top (**cm**)')*.1

gives % Organic C (dimensionless) x **g/cm^2** x .1

The conversion factor 0.1 is used to express **g/cm^2** as **kg/m**^{2} since **kg/m^2** = 10^{3}g/10^{4}cm^2 = 0.1 **g/cm^2**

3. Carbon calculation (total carbon): same calculation as for organic carbon, but using % total carbon.

review process is outlined in more detail below. Because of this staggered method of receiving data, it was agreed that no detailed statistical analysis of the data would be conducted or completed until all data was received. The full dataset is included in Appendix C.

During the second half of 2012, the statistician completed the following tasks:

1. **Data review and cleaning.** As cores were processed by the lab, project statisticians prepared diagnostic plots and tables to identify aberrant values. They were able to correspond by email or conference call with the lab to discuss these values; only three cores required correction of data records. Eight pairs of cores were discovered that shared the same pedon number. Working with the lab, the parties were able to assign individual pedon numbers to 14, leaving only two cores indeterminate.
2. **Revise master data table to include and track soil horizon data generated by the lab.** In addition to horizon labels that will be incorporated in the basic data analysis, the lab also generated data on probable soil movement for later analysis. Project statisticians worked with the lab to assure consistency of horizon labels in the data table.
3. **Generate initial statistical models of soil carbon.**
    1. Project statisticians built a number of linear models in both original scale and log (base 10) values. The log values appear to provide a better basis for analysis, stabilizing the variance over the range of responses.
    2. Project statisticians worked with total soil core carbon (kg C/m^2), derived from lab values of percent carbon and density, summed over the horizons (typically 3 horizons), fitting models in both organic and organic + inorganic carbon.
    3. Project statisticians used the following predictors in various linear models:

Predictor	Name	Type of Predictor	AES Source
Elevation	Elevation	Continuous	GIS data
Inches precipitation	IN_dec	Continuous	GIS data (30 year series, 1971-2001)
Topographic Wetness Index (TWI)	TWI_raw_ interpolated	Continuous	GIS
Time of year (days from March 15, 2012)	SampDate	Continuous	field records
Slope	SCODE	Categorical	Sample allocation table (high vs low)
Aspect	ACODE	Categorical	Sample allocation table (NE vs SW)
Tillage Code	HCODE	Categorical	Sample allocation table (0, 1-5, 6-12, 13-20, 21+ yrs no-till; also CRP and reference natural area)

During an in-person meeting on January 3, 2013 to discuss the progress the statistical team was making with the dataset, the following four primary points were shared with the project team.

1. Overview – Project statisticians reiterated that the problem is an analytic problem whereby a thorough understanding and characterization of the factors that drive the amount and spatial distribution of soil carbon on lands sampled can be used to predict the spatial distribution of soil carbon elsewhere so long as elsewhere is similar enough to lands actually sampled.

2. Factors – The original factors chosen were those that were believed to be significant predictors on the amount and spatial distribution of soil carbon in the Palouse and were based on a pretest. Across

different model formulations, statistically significant factors were precipitation, slope position and TWI.

However, these factors on lands subsequently sampled, appear to account for no more than 25% of the variability of sample results (R squared, adjusted). The remaining variability, about 75%, of actual sample results is unaccounted for or is considered "noise." While mean values of carbon did increase across the no-till categories (H1 to H5), the effect of the tillage factor was not statistically significant. The project statisticians recognize that the use of a categorical variable for tillage limited the ability to detect changes in soil carbon.

3. Going Forward – An effort forward, constrained by budget and time, will be to further refine selected factors in an attempt to gain more certainty and reduce the noise. Possible refinements include aspect in degrees, soil depth, soil layers, and contribution of the A horizon. Additions will include temperature and slope gradient.

4. Meanwhile – All parties will work to advance information for reports and upcoming presentations during Q1. The challenge will be, in part, to convey a scientifically robust message to stakeholders such as farmers, investors, prospective farmer recruits, agencies, and future clients among others that is reflective of the uncertainty while exciting opportunities in a favorable light.

The above-described discussion of the initial model fits with the project team generated a revised plan of work to increase the precision of the modeling:

a) Add additional information and refit the total carbon (kg/m^2) response
    - actual number of years of no-till (substituting for H1-H5 categories of management)
    - average annual air temperature
    - % slope (gradient)
    - Aspect in degrees

b) Replace the total carbon (kg/m2) response in a) by the carbon kg/m^2 from horizon A (and AB) only.

c) Replace the total carbon (kg/m2) response by the carbon kg/m^2 "non A (and AB)" horizons.

In addition to the statistical analyses that are beginning to be run, the project team has also developed a set of "qualitative findings" from the observations of the sampling team and laboratory analysis team:

- The project team's understanding of the landscape is improving – we can account for a lot of the variability, but not all. These are natural systems and we're still learning about them.
- The project team and statisticians are working toward a predictive model for carbon accruals in this landscape.
- The early results confirmed that Carbon is located in the wetter precipitation zones and lower slope positions.
- There are many instances of deeply buried soil carbon in this landscape.
- The carbon levels in the uplands/upper slope positions may never equal those in the lower slope positions, but the lab analysis is indicating there is great potential for accrual there.
- The data tables from the lab allow summations of the data (as needed) – e.g. sort by A and B horizons; look at an overall average number; include range in soil carbon values; soil carbon in topsoil – x tons / acre to y tons / acre; Split between upland vs. lowland, etc.
- It is still difficult to ferret out the direct influence of cultivation practices in this landscape.

Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers

In August 2010, TEP developed a term sheet that would govern the rights to carbon credits and the contractual relationship between an investor and a developer in the case of this project. This agreement provided protection for the investor and developer to commit the risk capital while also ensuring the producers certain rights. The agreement merged the language and structure of an Emissions Reduction Purchase Agreement (ERPA) with the flexibility that a legal agreement that can accommodate early-stage investment in a project where the carbon has not been verified, and as such, where the developer cannot provide warranties and guarantees around the carbon asset. This term sheet referenced the Producer Enrollment Agreement developed and disseminated during the first half of the year, which governed the long-term partnership with the producer, provided protections to both parties, governed economic terms, and set out the activities that the carbon developer was to perform.

In November 2012, TEP went on a trip to the Palouse, to meet with producers, facilitate program enrollment, and provide an on-the-ground due diligence opportunity for the investor. TEP is continuing to hone its understanding of farming practices in order to address the other important structural issues in a carbon deal, including eligibility, duration, additionality, buffers, ownership, etc.

The project team has not yet begun developing a Project Design Document (PDD), but has been in discussion with the Verified Carbon Standard (VCS) about eligibility criteria for producers under their program. Further research is needed to determine if a PDD will be the appropriate avenue for the programmatic approach and regional program that the Palouse Soil Carbon project is seeking to develop.

Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members

At the end of 2012, the project team had approximately 100,000-acres of Shepherd's Grain producers committed and/or under contract of the Producer Enrollment Agreement. On June 2012, TEP sent out a finalized Producer Enrollment Agreement following multiple iterations that incorporated input from farmer groups, lawyers, and potential investors. As of the last semi-annual report in August 2012, TEP had received signed enrollment contracts with producers encompassing an estimated 69,255. This represented the more responsive and engaged set of producers in Shepherd's Grain.

The second half of 2012 was spent communicating with the remaining farmers to participate, answering their questions, and encouraging them to sign the Producer Enrollment Agreement. It became easier to engage later in the year once the fall harvest and winter wheat and cover crop planting seasons were completed. Also, the validation of the TEP Soil Carbon Methodology, and the resulting press release, encouraged a few of the unsigned producers to participate. Some producers remain resistant to the program, mainly for political reasons.

Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

On November 16, 2012, The Earth Partners' Soil Carbon Quantification Methodology received final approval by the Verified Carbon Standard (VCS). It validated by two third parties, Environmental Services Inc. (ESI) and Scientific Certification Systems (SCS), a process which was completed in the summer of 2012. There were some delays in the final sign-off and public posting by the VCS. It was approved within the Sectoral Scope 14. Agriculture, Forestry, Land Use (ALM), and contains 18 modules. The methodology can be publically accessed here: http://v-c-s.org/methodologies/VM0021, summarized as follows:

> "This modular methodology is designed to be applicable to ALM projects, including changes to agricultural practices, grassland and rangeland restorations, soil carbon protection and accrual benefits from reductions in erosion, grassland protection projects and treatments designed to improve diversity and productivity of grassland and savanna plant communities. The associated modules provide methods for quantifying and montioring changes in carbon accrual in, and emissions from, soils as well as from other GHG pools and sources that may be affected by AFOLU projects."

The methodology includes the following tools/modules:

1. Methods to Determine Stratification, v1.0
2. Methods to Project Future Conditions, v1.0
3. Methods to Determine Project Boundaries, v1.0
4. Estimation of Stocks in the Soil Carbon Pool, v1.0
5. Estimation of Carbon Stocks in Living Plant Biomass, v1.0
6. Estimation of Carbon Stocks in the Litter Pool, v1.0
7. Estimation of Carbon Stocks in the Dead Wood Pool, v1.0
8. Estimation of Woody Biomass Harvesting and Utilization, v1.0
9. Estimation of Carbon Stocks in the Long-Lived Wood Products Pool, v1.0
10. Estimation of Domesticated Animal Populations, v1.0
11. Estimation of Emissions from Domesticated Animals, v1.0
12. Estimation of Emissions from Non-CO2 GHGs from Soils, v1.1
13. Estimation of Emissions from Power Equipment, v1.0
14. Estimation of Emissions from Burning, v1.0
15. Estimation of Emissions from Activity-Shifting Leakage, v1.0
16. Estimation of Emissions from Market Leakage, v1.0
17. Methods for Developing a Monitoring Plan, v1.0
18. Methods to Determine the Net Change in Atmospheric GHG Resulting from Project Activities, v1.0

TEP developed a press release, which was picked up by in several agricultural and environmental news organizations, including Ecosystem Marketplace:
http://www.ecosystemmarketplace.com/pages/dynamic/article.page.php?page_id=9481&section=news_articles&eod=1

The market for carbon has weakened globally over the last year—in particular the voluntary market. Nevertheless, TEP has continued to engage potential voluntary carbon buyers and brokers around the unique elements of this program. Entities include The Carbon Neutral Company, British Gas, and The Climate Trust. The Climate Trust, a potential voluntary carbon buyer in Oregon, remain interested in our enrollment progress, scientific rigor of our methodology, and the fact that the producers are based in their regional areas of interest: the Pacific Northwest, and specifically Oregon. The team is continuing to work with The Climate Trust to develop a term sheet for a purchase of carbon credits from the program.

TEP is involved in developing a stakeholder and advocacy group focused on soil carbon and sustainable land management that will support the TEP program on the policy and market front. To this end, the team is working on a strategy to get these Palouse credits accepted into the California market through the California Air Resources Board. While no such protocols currently exist for California, TEP has discussed with VCS and American Carbon Registry the possibility of turning the Palouse program into an "eco-regional" protocol that could be accepted into California. This would result in a much-needed programmatic, measurement-based protocol that meets the requirements of being scientifically rigorous, large-scale, and low cost. It could be applicable to other large eco-regions that span millions of acres where, like the Palouse, there is continuity in ecological conditions and agricultural practices.

Task 8 – Reporting and Knowledge Dissemination

Ongoing communications with USDA administrative contacts Gregorio Cruz continue on an as-needed basis to ensure all administrative and budget questions and issues are addressed for the CIG grant.

Project team members regularly communicate with Steve Campbell, NRCS Technical Contact, to keep him informed of project progress and invite any contributions he may make to the project.

Upon request of Adam Chambers, NRCS West Technology Support Center in Portland, Oregon, team members attended a pre-conference dinner attended by CIG-GHG grant recipients at the Coalition on Agricultural Greenhouse Gases (C-AGG) meeting in Washington DC in early November, 2012. Ry Thompson and Tom Hunt attended the dinner event and the C-AGG meeting that followed.

After learning of the EQIP funding for CIG associated producers, Tom Hunt and Ry Thompson participated in several conference calls with Steve Campbell, Adam Chambers and Todd Peplin to learn about and discuss the opportunity and strategize for the CIG Palouse project. This is anticipated to be an ongoing collaborative process between the project team and NRCS staff.

7. Next Steps

During the first half of 2013, the following activities will be undertaken by the project team:

Task 1 – Business Origination with Shepherd's Grain

During the first half of 2013, the project team will travel to the Palouse region to present at the Pacific Northwest Direct Seeding Association conference. While in the region, the project team will reach out to a number of producers to provide informal updates on the project. The team will continue to coordinate with the Shepherd's Grain group as an approach to the PDD is developed.

Task 2 – Mapping Screening and Stratification of the Palouse

During the first half of 2013, it is expected that the project team will begin applying the stratification mapping to any new acreage that is secured for enrollment for analysis and modeling purposes. It is expected that this acreage will primarily come from producers outside of the Shepherd's Grain group.

Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region

For a variety of budgetary, logistical and programmatic reasons, it is not anticipated that a second sampling season will be completed during 2013.

Task 4 – Analysis and Baseline Development

As data becomes available from laboratory analysis during the second half of 2012, the statistical team will begin building the predictive model of soil carbon levels in the Palouse region. It is expected that the initial phase of this work will be completed during the first half of 2013.

Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers

During the first half of 2013, the project team will continue to evaluate the best approach to developing a program and carbon deal for the project. Several options are being explored, including the PDD that was originally proposed for the project. If this is the appropriate tool, t is expected that the PDD will not be completed until late 2013, when the predictive model calibrated and validated.

Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members

This will be a major focus of the AES/TEP team in early 2013. A presentation will occur at the Pacific Northwest Direct Seed Association annual conference in early February an ongoing outreach will occur throughout winter and spring 2013. It is anticipated that the EQIP efforts being initiated by NRCS to support the Greehouse Gas (GHG) CIG projects will provide some additional interest in the project among area producers.

Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

Discussions with potential carbon buyers in the voluntary market will continue during the first half of 2013. Further discussions regarding getting Palouse carbon credit offsets into the California ARB market will be ongoing.

Task 8 – Reporting and Knowledge Dissemination

Regular reporting with Steve Campbell and with the NRCS administrative contacts (as needed) will continue through the first half of 2013. AES/TEP staff will attend the March C-AGG meeting in Sacramento to report on the project.

8. Cost Status

See ***Appendix A – SF 425 Federal Financial Reports*** for the financials for this period.

9. Schedule/Milestone Status

During the third bi-annual report period, the project is generally progressing according to schedule. The laboratory analysis took longer than expected and has delayed the schedule for statistical analysis. A second field season originally planned for spring 2013 is not expected due to a number of factors described above. A PDD may not be the most appropriate tool for the project and will not be initiated until it is clear this method is appropriate for developing the carbon project. We do not believe this will materially affect or delay any major milestones in the Schedule. A project schedule with milestones is presented in ***Appendix B – Updated Project Schedule with Milestones***.

APPENDICES

Appendix A – SF425 Federal Financial Reports for July – December 2012
Appendix B – Updated Project Schedule with Milestones
Appendix C – Palouse Soil Cores Raw data from UM Soils Characterization Lab

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page 1 of 1 pages
USDA-NRCS, Washington DC	**69-3A75-11-131**	

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	**39-1611274**		☑ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☑ Cash ☐ Accrual

8. Project/Grant Period (Month, Day, Year)		9. Reporting Period End Date (Month, Day, Year)
From: **July 1, 2012**	To: **September 30, 2012**	**September 30, 2012**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0**
b. Cash Disbursements	**645,800.25**
c. Cash on Hand (line a minus b)	**0**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000**
e. Federal share of expenditures	**460,794.86**
f. Federal share of unliquidated obligations	**0**
g. Total Federal share (sum of lines e and f)	**460,794.86**
h. Unobligated balance of Federal funds (line d minus g)	**89,205.14**
Recipient Share:	
i. Total recipient share required	**550,000**
j. Recipient share of expenditures	**185,005.39**
k. Remaining recipient share to be provided (line i minus j)	**364,994.61**
Program Income:	
l. Total Federal program income earned	**0**
m. Program income expended in accordance with the deduction alternative	**0**
n. Program income expended in accordance with the addition alternative	**0**
o. Unexpended program income (line l minus line m or line n)	**0**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number, and extension)
Ry Thompson, Ecologist/Project Manager **Applied Ecological Services, Inc.**	**(608) 897-8641 ext. 57**
	d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **10/31/12 (through 5th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page of
USDA-NRCS, Washington DC	**69-3A75-11-131**	1 of 1 pages

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	**39-1611274**		☒ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☒ Cash ☐ Accrual

8. Project/Grant Period (Month, Day, Year)		9. Reporting Period End Date (Month, Day, Year)
From: **October 1, 2012**	To: **December 31, 2012**	**December 31, 2012**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0**
b. Cash Disbursements	**709,911.95**
c. Cash on Hand (line a minus b)	**0**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000**
e. Federal share of expenditures	**517,663.31**
f. Federal share of unliquidated obligations	**0**
g. Total Federal share (sum of lines e and f)	**517,663.31**
h. Unobligated balance of Federal funds (line d minus g)	**32,336.69**
Recipient Share:	
i. Total recipient share required	**550,000**
j. Recipient share of expenditures	**192,248.64**
k. Remaining recipient share to be provided (line i minus j)	**357,751.36**
Program Income:	
l. Total Federal program income earned	**0**
m. Program income expended in accordance with the deduction alternative	**0**
n. Program income expended in accordance with the addition alternative	**0**
o. Unexpended program income (line l minus line m or line n)	**0**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number, and extension)
Ry Thompson, Ecologist/Project Manager **Applied Ecological Services, Inc.**	**(608) 897-8641 ext. 57**
	d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **1/31/13 (through 6th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

	Year 1				Year 2				Year 3				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
	Aug 15 - Sep 30, 2011	Sep 1 - Dec 31, 2011	Jan 1 - Mar 31, 2012	Apr 1 - Jun 30, 2012	Jul 1 - Sep 30, 2012	Oct 1 - Dec 31, 2012	Jan 1 - Mar 31, 2013	Apr 1 - Jun 30, 2013	Jul 1 - Sep 30, 2013	Oct 1 - Dec 31, 2013	Jan 1 - Mar 31, 2014	Apr 1 - Jun 30, 2014	Jul 1 - Jul 31, 2014
Project organization and set-up	■												
Introductory meetings		■											
Partnership development with Shepherd's Grain (SG) and surrounding landowners		■	■										
Partnership agreement finalized with farmers				◆									
Development and dissemination of educational materials		■	■	■	■								
Development of live farm field activity web site		■	■										
Mapping, screening, and stratification of the Palouse		■	■										
Mapping and stratification completed			◆										
Preparation for sampling		■	■										
Sampling across Palouse region				■	■								
Laboratory analysis of samples			■		■								
Statistical analysis and baseline development						■	■	■					
Review of analysis by experts and technical team							■						
Baseline developed for carbon project								◆					
Finalize soil method validation through VCS or other body		■	■	■									
Methodology validated						◆							
PDD drafting and review for SG and surrounding landowners							■	■	■				
Formal submittal of PDD to independent validator									■				
PDD delivered to market									◆				
Aggregation beyond SG and surrounding landowners							■	■	■	■			
Partnership agreement finalized with famers										◆			
Host meetings and discussions with high potential carbon buyers									■	■	■		
Drafting of deal structures to monetize credits											■	■	
Carbon deal structured												◆	
Engage ARB or other emerging compliance markets						■	■	■	■	■	■	■	■
USDA communications		■	■	■	■	■	■	■	■	■	■	■	■
Semi-annual Report (Due 1/31/12, 1/31/13 and 1/31/14)			◆				◆				◆		
Annual report (Due 7/31/12 and 7/31/13)					◆				◆				
Final Report (Due 10/31/14)													◆

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1000	PAL1000-1	0	35	A		684.51	555.36	1.15	0.00	2.22	0.00	2.22	
1000	PAL1000-2	35	56	AB		467.62	374.88	1.29	0.00	1.50	0.00	1.50	
1000	PAL1000-3	56	92	B		753.57	610.50	1.22	0.00	0.72	0.00	0.72	
1001	PAL1001-1	0	52	A		1085.12	850.03	1.18	0.00	2.43	0.00	2.43	No visible Ap
1001	PAL1001-2	52	71	AB		403.73	308.03	1.17	0.00	1.83	0.00	1.83	
1001	PAL1001-3	71	88	B		406.15	321.90	1.37	0.00	0.75	0.00	0.75	
1002	PAL1002-1	0	12	Ap	D	235.31	188.18	1.13	0.00	2.24	0.00	2.24	10YR 5/8
1002	PAL1002-2	12	63	A	D	983.02	769.73	1.09	0.00	1.69	0.00	1.69	
1002	PAL1002-3	63	94	2A	D	601.68	458.53	1.07	0.00	1.15	0.00	1.15	
1003	PAL1003-1	0	24	Ap		476.10	379.86	1.14	0.00	2.06	0.00	2.06	Ap1 appears to be hillslope sediment from upslope B horizon
1003	PAL1003-2	24	69	A1		921.80	718.83	1.15	0.00	1.30	0.00	1.30	
1003	PAL1003-3	69	88	AB1		486.76	397.94	1.51	0.00	0.35	0.00	0.35	
1004	PAL1004-1	0	24	Ap	S	493.60	407.80	1.23	0.00	1.95	0.00	1.95	
1004	PAL1004-2	24	52	BA	S	597.86	494.10	1.27	0.00	0.71	0.00	0.71	
1004	PAL1004-3	52	92	Bt	S	964.59	794.31	1.43	0.00	0.34	0.00	0.34	Thick organic matter films on ped faces of Bt horizon
1005	PAL1005-1	0	39	A1		809.98	641.83	1.19	0.00	1.90	0.00	1.90	Hillslope sediment 0-11 cm
1005	PAL1005-2	39	69	A2		531.01	372.45	0.90	0.00	2.08	0.00	2.08	
1005	PAL1005-3	69	93	AB		496.06	346.01	1.04	0.00	1.27	0.00	1.27	
1006	PAL1006-1	0	17	Ap		314.57	251.55	1.07	0.00	2.20	0.00	2.20	
1006	PAL1006-2	17	29	AB		246.39	200.25	1.20	0.00	0.96	0.00	0.96	
1006	PAL1006-3	29	93	B		1426.41	1163.09	1.31	0.00	0.35	0.00	0.35	
1007	PAL1007-1	0	53	A	D	1008.54	781.04	1.06	0.00	2.02	0.00	2.02	No Ap horizon
1007	PAL1007-2	53	86	AB	D	661.32	529.01	1.16	0.00	0.71	0.00	0.71	Krotovinas in AB and Bgc horizons
1007	PAL1007-3	86	98	B	D	292.42	238.17	1.43	0.00	0.38	0.00	0.38	
1008	PAL1008-1	0	35	A	S	693.40	587.02	1.21	0.00	1.49	0.00	1.49	
1008	PAL1008-2	35	52	BA	S	405.49	338.47	1.44	0.00	0.66	0.00	0.66	
1008	PAL1008-3	52	88	B	S	879.65	730.73	1.47	0.00	0.46	0.00	0.46	
1009	PAL1009-1	0	32	A	E	710.29	579.63	1.31	0.00	1.46	0.00	1.46	
1009	PAL1009-2	32	49	BA	E	390.90	314.10	1.33	0.00	0.58	0.00	0.58	
1009	PAL1009-3	49	95	Bt	E	1151.29	953.02	1.50	0.00	0.33	0.00	0.33	
1010	PAL1010-1	0	20	Ap		478.93	401.16	1.45	0.00	2.04	0.00	2.04	Hillslope sediment on surface
1010	PAL1010-2	20	65	A		853.42	668.38	1.07	0.00	2.04	0.00	2.04	
1010	PAL1010-3	65	98	AB		646.78	480.30	1.05	0.00	1.37	0.00	1.37	
1011	PAL1011-1	0	19	Ap	D	383.03	314.39	1.19	0.00	1.80	0.00	1.80	
1011	PAL1011-2	19	41	A	D	489.02	392.34	1.29	0.00	1.42	0.00	1.42	
1011	PAL1011-3	41	88	BA	D	1139.68	910.19	1.40	0.00	0.70	0.00	0.70	
1012	PAL1012-1	0	48	A	D	1004.56	804.28	1.21	0.00	1.91	0.00	1.91	No Ap horizon
1012	PAL1012-2	48	68	AB	D	444.00	340.79	1.23	0.00	1.26	0.00	1.26	
1012	PAL1012-3	68	88	BA	D	458.18	354.40	1.28	0.00	0.83	0.00	0.83	
1013	PAL1013-1	0	51	A	D	1194.24	937.80	1.33	0.00	1.35	0.00	1.35	
1013	PAL1013-2	51	77	Eg	D	630.48	503.86	1.40	0.00	0.37	0.00	0.37	
1013	PAL1013-3	77	96	Bt	D	494.70	386.82	1.47	0.49	0.30	0.00	0.30	
1014	PAL1014-1	0	24	Ap	D	509.36	401.43	1.21	0.00	1.76	0.00	1.76	
1014	PAL1014-2	24	58	A	D	765.82	603.57	1.28	0.00	0.97	0.00	0.97	
1014	PAL1014-3	58	97	E	D	1013.11	798.06	1.48	0.00	0.38	0.00	0.38	
1015	PAL1015-1	0	36	A1	D	720.95	560.75	1.12	0.00	2.48	0.00	2.48	No Ap horizon
1015	PAL1015-2	36	58	A2	D	419.92	300.53	0.99	0.00	1.98	0.00	1.98	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1015	PAL1015-3	58	88	AB	D	576.48	394.49	0.95	0.00	1.30	0.00	1.30	
1016	PAL1016-1	0	30	AB		657.57	547.76	1.32	0.00	1.74	0.00	1.74	Hillslope sediment 0-30 cm (AB)
1016	PAL1016-2	30	62	2A1		826.36	650.03	1.47	0.00	1.98	0.00	1.98	
1016	PAL1016-3	62	96	2A2		605.22	446.55	0.95	0.00	2.71	0.00	2.71	
1017	PAL1017-1	0	19	Ap		421.20	346.36	1.32	0.00	1.18	0.00	1.18	Ap is indistinct. Profile darkens with depth.
1017	PAL1017-2	19	51	A1		776.79	626.30	1.41	0.00	1.08	0.00	1.08	
1017	PAL1017-3	51	84	A2		834.37	651.92	1.43	0.00	0.79	0.00	0.79	
1018	PAL1018-1	0	31	A1	D	701.38	573.15	1.33	0.00	1.12	0.00	1.12	
1018	PAL1018-2	31	50	A2	D	454.25	360.31	1.37	0.00	1.00	0.00	1.00	
1018	PAL1018-3	50	82	A3	D	800.20	631.11	1.42	0.00	0.70	0.00	0.70	
1019	PAL1019-1	0	21	Ap		446.19	390.18	1.34	0.00	1.33	0.00	1.33	9 cm hillslope sediment in Ap. Bk carbonates effervesce
1019	PAL1019-2	21	39	B		447.42	373.96	1.50	0.00	0.41	0.08	0.49	
1019	PAL1019-3	39	67	Bk		604.30	497.81	1.28	0.00	0.24	0.95	1.19	
1020	PAL1020-1	0	21	Ap		425.05	361.19	1.24	0.00	1.79	0.00	1.79	
1020	PAL1020-2	21	46	AB		529.24	439.51	1.27	0.00	0.55	0.00	0.55	
1020	PAL1020-3	46	90	BA		1002.58	822.28	1.35	0.00	0.37	0.00	0.37	
1021	PAL1021-1	0	16	Ap	D	336.59	293.20	1.32	0.00	1.93	0.00	1.93	Ap horizon is hillslope sediment
1021	PAL1021-2	16	55	A	D	885.66	724.87	1.34	0.00	1.28	0.00	1.28	
1021	PAL1021-3	55	97	AB	D	1032.50	841.74	1.45	0.00	0.59	0.00	0.59	
1022	PAL1022-1	0	17	A1		310.94	275.87	1.17	0.00	2.06	0.00	2.06	A1 is hillslope sediment
1022	PAL1022-2	17	64	A2		1115.31	913.49	1.40	0.00	1.01	0.00	1.01	
1022	PAL1022-3	64	75	B		248.45	204.60	1.34	0.00	0.38	0.00	0.38	
1023	PAL1023-1	0	29	A		914.13	746.30	1.86	0.00	1.52	0.00	1.52	
1023	PAL1023-2	29	86	Bt1		1179.69	967.71	1.23	0.00	0.48	0.00	0.48	
1024	PAL1024-1	0	20	Ap	D	328.46	281.85	1.02	0.00	3.10	0.00	3.10	Ap horizon is hillslope sediment
1024	PAL1024-2	20	53	A	D	676.75	538.92	1.18	0.00	2.21	0.00	2.21	
1024	PAL1024-3	53	77	BA	D	625.69	501.35	1.51	0.00	0.69	0.00	0.69	
1025	PAL1025-1	0	19	Ap		349.79	299.28	1.14	0.00	2.46	0.00	2.46	
1025	PAL1025-2	19	48	A1		599.06	501.40	1.25	0.00	1.88	0.00	1.88	
1025	PAL1025-3	48	74	A2		524.47	424.22	1.18	0.00	1.42	0.00	1.42	
1025	PAL1025-4	74	98	A3		576.26	442.80	1.33	0.00	0.97	0.00	0.97	
1026	PAL1026-1	0	41	A	D	910.21	736.56	1.30	0.00	1.61	0.00	1.61	Clayey
1026	PAL1026-2	41	56	AB	D	357.24	283.37	1.36	0.00	0.76	0.00	0.76	
1026	PAL1026-3	56	86	B	D	750.57	605.95	1.46	0.00	0.40	0.00	0.40	
1027	PAL1027-1	0	15	Ap	E	327.32	290.02	1.40	0.00	1.05	0.00	1.05	Clayey
1027	PAL1027-2	15	54	Bt1	E	970.75	817.77	1.51	0.00	0.27	0.00	0.27	
1027	PAL1027-3	54	98	Bt2	E	1146.04	936.15	1.54	0.00	0.17	0.00	0.17	
1028	PAL1028-1	0	25	A		541.47	448.06	1.29	0.00	1.03	0.00	1.03	
1028	PAL1028-2	25	61	BA		786.97	657.16	1.32	0.00	0.52	0.00	0.52	
1028	PAL1028-3	61	95	Bt		773.54	647.95	1.38	0.00	0.23	0.00	0.23	
1029	PAL1029-1	0	20	Ap		346.65	289.31	1.04	0.00	1.60	0.00	1.60	
1029	PAL1029-2	20	51	A		554.23	462.96	1.08	0.00	1.18	0.00	1.18	
1029	PAL1029-3	51	97	Bt2		966.13	814.91	1.28	0.00	0.76	0.00	0.76	
1030	PAL1030-1	0	23	Ap		419.51	352.80	1.11	0.00	1.70	0.00	1.70	Very friable, weak Bt structure. Color-structure-texture break at 2A
1030	PAL1030-2	23	51	AB		561.55	482.14	1.24	0.00	0.71	0.00	0.71	
1030	PAL1030-3	51	83	Bt		647.39	556.58	1.26	0.00	0.39	0.00	0.39	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1030	PAL1030-4	83	90	2A		156.45	134.46	1.39	0.00	0.58	0.00	0.58	
1031	PAL1031-1	0	33	A		606.99	510.26	1.12	0.00	1.16	0.00	1.16	
1031	PAL1031-2	33	56	BA		466.45	399.49	1.25	0.00	0.49	0.00	0.49	
1031	PAL1031-3	56	94	Bt		813.74	694.84	1.32	0.00	0.33	0.00	0.33	
1032	PAL1032-1	0	32	A		569.55	475.24	1.07	0.00	1.43	0.00	1.43	Hillslope sediment 0-13 cm
1032	PAL1032-2	32	44	BA		225.72	191.95	1.15	0.00	0.81	0.00	0.81	
1032	PAL1032-3	44	96	Bt		1103.78	940.07	1.30	0.00	0.39	0.00	0.39	
1033	PAL1033-1	0	18	A		323.82	285.68	1.15	0.00	1.34	0.00	1.34	Ap probably B material from upslope - low clay in lower part of the profile
1033	PAL1033-2	18	48	2A		571.42	480.11	1.16	0.00	1.42	0.00	1.42	
1033	PAL1033-3	48	97	2AB		743.51	583.66	0.86	0.00	1.68	0.00	1.68	
1034	PAL1034-1	0	25	A		393.62	362.96	1.05	0.00	1.37	0.00	1.37	
1034	PAL1034-2	25	58	B1		622.94	570.32	1.25	0.00	0.52	0.00	0.52	
1034	PAL1034-3	58	95	B2		813.93	730.15	1.42	0.00	0.36	0.00	0.36	
1035	PAL1035-1	0	31	A	D	684.94	545.06	1.27	0.00	1.93	0.00	1.93	No visible Ap horizon - krotovinas
1035	PAL1035-2	31	60	BA	D	608.90	467.85	1.16	0.00	1.08	0.00	1.08	
1035	PAL1035-3	60	98	Bt	D	960.86	788.95	1.50	0.00	0.37	0.00	0.37	
1036	PAL1036-1	0	23	Ap	E	434.93	389.63	1.22	0.00	2.20	0.00	2.20	Krotovinas and roots throughout core
1036	PAL1036-2	23	65	BA	E	818.11	718.70	1.24	0.00	0.82	0.00	0.82	
1036	PAL1036-3	65	97	Bt	E	730.52	623.76	1.41	0.00	0.32	0.00	0.32	
1037	PAL1037-1	0	24	Ap	E	455.83	400.20	1.20	0.00	1.97	0.00	1.97	
1037	PAL1037-2	24	50	BA	E	479.29	418.21	1.16	0.00	0.84	0.00	0.84	
1037	PAL1037-3	50	97	Btc	E	980.47	836.07	1.28	0.00	0.37	0.00	0.37	Krotovinas in Btc horizon
1038	PAL1038-1	0	25	A1	D	599.02	489.14	1.41	0.00	1.79	0.00	1.79	
1038	PAL1038-2	25	43	A2	D	397.61	311.17	1.25	0.00	1.87	0.00	1.87	
1038	PAL1038-3	43	80	AB	D	920.35	721.65	1.41	0.00	0.98	0.00	0.98	
1039	PAL1039-1	0	14	A	E	328.61	268.09	1.38	0.00	1.37	0.00	1.37	Clayey
1039	PAL1039-2	14	43	B	E	801.90	645.87	1.61	0.00	0.25	0.00	0.25	
1040	PAL1040-1	0	36	A	S	747.91	590.90	1.18	0.00	1.73	0.00	1.73	Krotovinas - clayey
1040	PAL1040-2	36	56	BA	S	488.12	398.69	1.44	0.00	0.57	0.00	0.57	
1040	PAL1040-3	56	97	B	S	1012.00	825.98	1.45	0.00	0.33	0.00	0.33	
1041	PAL1041-1	0	23	A1	D	500.44	401.25	1.26	0.00	1.82	0.00	1.82	Krotovinas
1041	PAL1041-2	23	57	A2	D	720.25	544.75	1.16	0.00	1.47	0.00	1.47	
1041	PAL1041-3	57	91	BA	D	756.25	596.68	1.27	0.00	0.70	0.00	0.70	
1042	PAL1042-1	0	21	Ap	E	427.90	360.40	1.24	0.00	0.79	0.08	0.87	Everything below Ap horizon effervesces strongly
1042	PAL1042-2	21	68	Btk1	E	1069.44	867.20	1.33	0.00	0.20	1.19	1.39	
1042	PAL1042-3	68	86	Btk2	E	372.29	298.17	1.20	0.00	0.15	1.18	1.33	2Btk4 has sand
1043	PAL1043-1	0	15	Ap	E	263.04	240.68	1.16	0.00	1.69	0.00	1.69	Krotovinas - clayey
1043	PAL1043-2	15	31	BA	E	343.40	310.92	1.40	0.00	0.72	0.14	0.86	
1043	PAL1043-3	31	98	B	E	1465.77	1262.97	1.36	0.00	0.26	0.00	0.26	
1044	PAL1044-1	0	22	Ap	S	483.00	393.48	1.29	0.18	1.79	0.00	1.79	
1044	PAL1044-2	22	34	AB	S	266.74	212.71	1.28	0.00	1.10	0.00	1.10	
1044	PAL1044-3	34	50	B	S	360.44	277.83	1.25	0.31	1.01	1.32	2.33	Effervesces - 2Btk is light gray with abrupt color break
1045	PAL1045-1	0	45	A		918.37	735.51	1.18	0.00	1.91	0.00	1.91	
1045	PAL1045-1	0	23	Ap	E	449.97	380.59	1.19	0.00	2.15	0.00	2.15	Questionable bulk density - core is stretched in lower half
1045	PAL1045-2	45	62	AB		392.68	286.72	1.22	0.00	1.25	0.00	1.25	
1045	PAL1045-2	23	52	A	E	566.54	481.20	1.20	0.00	0.79	0.00	0.79	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1045	PAL1045-3	62	84	Bgc		624.49	470.09	1.54	0.00	0.67	0.00	0.67	
1045	PAL1045-3	52	99	BA	E	1130.86	947.79	1.46	0.00	0.40	0.00	0.40	
1046	PAL1046-1	0	33	A		664.49	567.18	1.23	2.61	2.18	0.00	2.18	
1046	PAL1046-2	33	70	AB		676.53	563.14	1.10	0.00	1.21	0.00	1.21	
1046	PAL1046-3	70	98	Btk		651.41	554.90	1.43	0.00	0.41	0.00	0.41	
1047	PAL1047-1	0	29	Ap	D	546.09	457.42	1.14	0.00	2.03	0.00	2.03	
1047	PAL1047-2	29	64	A	D	651.89	536.07	1.11	0.00	1.13	0.00	1.13	
1047	PAL1047-3	64	97	Bt	D	783.79	657.74	1.44	0.00	0.40	0.00	0.40	
1048	PAL1048-1	0	28	Ap	D	569.60	477.90	1.23	0.00	1.55	0.00	1.55	
1048	PAL1048-2	28	58	AB	D	618.51	497.46	1.20	0.00	0.83	0.00	0.83	
1048	PAL1048-3	58	99	B	D	1009.65	838.97	1.48	0.00	0.37	0.00	0.37	
1049	PAL1049-1	0	19	Ap	S	399.26	323.31	1.23	0.00	2.05	0.00	2.05	
1049	PAL1049-2	19	39	AB	S	452.51	362.51	1.31	0.00	1.01	0.00	1.01	
1049	PAL1049-3	39	99	Btc	S	1459.92	1198.14	1.44	0.00	0.40	0.00	0.40	
1050	PAL1050-1	0	10	Ap	E	221.09	184.15	1.33	0.00	2.35	0.00	2.35	
1050	PAL1050-2	10	47	E1	E	848.22	683.89	1.32	5.21	0.46	0.00	0.46	
1050	PAL1050-3	47	98	E2	E	1277.97	1019.96	1.36	60.00	0.18	0.06	0.24	
1051	PAL1051-1	0	29	A		651.69	516.71	1.29	0.00	1.66	0.00	1.66	No clear Ap horizon
1051	PAL1051-2	29	47	E		457.78	377.69	1.51	0.00	0.37	0.00	0.37	
1051	PAL1051-3	47	89	Btc		994.90	759.27	1.30	0.00	0.21	0.00	0.21	
1052	PAL1052-1	0	39	A	E	938.00	776.18	1.44	0.00	0.97	0.00	0.97	
1052	PAL1052-2	39	63	E	E	612.06	500.62	1.51	0.00	0.46	0.00	0.46	
1052	PAL1052-3	63	92	Bt	E	772.93	636.36	1.58	0.00	0.26	0.00	0.26	
1053	PAL1053-1	0	23	Ap		477.57	389.95	1.22	0.00	1.63	0.00	1.63	
1053	PAL1053-2	23	44	AB		543.80	440.26	1.51	0.00	0.67	0.00	0.67	
1053	PAL1053-3	44	85	Bt		974.79	804.73	1.42	0.00	0.30	0.00	0.30	
1054	PAL1054-1	0	26	A1		534.30	430.53	1.20	0.00	1.86	0.00	1.86	
1054	PAL1054-2	26	71	A2		1026.05	839.54	1.35	0.00	1.01	0.00	1.01	
1054	PAL1054-3	71	98	AB		724.44	592.87	1.58	0.00	0.54	0.00	0.54	
1055	PAL1055-1	0	29	A		627.49	499.95	1.24	0.00	1.88	0.00	1.88	No Ap
1055	PAL1055-2	29	59	Bt1		689.74	562.47	1.35	0.00	0.57	0.00	0.57	
1055	PAL1055-3	59	97	Bt2		917.65	749.42	1.42	0.00	0.30	0.00	0.30	
1056	PAL1056-1	0	32	A		738.73	585.04	1.32	0.00	1.67	0.00	1.67	
1056	PAL1056-2	32	68	AB		853.51	644.47	1.29	0.00	0.84	0.00	0.84	
1056	PAL1056-3	68	97	Bc		738.01	586.64	1.46	0.00	0.44	0.00	0.44	
1057	PAL1057-1	0	29	A		553.29	475.46	1.18	0.00	1.97	0.00	1.97	No clear Ap horizon
1057	PAL1057-2	29	61	BA		731.88	610.72	1.38	0.00	0.56	0.00	0.56	
1057	PAL1057-3	61	98	Bt		936.24	786.65	1.53	0.00	0.31	0.00	0.31	
1058	PAL1058-1	0	18	Ap	E	397.20	320.16	1.28	0.00	1.82	0.00	1.82	
1058	PAL1058-2	18	57	Bt1	E	946.55	767.90	1.42	0.00	0.51	0.00	0.51	
1058	PAL1058-3	57	98	Bt2	E	1064.57	881.60	1.55	0.00	0.25	0.00	0.25	
1059	PAL1059-1	0	28	A1		548.79	456.57	1.18	0.00	1.24	0.00	1.24	
1059	PAL1059-2	28	53	A2		444.23	372.40	1.08	0.00	0.80	0.00	0.80	
1059	PAL1059-3	53	91	BA		771.92	647.72	1.23	0.00	0.54	0.00	0.54	
1060	PAL1060-1	0	23	A		436.15	375.98	1.18	0.00	1.40	0.00	1.40	
1060	PAL1060-2	26	68	2A		767.54	665.45	1.14	0.00	0.88	0.00	0.88	
1060	PAL1060-3	68	98	2B		636.87	556.38	1.34	0.00	0.38	0.00	0.38	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1061	PAL1061-1	0	44	A	D	762.26	645.32	1.06	0.00	1.15	0.00	1.15	
1061	PAL1061-2	44	63	AB	D	346.94	296.94	1.13	0.00	0.80	0.00	0.80	
1061	PAL1061-3	63	98	BA	D	689.20	591.06	1.22	0.00	0.60	0.00	0.60	
1062	PAL1062-1	0	20	Ap		419.63	349.96	1.26	0.00	1.76	0.00	1.76	6 cm hillslope sediment on top of Ap
1062	PAL1062-2	20	52	A		675.49	540.96	1.22	0.00	1.57	0.00	1.57	
1062	PAL1062-3	52	94	AB		824.00	629.92	1.08	0.00	1.09	0.00	1.09	
1063	PAL1063-1	0	37	Bt1	E	568.71	509.69	0.99	0.00	0.81	0.00	0.81	
1063	PAL1063-2	37	60	Bt2	E	424.88	371.51	1.17	0.00	0.42	0.00	0.42	
1063	PAL1063-3	60	90	Bt3	E	575.61	501.22	1.21	0.00	0.31	0.00	0.31	
1064	PAL1064-1	0	47	A		962.04	794.43	1.22	1.06	1.09	0.00	1.09	
1064	PAL1064-2	47	75	BA		568.00	464.39	1.20	0.30	0.62	0.00	0.62	
1064	PAL1064-3	75	96	B		431.87	350.33	1.20	0.00	0.51	0.00	0.51	
1065	PAL1065-1	0	45	A	D	937.35	778.57	1.25	0.30	1.12	0.00	1.12	Clayey
1065	PAL1065-2	45	69	BA	D	521.19	433.65	1.30	0.00	0.45	0.00	0.45	
1065	PAL1065-3	69	89	B	D	484.79	405.35	1.46	0.00	0.29	0.00	0.29	
1066	PAL1066-1	0	25	Ap	D	466.90	401.11	1.16	0.00	1.58	0.00	1.58	
1066	PAL1066-2	25	68	A	D	813.10	674.39	1.13	0.00	1.38	0.00	1.38	
1066	PAL1066-3	68	98	AB	D	565.39	464.41	1.12	0.00	0.93	0.00	0.93	
1067	PAL1067-1	0	46	A	D	1026.12	829.65	1.30	0.00	1.53	0.00	1.53	
1067	PAL1067-2	46	65	AB	D	433.79	351.79	1.34	0.00	0.81	0.00	0.81	
1067	PAL1067-3	65	89	BA	D	495.61	399.36	1.20	0.00	0.62	0.00	0.62	
1068	PAL1068-1	0	28	A		630.56	523.23	1.34	1.93	1.65	0.00	1.65	Krotovina in Bt
1068	PAL1068-2	28	54	BA		549.80	455.35	1.26	0.00	0.68	0.00	0.68	
1068	PAL1068-3	54	96	Bt		911.22	753.51	1.29	0.00	0.31	0.00	0.31	
1069	PAL1069-1	0	41	A	D	908.89	719.34	1.27	0.00	1.85	0.00	1.85	No Ap horizon - krotovinas - clayey
1069	PAL1069-2	41	53	AB	D	286.34	229.42	1.38	0.00	0.71	0.00	0.71	
1069	PAL1069-3	53	88	Bt	D	855.12	679.51	1.40	0.00	0.40	0.00	0.40	
1070	PAL1070-1	0	31	A		672.79	538.38	1.25	0.00	1.98	0.00	1.98	
1070	PAL1070-2	31	56	AB		601.65	475.84	1.37	0.00	0.89	0.00	0.89	
1070	PAL1070-3	56	94	Bt		966.65	773.97	1.47	0.00	0.27	0.00	0.27	
1071	PAL1071-1	0	14	Ap		286.88	230.50	1.19	0.00	2.14	0.00	2.14	
1071	PAL1071-2	14	51	A1		824.30	664.50	1.30	0.00	1.23	0.00	1.23	
1071	PAL1071-3	51	96	Bt		1103.04	884.79	1.42	0.00	0.36	0.00	0.36	Large krotovinas in Bt1
1072	PAL1072-1	0	31	Ap	D	604.19	470.62	1.10	0.00	2.24	0.00	2.24	
1072	PAL1072-2	31	64	A	D	765.95	564.91	1.24	0.00	1.55	0.00	1.55	
1072	PAL1072-3	64	92	AB	D	723.50	549.94	1.42	0.00	0.96	0.00	0.96	
1073	PAL1073-1	0	21	Ap	S	471.91	375.56	1.29	0.00	1.89	0.00	1.89	Faint Ap horizon
1073	PAL1073-2	21	40	AB	S	420.68	338.11	1.28	0.00	0.75	0.00	0.75	
1073	PAL1073-3	40	94	Bt	S	1409.60	1115.23	1.49	0.00	0.37	0.00	0.37	
1074	PAL1074-1	0	20	Ap	E	361.59	340.25	1.23	0.00	0.97	0.00	0.97	
1074	PAL1074-2	20	33	BA	E	280.81	265.56	1.47	0.00	0.44	0.00	0.44	
1074	PAL1074-3	33	96	Bt	E	1229.73	1160.32	1.33	0.00	0.20	0.00	0.20	
1075	PAL1075-1	0	27	A	D	471.94	453.63	1.21	0.00	0.86	0.00	0.86	
1075	PAL1075-2	27	55	A	D	530.36	503.34	1.30	0.00	0.66	0.00	0.66	
1075	PAL1075-3	55	93	2A	D	749.39	699.06	1.33	0.00	0.50	0.00	0.50	
1076	PAL1076-1	0	35	Ap	E	605.28	573.90	1.18	0.00	0.83	0.00	0.83	
1076	PAL1076-2	35	61	Bt1	E	482.58	456.70	1.27	0.00	0.72	0.00	0.72	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1076	PAL1076-3	61	97	Bt2	E	698.15	649.86	1.30	0.00	0.53	0.00	0.53	
1077	PAL1077-1	0	18	Ap		403.72	358.35	1.44	0.00	0.75	0.00	0.75	
1077	PAL1077-2	18	39	AB		429.32	383.91	1.32	0.00	0.37	0.00	0.37	
1077	PAL1077-3	39	92	Bt		1132.05	1011.04	1.38	0.00	0.22	0.00	0.22	
1078	PAL1078-1	0	35	Ap	E	647.45	595.02	1.22	1.12	1.03	0.00	1.03	Ap horizon is in old Bt material
1078	PAL1078-2	35	69	Bt	E	586.21	543.26	1.15	0.72	0.50	0.00	0.50	
1078	PAL1078-3	69	98	Btk	E	468.24	433.27	1.08	1.09	0.68	0.52	1.20	Effervesces
1079	PAL1079-1	0	20	Ap		358.29	333.15	1.16	12.98	1.17	0.00	1.17	Severely eroded - free carbonates 44 cm from bottom - Ap in old B
1079	PAL1079-2	20	52	Bt1		583.21	539.34	1.22	0.17	0.62	0.00	0.62	
1079	PAL1079-3	52	98	Btk		817.07	752.13	1.18	0.48	0.35	0.49	0.84	
1080	PAL1080-1	0	25	Ap		512.93	459.41	1.33	0.47	1.04	0.00	1.04	Erosional surface
1080	PAL1080-1	0	51	A	S	854.65	712.24	1.01	0.00	1.44	0.00	1.44	
1080	PAL1080-2	25	57	BA		592.28	525.98	1.19	0.30	0.52	0.00	0.52	
1080	PAL1080-2	51	82	AB	S	584.24	496.46	1.16	0.00	0.59	0.00	0.59	
1080	PAL1080-3	57	95	Bt		687.80	613.77	1.16	1.19	0.28	0.00	0.28	
1080	PAL1080-3	82	98	Bt	S	336.75	296.08	1.34	0.00	0.29	0.00	0.29	
1081	PAL1081-1	0	17	Ap		311.69	266.93	1.12	2.15	1.24	0.00	1.24	
1081	PAL1081-2	17	37	A		432.27	369.57	1.32	3.02	0.70	0.00	0.70	
1081	PAL1081-3	37	72	Bt		750.61	666.54	1.36	7.75	0.30	0.00	0.30	
1082	PAL1082-1	0	34	A	D	711.58	594.80	1.26	0.00	0.95	0.00	0.95	Appear to be two weak, buried A horizons at 57 & 84 cm
1082	PAL1082-2	34	57	B	D	494.93	421.78	1.32	0.00	0.36	0.00	0.36	
1082	PAL1082-3	57	98	2BA	D	864.59	731.79	1.29	0.13	0.25	0.00	0.25	
1083	PAL1083-1	0	32	A1		584.71	472.38	1.07	0.00	1.56	0.00	1.56	Stable surface
1083	PAL1083-2	32	51	A2		317.74	255.58	0.97	0.00	1.12	0.00	1.12	
1083	PAL1083-3	51	95	BA		855.69	699.47	1.15	0.00	0.63	0.00	0.63	
1084	PAL1084-1	0	41	A	D	805.58	678.21	1.19	0.00	1.09	0.00	1.09	
1084	PAL1084-2	41	70	BA	D	572.93	489.95	1.22	0.00	0.45	0.00	0.45	
1084	PAL1084-3	70	95	2B	D	504.74	437.59	1.26	0.00	0.46	0.00	0.46	
1085	PAL1085-1	0	10	Ap		256.30	213.89	1.54	0.00	1.47	0.00	1.47	Ap is hillslope sediment
1085	PAL1085-2	10	43	A		648.82	547.53	1.20	0.00	0.75	0.00	0.75	
1085	PAL1085-3	43	68	Btc		534.17	464.11	1.34	0.00	0.33	0.00	0.33	
1086	PAL1086-1	0	27	A		502.77	408.10	1.09	0.00	1.20	0.00	1.20	No Ap - core is 5YR red
1086	PAL1086-2	27	51	Bt1		567.83	486.56	1.46	0.08	0.29	0.00	0.29	
1086	PAL1086-3	51	96	Btkc		1207.65	1012.50	1.62	0.60	0.21	0.00	0.21	
1087	PAL1087-1	0	22	Ap	S	354.93	302.33	0.99	0.00	1.44	0.00	1.44	
1087	PAL1087-2	22	44	AB	S	453.74	389.81	1.28	0.00	0.60	0.00	0.60	
1087	PAL1087-3	44	98	Bt	S	1094.89	943.56	1.26	0.00	0.34	0.00	0.34	
1089	PAL1089-1	0	26	A		464.42	399.32	1.11	0.00	1.14	0.00	1.14	No visible Ap (no till)
1089	PAL1089-2	26	42	BA		293.69	253.82	1.15	0.00	0.58	0.00	0.58	
1089	PAL1089-3	42	98	Bt		1145.38	990.75	1.28	0.00	0.30	0.00	0.30	
1090	PAL1090-1	0	21	Ap	S	355.65	303.87	1.04	0.00	1.37	0.00	1.37	
1090	PAL1090-2	21	53	A	S	679.88	577.61	1.30	0.00	0.56	0.00	0.56	
1090	PAL1090-3	53	90	BA	S	739.68	625.32	1.22	0.35	0.35	0.27	0.62	Effervesces
1091	PAL1091-1	0	30	Ap	D	622.36	533.39	1.28	0.00	1.18	0.00	1.18	
1091	PAL1091-2	30	53	A1	D	399.97	330.72	1.04	0.00	1.26	0.00	1.26	
1091	PAL1091-3	53	92	2A	D	785.49	669.04	1.24	0.00	0.54	0.00	0.54	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1092	PAL1092-1	0	16	Ap		258.94	221.04	1.00	0.00	1.34	0.00	1.34	
1092	PAL1092-2	16	39	AB		427.67	364.48	1.14	0.00	0.92	0.00	0.92	
1092	PAL1092-3	39	74	BA		691.92	594.34	1.23	0.29	0.45	0.00	0.45	
1092	PAL1092-4	74	97	Bt1		510.93	444.59	1.40	0.00	0.25	0.00	0.25	
1093	PAL1093-1	0	19	Ap	S	316.09	267.53	1.02	0.00	1.50	0.00	1.50	
1093	PAL1093-2	19	49	AB	S	547.50	468.15	1.13	0.00	0.92	0.00	0.92	
1093	PAL1093-3	49	97	Bt	S	1016.24	894.43	1.34	0.00	0.27	0.00	0.27	
1094	PAL1094-1	0	22	Ap	E	390.77	335.91	1.10	0.00	1.39	0.00	1.39	
1094	PAL1094-2	22	53	BA	E	604.70	522.46	1.22	0.00	0.79	0.00	0.79	
1094	PAL1094-3	53	95	Btk	E	772.43	644.84	1.10	3.54	0.47	1.66	2.13	Effervesces
1095	PAL1095-1	0	16	Ap		382.30	314.28	1.42	0.00	1.25	0.00	1.25	Hillslope sediment 0-16 cm. Btgc effervesces.
1095	PAL1095-2	16	39	A		507.19	398.80	1.25	0.00	1.17	0.00	1.17	
1095	PAL1095-3	39	76	B		896.65	725.29	1.41	0.00	0.51	0.00	0.51	
1096	PAL1096-1	0	24	Ap	D	522.76	427.16	1.28	0.00	1.24	0.00	1.24	
1096	PAL1096-2	24	50	A	D	606.35	475.25	1.32	0.00	1.14	0.00	1.14	
1096	PAL1096-3	50	84	BA	D	914.99	733.61	1.56	0.00	0.52	0.00	0.52	
1097	PAL1097-1	0	19	Ap	S	326.47	267.62	1.02	0.00	1.86	0.00	1.86	
1097	PAL1097-2	19	53	A	S	579.41	479.18	1.02	0.00	1.07	0.00	1.07	
1097	PAL1097-3	53	98	AB	S	794.91	674.65	1.08	0.00	0.47	0.00	0.47	
1098	PAL1098-1	0	29	A1		445.79	370.56	0.92	0.00	1.68	0.00	1.68	No distinct Ap. Erosion with alternating A and B horizons 55-96 cm.
1098	PAL1098-2	29	55	AB		469.62	391.59	1.09	0.00	1.03	0.00	1.03	
1098	PAL1098-3	55	96	BA		801.94	679.65	1.20	0.00	0.51	0.00	0.51	
1099	PAL1099-1	0	43	A		748.59	616.89	1.04	0.00	1.17	0.00	1.17	No visible Ap horizon
1099	PAL1099-2	43	65	BA		402.97	343.44	1.13	0.00	0.56	0.00	0.56	
1099	PAL1099-3	65	95	Bt		615.97	523.92	1.26	0.00	0.32	0.00	0.32	
1100	PAL1100-1	0	31	A		666.26	575.63	1.34	0.21	0.62	0.00	0.62	
1100	PAL1100-2	31	63	BAk		661.17	570.22	1.29	0.28	0.18	0.10	0.28	
1100	PAL1100-3	63	94	Btk		630.13	530.73	1.24	0.00	0.11	1.10	1.21	
1101	PAL1101-1	0	28	Ap	D	487.91	455.78	1.17	0.00	0.91	0.00	0.91	Alternating colors - appears wind blown
1101	PAL1101-2	28	42	BA	D	254.74	236.23	1.22	0.00	0.37	0.00	0.37	
1101	PAL1101-3	42	98	B	D	1065.13	978.87	1.26	0.00	0.31	0.01	0.32	
1102	PAL1102-1	0	19	Ap		311.53	287.49	1.09	0.00	1.00	0.00	1.00	Severely eroded - Btk1 & Btk2 effervesce
1102	PAL1102-2	19	42	BA		412.93	373.81	1.17	0.00	0.57	0.00	0.57	
1102	PAL1102-3	42	99	Btk		1046.28	916.29	1.15	10.50	0.46	0.71	1.17	
1103	PAL1103-1	0	33	Apk	E	563.40	517.61	1.13	0.00	0.84	0.00	0.84	Weak effervescence in Ap horizon - probably is sediment from upslope
1103	PAL1103-2	33	63	B1	E	579.38	523.22	1.26	0.17	0.51	0.00	0.51	
1103	PAL1103-3	63	96	Bk	E	676.52	595.10	1.29	6.12	0.31	0.89	1.20	Common, small free carbonate masses in Bk2 horizon
1104	PAL1104-1	0	32	Ap	E	625.63	579.14	1.30	0.96	0.66	0.00	0.66	
1104	PAL1104-2	32	66	BA	E	735.97	676.91	1.44	0.07	0.25	0.00	0.25	
1104	PAL1104-3	66	96	Bt	E	664.84	606.80	1.46	0.67	0.18	0.00	0.18	
1105	PAL1105-1	0	24	BA1		446.68	412.98	1.24	0.00	1.11	0.00	1.11	Eroded - krotovinas in B horizons - no Ap horizon
1105	PAL1105-2	24	42	BA2		337.27	312.22	1.25	0.00	0.67	0.00	0.67	
1105	PAL1105-3	42	94	Bt		986.79	899.00	1.25	0.00	0.41	0.00	0.41	
1106	PAL1106-1	0	25	Ap	S	467.97	439.15	1.27	0.00	0.99			
1106	PAL1106-2	25	49	BA	S	419.78	393.69	1.18	0.00	0.55			

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1106	PAL1106-3	49	98	Bw	S	932.98	871.52	1.28	0.00	0.34			"Layered" appearance in Bw horizon
1107	PAL1107-1	0	35	A		617.64	510.37	1.05	0.00	1.61	0.00	1.61	Ap/A boundary is indistinct
1107	PAL1107-2	35	69	AB		560.78	462.11	0.98	0.00	1.04	0.00	1.04	
1107	PAL1107-3	69	98	Bt		567.72	492.10	1.22	0.00	0.35	0.00	0.35	
1108	PAL1108-1	0	13	Ap		228.64	159.93	0.89	0.00	0.96	0.00	0.96	Ap defined only by color - light surface, hillslope sediments - clayey.
1108	PAL1108-2	13	47	A		603.45	417.07	0.89	0.00	2.20	0.00	2.20	
1108	PAL1108-3	47	74	AB		602.92	428.38	1.15	0.00	1.73	0.00	1.73	
1109	PAL1109-1	0	33	A	E	672.73	541.58	1.18	0.00	1.07	0.00	1.07	A horizon appears to have buried A horizon
1109	PAL1109-2	33	66	B	E	808.74	662.54	1.45	0.00	0.25	0.00	0.25	
1109	PAL1109-3	66	85	2AB	E	489.11	394.87	1.50	0.00	0.32	0.00	0.32	
1110	PAL1110-1	0	25	A		553.39	437.96	1.26	0.00	1.63	0.00	1.63	No Ap horizon
1110	PAL1110-2	25	65	Bt1		938.08	770.60	1.39	0.00	0.34	0.00	0.34	Bt3 is darker than Bt1 and Bt2
1110	PAL1110-3	65	85	Bt2		493.32	400.65	1.45	0.00	0.32	0.00	0.32	
1111	PAL1111-1	0	13	Ap		254.28	211.39	1.17	0.00	1.38	0.00	1.38	
1111	PAL1111-2	13	39	Bt		636.24	535.19	1.48	1.95	0.44	0.06	0.50	
1111	PAL1111-3	39	74	Btk		890.00	741.56	1.53	0.00	0.13	0.16	0.29	Both Btk horizons effervesce
1112	PAL1112-1	0	29	A	D	550.50	450.33	1.12	0.20	2.15	0.00	2.15	
1112	PAL1112-2	29	50	AB	D	457.23	377.72	1.30	0.52	1.00	0.00	1.00	Mica in AB horizon through BA2 horizon
1112	PAL1112-3	50	78	BA	D	684.15	555.26	1.43	0.00	0.55	0.00	0.55	
1113	PAL1113-1	0	15	Ap		326.01	273.45	1.32	0.00	2.06	0.00	2.06	Hillslope sediment upper 15 cm. Free carbonates 61-95 cm.
1113	PAL1113-2	15	51	A2		870.43	671.41	1.34	0.84	1.60	0.00	1.60	
1113	PAL1113-3	51	95	Ak		535.09	393.31	0.65	0.00	1.07	0.00	1.07	
1114	PAL1114-1	0	45	A		834.14	606.83	0.97	0.00	2.40	0.00	2.40	Plant residue at bottom of core
1114	PAL1114-2	45	77	BA		748.00	578.30	1.30	0.00	1.46	0.00	1.46	
1115	PAL1115-1	0	24	Ap	D	525.28	417.57	1.26	0.00	1.15	0.00	1.15	Surface is hillslope sediment
1115	PAL1115-2	24	69	A1	D	1156.92	836.65	1.34	0.00	2.26	0.00	2.26	
1115	PAL1115-3	69	95	A2	D	341.86	258.66	0.72	0.20	1.10	0.00	1.10	
1116	PAL1116-1	0	44	A		773.79	682.56	1.12	0.00	0.69	0.18	0.87	Eroded old A - Carbonates 44-80 cm
1116	PAL1116-2	44	80	Btk		667.38	593.66	1.18	4.46	0.60	0.23	0.83	
1116	PAL1116-3	80	99	Bt4		345.47	308.55	1.17	0.00	0.81	0.00	0.81	
1117	PAL1117-1	0	26	Ap	E	354.55	313.93	0.87	0.00	0.71	0.00	0.71	
1117	PAL1117-2	26	53	BA	E	506.95	453.36	1.21	0.00	0.51	0.00	0.51	
1117	PAL1117-3	53	100	Btk	E	928.24	836.33	1.28	0.00	0.40	0.00	0.40	Weak effervescence
1118	PAL1118-1	0	29	Ap	E	458.65	406.96	1.01	0.00	0.58	0.00	0.58	Surface in old B material
1118	PAL1118-2	29	65	BA	E	701.11	626.09	1.26	0.00	0.31	0.00	0.31	
1118	PAL1118-3	65	96	Bt	E	629.54	568.50	1.32	0.00	0.30	0.00	0.30	
1119	PAL1119-1	0	33	Ap	E	564.22	502.70	1.10	0.00	0.58	0.00	0.58	Ap horizon in old Bt material
1119	PAL1119-2	33	75	Bt1	E	821.54	739.21	1.27	0.00	0.37	0.00	0.37	
1119	PAL1119-3	75	95	Bt2	E	378.60	346.19	1.25	0.00	0.32	0.00	0.32	
1120	PAL1120-1	0	31	BA1		542.61	481.39	1.12	0.00	0.68	0.00	0.68	Eroded - No original A
1120	PAL1120-2	31	60	BA2		546.50	489.79	1.22	0.00	0.49	0.00	0.49	
1120	PAL1120-3	60	98	Bt		729.91	662.09	1.26	0.00	0.34	0.00	0.34	
1121	PAL1121-1	0	36	Ap	D	620.61	550.35	1.10	0.00	0.62	0.00	0.62	
1121	PAL1121-2	36	73	BA	D	678.23	607.28	1.18	0.00	0.48	0.00	0.48	
1121	PAL1121-3	73	89	C	D	309.93	283.19	1.28	0.00	0.37	0.00	0.37	
1122	PAL1122-1	0	17	Ap	E	268.99	241.35	1.02	0.00	1.05	0.00	1.05	No A horizon

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1122	PAL1122-2	17	67	Bt	E	868.16	780.61	1.13	0.00	0.52	0.22	0.74	
1122	PAL1122-3	67	94	Btk	E	508.58	457.67	1.22	0.83	0.42	0.81	1.23	Effervesces
1123	PAL1123-1	0	34	A		500.19	433.90	0.91	6.13	2.29	0.00	2.29	
1123	PAL1123-1	0	21	Ap	E	295.04	265.75	0.91	0.00	0.70	0.00	0.70	No picture
1123	PAL1123-2	34	65	BA		478.67	415.74	0.96	4.07	1.23	0.00	1.23	
1123	PAL1123-2	21	45	BA	E	436.39	397.47	1.20	0.00	0.47	0.00	0.47	
1123	PAL1123-3	65	86	Bt		409.94	361.94	1.24	0.00	0.36	0.00	0.36	
1123	PAL1123-3	45	98	Bt	E	1083.39	995.45	1.36	0.00	0.35	0.07	0.42	
1124	PAL1124-1	0	15	Ap		296.80	257.02	1.24	0.00	1.00	0.00	1.00	
1124	PAL1124-2	15	43	BA		599.10	525.91	1.36	0.00	0.52	0.00	0.52	
1124	PAL1124-3	43	94	Bt		1166.61	1026.34	1.45	0.68	0.26	0.17	0.43	
1125	PAL1125-1	0	26	Ap		504.89	437.53	1.21	0.06	1.26	0.00	1.26	
1125	PAL1125-2	26	53	AB		569.97	500.62	1.34	0.08	0.78	0.00	0.78	
1125	PAL1125-3	53	93	Bt		814.52	704.15	1.27	2.81	0.50	0.00	0.50	
1126	PAL1126-1	0	27	A	S	500.92	447.09	1.20	0.05	1.29	0.00	1.29	
1126	PAL1126-2	27	46	BA	S	334.02	305.52	1.16	0.00	1.25	0.00	1.25	
1126	PAL1126-3	46	82	Btk	S	592.44	537.03	1.07	5.32	1.08	0.35	1.43	Effervesces
1127	PAL1127-1	0	27	A	D	578.54	465.09	1.24	0.00	1.92	0.00	1.92	
1127	PAL1127-2	27	64	BA	D	864.15	718.73	1.40	0.00	0.66	0.00	0.66	
1127	PAL1127-3	64	98	2AB	D	916.63	774.87	1.64	0.00	0.25	0.00	0.25	Siltans in E horizon
1128	PAL1128-1	0	34	A	S	645.07	503.60	1.07	0.15	2.65	0.00	2.65	Clayey - no visible Ap horizon
1128	PAL1128-2	34	47	AB	S	270.52	214.79	1.19	0.00	1.31	0.00	1.31	
1128	PAL1128-3	47	99	Bt	S	1325.22	1106.83	1.54	0.00	0.34	0.00	0.34	
1129	PAL1129-1	0	23	Ap	S	481.01	387.82	1.22	0.00	1.49	0.00	1.49	
1129	PAL1129-2	23	41	AB	S	398.11	327.17	1.31	0.15	0.61	0.00	0.61	
1129	PAL1129-3	41	95	Bt	S	1360.59	1135.81	1.52	1.25	0.31	0.00	0.31	Appears to be a parent material break at 70 cm
1130	PAL1130-1	0	28	A		543.75	424.48	1.09	0.00	1.66	0.00	1.66	Horizon designation 2Bt due to change in color and texture
1130	PAL1130-2	28	47	AB		365.39	282.69	1.07	0.00	1.15	0.00	1.15	
1130	PAL1130-3	47	96	Bt		1103.44	891.87	1.31	0.00	0.32	0.00	0.32	
1131	PAL1131-1	0	36	A		792.93	593.85	1.19	0.00	1.80	0.00	1.80	No Ap in evidence
1131	PAL1131-2	36	53	AB		381.62	282.58	1.20	0.00	0.80	0.00	0.80	
1131	PAL1131-3	53	85	Bt		780.95	625.88	1.41	0.00	0.27	0.00	0.27	
1132	PAL1132-1	0	17	Ap	E	355.08	281.70	1.20	0.00	1.56	0.00	1.56	
1132	PAL1132-2	17	33	BA	E	353.45	295.24	1.33	0.00	0.41	0.00	0.41	
1132	PAL1132-3	33	98	Btk	E	1512.46	1211.14	1.34	0.44	0.26	0.23	0.49	
1133	PAL1133-1	0	26	Ap		624.58	513.28	1.42	0.00	0.86	0.00	0.86	Eroded - clayey - red
1133	PAL1133-2	26	67	Bt		1070.69	884.58	1.56	0.00	0.31	0.00	0.31	
1133	PAL1133-3	67	98	Btc		822.90	702.60	1.64	0.00	0.12	0.00	0.12	
1134	PAL1134-1	0	17	Ap	E	347.08	306.17	1.24	13.20	1.35	0.00	1.35	
1134	PAL1134-2	17	58	B	E	1024.65	860.11	1.49	14.50	0.30	0.00	0.30	
1134	PAL1134-3	58	76	2Bt	E	481.03	422.40	1.68	3.15	0.10	0.00	0.10	
1135	PAL1135-1	0	14	A	E	289.49	249.43	1.23	11.42	1.22	0.00	1.22	
1135	PAL1135-2	14	66	Btc	E	1210.86	1019.26	1.41	2.60	0.32	0.00	0.32	
1135	PAL1135-3	66	97	2Bgc	E	814.51	690.82	1.58	13.65	0.09	0.00	0.09	
1136	PAL1136-1	0	30	Ap	S	593.52	496.99	1.19	0.69	1.10	0.00	1.10	Abundant mica - sandy (fine sand) below surface 20 cm
1136	PAL1136-2	30	53	A	S	448.63	362.91	1.14	0.00	0.72	0.00	0.72	
1136	PAL1136-3	53	93	Bg	S	929.57	817.33	1.47	0.90	0.21	0.00	0.21	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1137	PAL1137-1	0	35	A1	D	680.37	536.21	1.09	5.67	1.87	0.00	1.87	Mica in lower profile (AB through 2A)
1137	PAL1137-2	35	62	A2	D	531.72	422.05	1.11	8.58	0.93	0.00	0.93	
1137	PAL1137-3	62	93	BA	D	761.38	636.86	1.48	1.70	0.25	0.00	0.25	
1138	PAL1138-1	0	26	Ap	S	573.58	474.43	1.32	0.00	0.94			
1138	PAL1138-2	26	66	BA	S	925.60	749.52	1.35	1.28	0.36		0.82	
1138	PAL1138-3	66	99	Bt	S	805.27	647.93	1.41	3.05	0.08			Thin horizon with free carbonates
1139	PAL1139-1	0	16	Ap		361.13	289.55	1.24	14.27	1.01	0.00	1.01	Discarded 75-83 cm
1139	PAL1139-2	16	39	BA		536.90	430.59	1.27	26.35	0.37	0.00	0.37	
1139	PAL1139-3	39	83	Bt		965.23	818.20	1.23	69.03	0.11	0.00	0.11	
1140	PAL1140-1	0	27	A	S	565.91	476.26	1.26	4.79	1.33	0.00	1.33	Sandy at base. Mica in subsurface.
1140	PAL1140-2	27	54	BA	S	639.09	551.01	1.45	8.77	0.47	0.00	0.47	
1140	PAL1140-3	54	96	Btg	S	1037.95	937.52	1.54	39.92	0.11	0.00	0.11	
1141	PAL1141-1	0	34	A	S	652.04	549.83	1.15	8.09	1.28	0.00	1.28	No visible Ap horizon - sandy at base
1141	PAL1141-2	34	47	AB	S	455.80	390.30	2.14	5.37	0.45	0.00	0.45	
1141	PAL1141-3	47	90	Bt	S	925.58	833.58	1.34	37.08	0.12	0.00	0.12	
1142	PAL1142-1	0	23	A1		462.22	345.17	1.08	0.00	2.09	0.00	2.09	
1142	PAL1142-2	23	64	A		846.68	588.55	1.04	0.00	1.63	0.00	1.63	
1142	PAL1142-3	64	97	B		778.79	548.00	1.20	0.00	0.45	0.00	0.45	
1143	PAL1143-1	0	12	A		197.94	162.64	0.98	0.00	1.46	0.00	1.46	
1143	PAL1143-2	12	40	BA		577.20	486.61	1.25	0.00	0.28	0.00	0.28	
1143	PAL1143-3	40	99	Btk		1239.33	1022.65	1.25	0.00	0.16	0.06	0.22	Btk effervesces
1144	PAL1144-1	0	12	Ap		188.95	156.41	0.94	0.00	1.59	0.00	1.59	Eroded
1144	PAL1144-2	12	69	Bt1		1259.90	1059.40	1.34	0.00	0.25	0.00	0.25	
1144	PAL1144-3	69	99	Bt2		620.46	515.35	1.24	0.00	0.13	0.00	0.13	
1145	PAL1145-1	0	29	BA		694.02	596.77	1.49	0.00	0.48	0.00	0.48	Eroded - clayey
1145	PAL1145-2	29	45	B1		404.52	346.76	1.56	0.00	0.32	0.00	0.32	
1145	PAL1145-3	45	67	Btc		559.86	472.29	1.55	0.00	0.20	0.00	0.20	
1146	PAL1146-1	0	21	Ap		373.07	318.30	1.09	0.00	1.48	0.00	1.48	Both BAk horizons effervesce
1146	PAL1146-2	21	63	A		789.35	670.38	1.15	1.59	1.24	0.00	1.24	
1146	PAL1146-3	63	94	BA		586.21	498.26	1.14	9.36	0.88	0.22	1.10	
1147	PAL1147-1	0	21	Ap		378.31	315.01	1.08	0.00	1.56	0.00	1.56	
1147	PAL1147-2	21	43	AB		420.21	360.10	1.18	0.00	0.56	0.00	0.56	
1147	PAL1147-3	43	87	B		900.82	774.18	1.27	1.33	0.38	0.00	0.38	
1148	PAL1148-1	0	33	S	S	614.05	512.55	1.12	0.00	1.26	0.00	1.26	
1148	PAL1148-2	33	66	B1	S	639.19	544.08	1.19	0.00	0.46	0.00	0.46	
1148	PAL1148-3	66	95	B2	S	649.18	551.55	1.37	0.00	0.40	0.00	0.40	Bt3 horizon darker than overlying Bt horizon
1149	PAL1149-1	0	21	Ap		412.64	340.28	1.17	0.05	1.32	0.00	1.32	
1149	PAL1149-2	21	34	AB		308.18	254.43	1.41	0.00	0.80	0.00	0.80	
1149	PAL1149-3	34	88	Bt		1196.65	1002.16	1.34	0.00	0.38	0.00	0.38	
1150	PAL1150-1	0	31	A1	D	643.16	525.58	1.22	0.00	1.39	0.00	1.39	No Ap horizon
1150	PAL1150-2	31	60	AB	D	582.60	474.03	1.17	2.27	1.03	0.00	1.03	
1150	PAL1150-3	60	92	BA	D	624.89	515.45	1.16	1.25	0.61	0.00	0.61	
1151	PAL1151-1	0	31	AB	D	573.80	484.07	1.13	0.00	1.21	0.00	1.21	AB horizon is hillslope sediment
1151	PAL1151-2	31	53	2A	D	390.23	323.77	1.06	0.00	1.48	0.00	1.48	
1151	PAL1151-3	53	90	2AB	D	623.35	520.72	1.02	0.00	1.21	0.00	1.21	
1152	PAL1152-1	0	37	A		672.97	589.83	1.15	0.00	0.67	0.00	0.67	
1152	PAL1152-2	37	68	Bt1		621.18	549.18	1.28	0.00	0.29	0.00	0.29	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1152	PAL1152-3	68	96	Bt2		555.10	494.15	1.27	0.00	0.23	0.00	0.23	
1153	PAL1153-1	0	30	Ap	E	511.26	442.57	1.06	0.31	0.92	0.00	0.92	
1153	PAL1153-2	30	46	BA	E	268.41	234.66	1.06	0.00	0.66	0.00	0.66	
1153	PAL1153-3	46	80	Bt	E	643.17	567.62	1.21	0.00	0.36	0.00	0.36	No picture
1154	PAL1154-1	0	21	A	D	375.51	327.69	1.12	0.80	0.95	0.04	0.99	Alternating A - B layers
1154	PAL1154-2	21	49	A	D	523.66	444.81	1.15	0.00	0.76	0.06	0.82	
1154	PAL1154-3	49	88	B	D	702.96	605.80	1.08	22.67	0.55	0.00	0.55	Btk horizon effervesces
1155	PAL1155-1	0	23	A	D	383.33	334.60	1.05	0.00	1.17	0.00	1.17	
1155	PAL1155-2	23	49	A	D	516.04	449.05	1.20	17.51	0.79	0.00	0.79	
1155	PAL1155-3	49	66	AB	D	375.45	330.27	1.25	35.53	0.53	0.00	0.53	Basalt fragments at base of profile
1156	PAL1156-1	0	41	A		752.26	607.93	1.07	0.00	1.23	0.00	1.23	
1156	PAL1156-2	41	82	AB		713.88	573.95	1.01	0.29	0.72	0.15	0.87	
1156	PAL1156-3	82	95	Bt		243.51	196.20	1.08	0.81	0.55	0.77	1.32	
1157	PAL1157-1	0	23	Ap	S	410.95	347.05	1.09	0.00	1.15	0.00	1.15	
1157	PAL1157-2	23	42	A	S	306.50	254.77	0.97	0.00	1.06	0.00	1.06	
1157	PAL1157-3	42	96	Bt	S	904.54	755.90	1.01	0.00	0.42	0.33	0.75	
1158	PAL1158-1	0	19	Ap		343.70	295.57	1.12	0.00	0.94	0.00	0.94	
1158	PAL1158-2	19	57	A		708.68	610.43	1.16	0.00	0.72	0.00	0.72	
1158	PAL1158-3	57	86	Bt		573.91	503.19	1.25	0.00	0.48	0.00	0.48	
1159	PAL1159-1	0	21	Ap	D	350.37	301.25	1.03	0.27	0.86	0.00	0.86	Ap horizon appears to be hillslope sediment
1159	PAL1159-2	21	55	A	D	610.49	527.25	1.12	0.00	0.61	0.00	0.61	
1159	PAL1159-3	55	76	B	D	420.75	370.33	1.27	0.00	0.48	0.00	0.48	
1160	PAL1160-1	0	21	Ap	E	378.39	317.38	1.06	8.16	0.98	0.22	1.20	
1160	PAL1160-2	21	33	E	E	226.11	193.57	1.16	0.00	0.63	0.00	0.63	
1160	PAL1160-3	33	46	BA	E	301.75	264.82	1.41	10.28	0.39	0.00	0.39	
1161	PAL1161-1	0	31	A		442.07	380.67	0.89	0.00	1.98	0.00	1.98	
1161	PAL1161-2	31	53	BA		404.86	365.27	1.20	0.23	0.46	0.00	0.46	
1161	PAL1161-3	53	90	Btk		780.96	626.34	1.22	3.00	0.25	1.87	2.12	Btk1 & Btk2 effervesce
1162	PAL1162-1	0	27	A		421.55	312.03	0.83	0.00	2.38	0.75	3.13	
1162	PAL1162-2	27	80	AB		943.71	703.74	0.96	0.28	1.31	0.91	2.22	
1162	PAL1162-3	80	98	Bg		344.53	249.69	1.00	0.00	1.03	1.76	2.79	
1163	PAL1163-1	0	36	A		679.81	505.91	1.01	0.00	2.48	0.00	2.48	2Btc sample discarded (92-99 cm)
1163	PAL1163-2	36	51	BA		309.10	222.95	1.07	0.00	1.60	0.00	1.60	
1163	PAL1163-3	51	92	2A		929.91	668.49	1.18	0.56	1.53	0.00	1.53	
1164	PAL1164-1	0	23	Ap	E	435.47	359.17	1.13	0.00	1.04	0.19	1.23	Some calcium carbonate in Ap horizon
1164	PAL1164-2	23	32	E	E	184.93	142.35	1.14	0.00	0.37	3.16	3.53	
1164	PAL1164-3	32	61	Btk	E	639.28	520.54	1.30	0.00	0.13	0.71	0.84	Strong effervescence
1165	PAL1165-1	0	33	A		604.70	451.51	0.99	0.00	1.55	0.00	1.55	Distinct Ap
1165	PAL1165-2	33	59	BA		574.87	454.42	1.26	0.00	0.50	0.00	0.50	
1165	PAL1165-3	59	98	Bt		982.94	811.29	1.50	0.00	0.15	0.00	0.15	
1166	PAL1166-1	0	39	A		744.06	543.80	1.01	0.00	1.48	0.00	1.48	A horizon (0-10 cm) is hillslope sediment
1166	PAL1166-2	39	61	BA		495.97	403.08	1.32	0.00	0.44	0.00	0.44	
1166	PAL1166-3	61	98	Bt		955.31	783.97	1.53	0.00	0.19	0.00	0.19	
1167	PAL1167-1	0	38	A		690.59	510.54	0.97	0.00	1.82	0.00	1.82	No clear Ap horizon. All B horizons have weak effervescence.
1167	PAL1167-2	38	52	AB		263.38	189.51	0.98	0.06	1.20	0.00	1.20	
1167	PAL1167-3	52	99	Btk		1113.81	872.19	1.34	0.00	0.37	0.42	0.79	
1168	PAL1168-1	0	15	Ap		360.65	296.75	1.43	0.00	0.22	0.17	0.39	Severely eroded - no original A

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1168	PAL1168-2	15	56	Bt1		963.77	798.55	1.41	0.00	0.05	0.01	0.06	
1168	PAL1168-3	56	99	Bt2		1001.26	811.78	1.36	0.00	0.03	0.01	0.04	
1169	PAL1169-1	0	18	A	E	400.61	333.02	1.34	0.00	1.16			
1169	PAL1169-2	18	46	Bt	E	661.00	556.21	1.43	0.00	0.36			Clayey in upper B horizon
1169	PAL1169-3	46	96	Btk	E	1249.44	1048.89	1.51	2.48	0.13		0.32	Siltans on ped faces of Btk horizon - weak effervescence
1170	PAL1170-1	0	22	Ap	E	412.13	312.08	1.02	0.00	1.06	0.00	1.06	
1170	PAL1170-2	22	54	B	E	780.68	656.07	1.48	0.00	0.26	0.00	0.26	
1171	PAL1171-1	0	13	Ap		251.40	212.36	1.18	0.00	1.08	0.00	1.08	Btk1 strongly effervescent
1171	PAL1171-2	13	74	Btk1		1450.86	1206.43	1.42	3.80	0.16	0.37	0.53	
1171	PAL1171-3	74	98	Bt		555.76	455.79	1.37	0.00	0.04	0.04	0.08	
1172	PAL1172-1	0	10	Ap	E	223.63	188.25	1.36	0.00	0.97	0.00	0.97	
1172	PAL1172-2	10	42	Btk	E	742.68	619.77	1.40	0.00	0.09	0.41	0.50	
1172	PAL1172-3	42	91	Bt	E	1166.97	973.58	1.43	0.00	0.09	0.08	0.17	
1173	PAL1173-1	0	34	A		675.24	536.32	1.14	0.00	1.65	0.00	1.65	
1173	PAL1173-2	34	61	AB		538.06	393.89	1.05	0.00	1.25	0.00	1.25	
1173	PAL1173-3	61	96	Bt		767.33	592.95	1.22	0.00	0.52	0.00	0.52	
1174	PAL1174-1	0	42	A	D	831.93	687.46	1.12	35.44	1.53	0.00	1.53	Mica throughout
1174	PAL1174-2	42	71	AB	D	536.70	432.30	1.04	15.90	1.08	0.00	1.08	
1174	PAL1174-3	71	95	B	D	539.66	471.45	1.30	37.53	0.34	0.00	0.34	
1175	PAL1175-1	0	26	A		509.86	397.98	1.01	33.54	1.51	0.00	1.51	
1175	PAL1175-2	26	46	AB		498.70	423.74	1.12	113.14	0.52	0.00	0.52	
1176	PAL1176-1	0	31	A	S	602.17	494.14	1.15	0.10	1.13	0.00	1.13	Core is "stretched"
1176	PAL1176-2	31	55	BA	S	511.51	428.44	1.29	0.00	0.49	0.00	0.49	
1176	PAL1176-3	55	76	Bt	S	503.89	441.50	1.52	0.00	0.24	0.00	0.24	
1177	PAL1177-1	0	41	A		690.05	574.21	1.01	0.00	1.60	0.00	1.60	
1177	PAL1177-2	41	66	AB		463.83	400.47	1.16	0.00	0.57	0.00	0.57	
1177	PAL1177-3	66	97	Bt		631.57	548.42	1.28	0.00	0.28	0.00	0.28	
1178	PAL1178-1	0	31	A1		522.13	413.11	0.96	0.24	1.72	0.00	1.72	Effervescence in Btk
1178	PAL1178-2	31	44	A2		244.72	195.04	1.08	0.42	1.01	0.00	1.01	
1178	PAL1178-3	44	68	BA		474.40	390.97	1.17	1.39	0.63	0.00	0.63	
1178	PAL1178-4	68	96	Bt		636.94	530.68	1.35	7.85	0.24	0.08	0.32	
1179	PAL1179-1	0	23	Ap	S	394.15	319.43	1.00	0.00	1.61	0.00	1.61	
1179	PAL1179-2	23	52	BA	S	551.10	462.76	1.15	0.00	0.70	0.00	0.70	
1179	PAL1179-3	52	91	Bt	S	783.76	667.62	1.24	0.00	0.35	0.00	0.35	
1180	PAL1180-1	0	29	A	S	530.37	427.48	1.06	0.00	1.59	0.00	1.59	
1180	PAL1180-2	29	51	BA	S	462.04	387.67	1.27	0.00	0.60	0.00	0.60	
1180	PAL1180-3	51	88	Bt	S	769.56	652.85	1.27	0.00	0.38	0.00	0.38	
1181	PAL1181-1	0	35	A	S	631.63	529.69	1.09	0.00	1.44	0.00	1.44	
1181	PAL1181-2	35	59	AB	S	414.32	354.07	1.06	0.00	0.81	0.00	0.81	
1181	PAL1181-3	59	93	Bt	S	688.52	601.49	1.28	0.06	0.29	0.00	0.29	
1182	PAL1182-1	0	35	A	S	609.60	510.89	1.05	0.00	1.33	0.00	1.33	Ap horizon is not visible
1182	PAL1182-2	35	74	AB	S	744.68	635.87	1.18	0.00	0.63	0.00	0.63	
1182	PAL1182-3	74	93	Bt	S	392.10	338.41	1.29	0.00	0.32	0.00	0.32	Bt horizon ped faces have organic matter coats
1183	PAL1183-1	0	35	A	E	615.90	516.11	1.06	0.00	1.38	0.00	1.38	
1183	PAL1183-2	35	66	BA	E	562.34	481.57	1.12	0.00	0.75	0.00	0.75	
1183	PAL1183-3	66	94	Bt	E	557.60	481.40	1.24	0.00	0.32	0.00	0.32	
1184	PAL1184-1	0	23	A	S	387.68	326.54	1.02	0.00	1.44	0.00	1.44	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1184	PAL1184-2	23	65	BA	S	777.76	652.07	1.12	0.00	0.71	0.00	0.71	
1184	PAL1184-3	65	97	B	S	652.68	549.71	1.24	0.00	0.35	0.00	0.35	
1185	PAL1185-1	0	36	A		660.21	543.92	1.09	0.00	1.10	0.00	1.10	
1185	PAL1185-2	36	62	BA		501.07	419.78	1.17	0.00	0.54	0.00	0.54	
1185	PAL1185-3	62	99	Bt		769.88	645.88	1.26	0.00	0.28	0.07	0.35	
1186	PAL1186-1	0	27	A	S	536.09	445.16	1.19	1.51	1.44	0.00	1.44	
1186	PAL1186-2	27	60	BA	S	669.41	572.98	1.25	1.52	0.49	0.00	0.49	
1186	PAL1186-3	60	95	Bt	S	704.79	604.41	1.24	0.79	0.28	0.00	0.28	
1187	PAL1187-1	0	26	A		471.51	396.42	1.10	1.42	1.54	0.00	1.54	
1187	PAL1187-2	26	44	BA		376.00	322.77	1.29	0.00	0.58	0.00	0.58	
1187	PAL1187-3	44	98	Bt		1129.19	970.53	1.29	3.23	0.32	0.00	0.32	
1188	PAL1188-1	0	46	A	S	906.10	683.13	1.07	0.81	1.59	0.00	1.59	Ap horizon not visible
1188	PAL1188-2	46	66	BA	S	486.86	398.28	1.44	0.00	0.32	0.00	0.32	
1188	PAL1188-3	66	85	Bt	S	481.52	392.29	1.49	0.00	0.19	0.00	0.19	
1189	PAL1189-1	0	15	A		451.98	370.89	1.78	1.00	1.66	0.00	1.66	
1189	PAL1189-2	15	40	B1		539.13	456.30	1.31	1.31	0.49	0.00	0.49	
1189	PAL1189-3	40	97	B2		1194.46	998.96	1.26	0.15	0.35	0.00	0.35	
1190	PAL1190-1	0	20	Ap		418.91	341.63	1.23	0.02	1.68	0.00	1.68	Apparent stable surface, "normal profile"
1190	PAL1190-2	20	42	AB		462.87	383.24	1.26	0.13	0.70	0.00	0.70	
1190	PAL1190-3	42	63	B1		501.42	426.15	1.46	0.26	0.38	0.00	0.38	
1190	PAL1190-4	63	98	B2		772.85	644.57	1.33	0.10	0.27	0.00	0.27	
1191	PAL1191-1	0	29	A		543.52	460.25	1.15	0.00	0.97	0.00	0.97	Ap is indistinct. Parent material break based on texture.
1191	PAL1191-2	29	47	BA		401.88	340.68	1.37	0.00	0.47	0.00	0.47	
1191	PAL1191-3	47	97	Bt		1148.50	974.65	1.41	0.00	0.19	0.00	0.19	
1192	PAL1192-1	0	21	Ap		441.60	374.68	1.29	0.00	1.00	0.00	1.00	
1192	PAL1192-2	21	47	A1		505.03	425.71	1.18	0.00	0.61	0.00	0.61	
1192	PAL1192-3	47	96	Bt		1155.32	981.35	1.45	0.05	0.18	0.00	0.18	
1193	PAL1193-1	0	32	A		693.44	589.51	1.33	1.77	1.01	0.00	1.01	
1193	PAL1193-2	32	56	AB		501.27	425.60	1.28	0.54	0.69	0.00	0.69	
1193	PAL1193-3	56	92	Bt		784.74	676.78	1.35	1.28	0.31	0.00	0.31	
1194	PAL1194-1	0	39	A		811.64	690.17	1.27	2.55	1.00	0.00	1.00	
1194	PAL1194-2	39	61	BA		443.43	380.28	1.25	0.09	0.54	0.00	0.54	
1194	PAL1194-3	61	95	B		780.24	675.39	1.41	9.67	0.29	0.00	0.29	
1195	PAL1195-1	0	41	A	D	726.52	613.07	1.08	0.26	1.23	0.00	1.23	
1195	PAL1195-2	41	86	BA	D	946.56	801.77	1.28	1.41	0.46	0.00	0.46	
1195	PAL1195-3	86	94	2A	D	180.41	153.87	1.39	0.29	0.35	0.00	0.35	Another buried A horizon at base of core
1196	PAL1196-1	0	29	A		556.76	470.43	1.17	1.60	1.28	0.00	1.28	6 cm hillslope sediment on surface
1196	PAL1196-2	29	45	AB		324.32	275.08	1.24	0.95	0.89	0.00	0.89	
1196	PAL1196-3	45	88	BA		874.46	745.98	1.24	5.04	0.61	0.00	0.61	
1197	PAL1197-1	0	23	Ap	S	364.88	309.24	0.97	0.18	1.66	0.00	1.66	
1197	PAL1197-2	23	53	BA	S	520.71	451.99	1.09	0.30	0.98	0.00	0.98	
1197	PAL1197-3	53	95	Bt	S	838.71	731.65	1.26	0.71	0.40	0.00	0.40	Strong effervescence
1198	PAL1198-1	0	43	A		812.53	621.91	1.04	0.25	1.47	0.00	1.47	
1198	PAL1198-2	43	64	BA		472.13	379.95	1.31	0.00	0.38	0.00	0.38	
1198	PAL1198-3	64	78	Bt1		327.53	273.00	1.41	0.00	0.23	0.00	0.23	
1198	PAL1198-4	78	99	Bt2		590.41	490.43	1.69	0.00	0.13	0.00	0.13	
1199	PAL1199-1	0	20	A	E	391.25	304.77	1.10	0.00	1.51	0.00	1.51	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1199	PAL1199-2	20	44	BA	E	537.96	434.32	1.31	0.00	0.48	0.00	0.48	
1199	PAL1199-3	44	91	B	E	1192.23	990.86	1.52	0.00	0.19	0.00	0.19	
1200	PAL1200-1	0	32	A		575.36	446.19	0.94	29.58	1.98	0.00	1.98	No Ap horizon - truncated at bottom of core
1200	PAL1200-2	32	47	AB		314.30	255.14	1.17	12.85	1.02	0.00	1.02	
1201	PAL1201-1	0	30	A	S	505.13	419.75	1.01	0.25	1.46			Ap horizon not clear
1201	PAL1201-2	30	48	BA	S	349.09	298.75	1.20	0.00	0.62			
1201	PAL1201-3	48	94	Bt	S	995.46	843.14	1.32	0.00	0.33			
1202	PAL1202-1	0	37	A		684.63	582.90	1.13	1.36	1.25	0.00	1.25	
1202	PAL1202-2	37	56	BA		361.02	305.74	1.16	0.33	0.78	0.00	0.78	
1202	PAL1202-3	56	97	Bt		837.17	711.20	1.25	1.50	0.36	0.00	0.36	
1203	PAL1203-1	0	52	A		826.75	623.60	0.87	0.00	2.79	0.00	2.79	
1203	PAL1203-2	52	96	AB		748.21	559.78	0.92	0.00	1.41	0.00	1.41	
1204	PAL1204-1	0	44	A1		767.63	609.91	1.00	0.55	1.65	0.00	1.65	Ap indistinct
1204	PAL1204-2	44	71	AB		527.58	436.77	1.16	1.18	0.63	0.00	0.63	
1204	PAL1204-3	71	87	Bt		312.67	274.48	1.24	0.00	0.25	0.00	0.25	
1205	PAL1205-1	0	26	Ap	D	469.38	360.91	1.00	0.38	1.89	0.00	1.89	
1205	PAL1205-2	26	58	BA	D	631.86	475.71	1.07	0.00	0.78	0.00	0.78	
1205	PAL1205-3	58	96	Bt	D	842.33	660.75	1.25	0.90	0.34	0.00	0.34	
1206	PAL1206-1	0	28	Ap		586.38	466.40	1.20	0.00	1.62	0.00	1.62	Hillslope sediments on Ap
1206	PAL1206-2	28	69	A		744.72	506.92	0.89	0.00	2.25	0.00	2.25	
1206	PAL1206-3	69	96	AB		572.41	391.31	1.05	0.00	0.81	0.00	0.81	
1207	PAL1207-1	0	19	Ap		427.05	343.65	1.31	0.00	1.66	0.00	1.66	
1207	PAL1207-2	19	36	A1		357.52	278.29	1.18	0.00	1.92	0.00	1.92	
1207	PAL1207-3	36	70	A2		647.63	431.74	0.92	0.00	2.37	0.00	2.37	
1207	PAL1207-4	70	89	A3		379.47	258.04	0.98	0.00	1.03	0.00	1.03	
1208	PAL1208-1	0	34	A		649.69	558.87	1.19	0.00	0.85	0.00	0.85	Appears to have been eroded
1208	PAL1208-2	34	82	Bt		1061.57	907.92	1.37	0.00	0.35	0.00	0.35	
1209	PAL1209-1	0	22	Ap		383.94	321.85	1.06	0.00	1.34	0.00	1.34	
1209	PAL1209-2	22	54	A		509.31	412.31	0.93	0.00	1.41	0.00	1.41	
1209	PAL1209-3	54	72	AB		289.35	237.24	0.95	0.00	1.09	0.00	1.09	
1209	PAL1209-4	72	93	BA		392.95	327.62	1.13	0.08	0.66	0.00	0.66	
1210	PAL1210-1	0	19	Ap		364.04	309.01	1.17	0.00	0.76	0.00	0.76	
1210	PAL1210-2	19	68	Bt1		1069.94	897.96	1.32	0.28	0.32	0.00	0.32	
1210	PAL1210-3	68	99	Bt2		695.93	590.44	1.37	0.00	0.10	0.00	0.10	
1211	PAL1211-1	0	25	Ap	E	433.39	392.57	1.13	0.72	0.66	0.00	0.66	
1211	PAL1211-2	25	42	Bt	E	313.24	285.13	1.17	10.62	0.36	0.00	0.36	
1211	PAL1211-3	42	66	Btg	E	509.86	459.12	1.12	86.51	0.41	0.00	0.41	
1212	PAL1212-1	0	33	Bw	D	572.50	516.02	1.11	8.88	0.49	0.00	0.49	Surface is sediment from upslope
1212	PAL1212-2	33	50	2BA	D	450.85	400.69	1.61	22.36	0.36	0.00	0.36	Core truncated by basalt fragments
1212	PAL1212-3	50	67	3A	D	278.45	251.42	0.57	117.62	0.43	0.30	0.73	
1213	PAL1213-1	0	15	Ap	E	243.75	219.26	0.73	66.92	0.63	0.00	0.63	No A horizon - effervesces
1213	PAL1213-2	15	45	BA	E	607.14	544.32	1.31	0.22	0.43	0.00	0.43	
1213	PAL1213-3	45	97	Bt	E	1078.99	984.20	1.37	0.06	0.27	0.00	0.27	
1214	PAL1214-1	0	20	Ap	E	372.72	335.09	1.21	0.00	0.85	0.00	0.85	
1214	PAL1214-2	20	46	BA	E	523.49	471.73	1.31	0.00	0.42	0.00	0.42	
1214	PAL1214-3	46	92	Btk	E	902.12	801.04	1.26	0.00	0.28	0.71	0.99	
1215	PAL1215-1	0	25	Ap	S	415.04	344.49	0.99	0.00	1.19	0.00	1.19	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1215	PAL1215-2	25	59	AB	S	650.77	534.52	1.13	0.31	0.82	0.00	0.82	
1215	PAL1215-3	59	94	Bt	S	795.40	660.33	1.36	0.00	0.25	0.00	0.25	
1216	PAL1216-1	0	28	Ap	E	461.19	407.59	1.05	0.00	1.07	0.00	1.07	
1216	PAL1216-2	28	45	BA	E	329.35	295.28	1.25	0.00	0.50	0.00	0.50	
1216	PAL1216-3	45	95	Bt	E	1010.90	884.62	1.28	0.00	0.35	0.00	0.35	
1217	PAL1217-1	0	20	B	E	364.86	311.59	1.12	0.00	0.47	0.00	0.47	Surface is hillslope sediment
1217	PAL1217-2	20	51	B	E	635.73	533.78	1.24	0.00	0.45	0.00	0.45	
1217	PAL1217-3	51	95	2BA	E	919.45	778.73	1.28	0.00	0.32	0.00	0.32	
1218	PAL1218-1	0	19	Ap		323.87	279.55	1.06	0.00	0.57	0.00	0.57	
1218	PAL1218-2	19	63	BA		881.76	754.51	1.24	0.00	0.36	0.00	0.36	
1218	PAL1218-3	63	98	2AB		770.98	669.87	1.38	0.00	0.35	0.14	0.49	
1219	PAL1219-1	0	41	A		836.75	678.78	1.19	0.00	1.65	0.00	1.65	16 cm hillslope sediment on surface
1219	PAL1219-2	41	69	AB1		449.98	348.34	0.90	0.00	1.78	0.00	1.78	
1219	PAL1219-3	69	96	AB2		433.94	340.42	0.91	0.00	1.22	0.00	1.22	
1220	PAL1220-1	0	31	A	S	559.60	475.77	1.06	22.65	1.47	0.00	1.47	
1220	PAL1220-2	31	51	BA	S	379.09	327.81	1.12	17.12	0.69	0.00	0.69	
1220	PAL1220-3	51	97	Bt	S	1098.33	953.41	1.29	133.74	0.26	0.00	0.26	
1221	PAL1221-1	0	17	Ap	E	314.67	262.00	1.09	4.81	1.74	0.00	1.74	
1221	PAL1221-2	17	31	BA	E	243.65	208.77	1.06	3.42	0.93	0.00	0.93	
1221	PAL1221-3	31	69	Btc	E	904.18	785.06	1.43	30.44	0.35	0.00	0.35	
1222	PAL1222-1	0	38	A		598.45	522.58	0.98	8.84	2.06	0.00	2.06	Krotovina in Bt
1222	PAL1222-2	38	59	BA		346.84	301.58	1.04	0.00	1.05	0.00	1.05	
1222	PAL1222-3	59	97	Bt		731.35	643.61	1.22	0.00	0.43	0.00	0.43	
1225	PAL1225-1	0	19	Ap		471.13	393.03	1.49	0.00	0.89	0.00	0.89	Severely eroded Ap is mix of A and B material
1225	PAL1225-2	19	58	Bt1		978.85	821.33	1.52	0.00	0.17	0.03	0.20	
1225	PAL1225-3	58	97	Bt2		967.19	805.08	1.49	0.00	0.08	0.04	0.12	
1226	PAL1226-1	0	12	B	D	301.68	261.06	1.57	0.10	0.85	0.00	0.85	Alternating A and B horizons
1226	PAL1226-2	12	54	A	D	822.45	699.18	1.20	0.92	1.03	0.00	1.03	
1226	PAL1226-3	54	89	B	D	740.41	629.97	1.30	0.00	0.40	0.00	0.40	
1227	PAL1227-1	0	16	A		323.80	262.14	1.18	0.00	1.00	0.00	1.00	Surface 16 cm is B horizon from higher in landscape, 10YR 5/8
1227	PAL1227-2	16	39	2A		438.59	375.05	1.18	0.00	1.07	0.00	1.07	
1227	PAL1227-3	39	90	Bt		1188.52	1013.71	1.43	0.00	0.42	0.00	0.42	
1228	PAL1228-1	0	29	A		577.85	482.62	1.20	0.00	1.70	0.00	1.70	
1228	PAL1228-2	29	57	BA		524.98	442.74	1.14	0.00	0.98	0.00	0.98	
1228	PAL1228-3	57	94	B		756.95	636.41	1.24	0.00	0.61	0.00	0.61	
1229	PAL1229-1	0	30	Ap	D	553.99	465.52	1.12	0.00	1.58	0.00	1.58	
1229	PAL1229-2	30	59	BA	D	547.90	465.02	1.16	0.29	0.89	0.00	0.89	
1229	PAL1229-3	59	96	Bt	D	778.74	668.78	1.30	0.00	0.48	0.00	0.48	
1230	PAL1230-1	0	32	Ap	E	638.42	571.25	1.29	0.00	1.49	0.00	1.49	
1230	PAL1230-2	32	80	Btk1	E	1151.80	951.80	1.43	0.00	0.76	0.00	0.76	
1230	PAL1230-3	80	99	Btk2	E	467.08	382.01	1.45	0.00	0.22	0.23	0.45	Strong effervescence
1231	PAL1231-1	0	25	Ap	E	482.12	442.29	1.28	0.00	0.87	0.00	0.87	
1231	PAL1231-2	25	45	BAk	E	481.62	402.87	1.45	0.00	0.47	0.41	0.88	
1231	PAL1231-3	45	98	Btk	E	1222.88	1012.70	1.38	1.42	0.15	0.43	0.58	Strong effervescence
1232	PAL1232-1	0	25	Ap		499.31	457.00	1.32	0.00	1.07	0.00	1.07	Hillslope sediment 0-25 cm
1232	PAL1232-2	25	42	A		336.59	297.90	1.26	0.00	0.84	0.00	0.84	
1232	PAL1232-3	42	96	Bt		853.85	735.92	0.95	22.56	0.53	0.00	0.53	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1233	PAL1233-1	0	37	A	S	714.42	645.70	1.26	0.43	1.00	0.00	1.00	
1233	PAL1233-2	37	59	Bt1	S	429.87	370.80	1.22	0.08	0.62	0.00	0.62	
1233	PAL1233-3	59	75	Bt2	S	385.70	332.70	1.44	12.65	0.46	0.00	0.46	
1234	PAL1234-1	0	38	A	S	676.33	597.91	1.13	1.21	1.23	0.00	1.23	No distinct Ap horizon
1234	PAL1234-2	38	57	BA	S	410.01	354.11	1.35	0.00	0.57	0.00	0.57	
1234	PAL1234-3	57	87	Btc	S	706.03	614.82	1.43	22.21	0.43	0.09	0.52	
1235	PAL1235-1	0	23	Ap	D	432.33	390.70	1.22	1.36	1.24	0.00	1.24	
1235	PAL1235-2	23	41	AB	D	348.35	307.00	1.23	0.17	0.87	0.00	0.87	
1235	PAL1235-3	41	63	BA	D	458.92	399.70	1.31	1.15	0.52	0.00	0.52	
1236	PAL1236-1	0	37	A	S	710.94	628.01	1.22	3.65	1.04	0.00	1.04	
1236	PAL1236-2	37	60	BA	S	479.07	416.44	1.30	1.62	0.57	0.00	0.57	
1236	PAL1236-3	60	79	Bt	S	402.88	351.91	1.28	15.42	0.56	0.24	0.80	Effervesces
1237	PAL1237-1	0	33	A		614.53	542.36	1.18	2.18	1.11	0.00	1.11	Hillslope sediment 0-8 cm
1237	PAL1237-2	33	55	BA		448.63	388.77	1.27	0.57	0.61	0.00	0.61	
1237	PAL1237-3	55	69	Bt1		296.14	259.65	1.31	6.12	0.54	0.16	0.70	
1237	PAL1237-4	69	83	2Bt		258.55	220.86	0.86	54.55	0.41	2.17	2.58	
1238	PAL1238-1	0	41	A	S	761.42	663.97	1.17	0.61	1.05	0.00	1.05	Ap horizon not evident
1238	PAL1238-2	41	67	BA	S	541.04	462.29	1.28	0.00	0.51	0.00	0.51	
1238	PAL1238-3	67	88	Bt	S	521.75	449.23	1.47	21.00	0.44	0.29	0.73	
1239	PAL1239-1	0	17	Ap		268.78	244.76	1.04	0.53	1.72	0.00	1.72	Hillslope sediments on surface 20 cm. Bt sample includes 2 cm of Btk. Btk effervesces.
1239	PAL1239-2	17	42	A		490.72	429.11	1.24	0.08	0.93	0.00	0.93	
1239	PAL1239-3	42	88	Bt		1011.41	868.47	1.33	18.64	0.60	0.00	0.60	
1240	PAL1240-1	0	38	Ap	D	716.97	629.33	1.20	0.00	1.19	0.00	1.19	
1240	PAL1240-2	38	61	BA	D	476.55	407.52	1.28	0.00	0.54	0.00	0.54	
1240	PAL1240-3	61	97	Bt	D	856.55	737.11	1.45	12.80	0.38	0.00	0.38	
1241	PAL1241-1	0	25	Ap	E	441.23	397.60	1.15	0.00	0.89	0.00	0.89	Ap horizon is hillslope sediment
1241	PAL1241-2	25	43	A	E	397.48	347.09	1.34	13.10	0.70	0.00	0.70	
1241	PAL1241-3	43	89	Btk	E	1001.41	865.09	1.28	51.55	0.46	0.59	1.05	Strong effervescence
1242	PAL1242-1	0	12	Ap	E	202.30	184.97	1.11	0.00	0.82	0.00	0.82	
1242	PAL1242-2	12	38	A	E	569.98	492.39	1.37	0.00	0.70	0.00	0.70	
1242	PAL1242-3	38	67	B	E	719.84	631.51	1.44	51.45	0.47	0.00	0.47	
1243	PAL1243-1	0	14	Ap	E	256.68	232.94	1.20	0.00	0.99	0.00	0.99	
1243	PAL1243-2	14	34	A	E	402.81	347.92	1.25	1.08	0.71	0.00	0.71	
1243	PAL1243-3	34	54	BA	E	442.39	382.37	1.38	0.00	0.53	0.00	0.53	
1244	PAL1244-1	0	41	A		768.72	665.11	1.17	1.95	1.50	0.00	1.50	Ap/A boundary very indistinct
1244	PAL1244-1	0	21	Ap	E	472.61	407.92	1.28	36.86	0.67	0.00	0.67	
1244	PAL1244-2	41	56	BA		283.92	242.00	1.16	0.69	0.81	0.00	0.81	
1244	PAL1244-2	21	47	BA	E	624.63	548.94	1.35	63.04	0.41	0.00	0.41	
1244	PAL1244-3	56	74	Bt		392.70	336.32	1.35	0.00	0.59	0.00	0.59	
1244	PAL1244-3	47	84	2BC	E	947.10	870.29	1.35	180.40	0.17	0.00	0.17	Sand in lower 40 cm - clay films bridging sand grains - sand is angular
1245	PAL1245-1	0	24	AB		488.11	423.68	1.26	3.11	0.89	0.00	0.89	24 cm hillslope sediment on surface
1245	PAL1245-2	24	44	2A		529.84	453.86	1.63	2.72	0.88	0.00	0.88	
1245	PAL1245-3	44	67	2BA		336.20	288.95	0.90	0.88	0.75	0.00	0.75	
1246	PAL1246-1	0	38	A	D	774.59	658.10	1.25	1.74	1.04	0.00	1.04	
1246	PAL1246-2	38	76	B	D	822.10	693.89	1.29	13.22	0.63	0.00	0.63	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1246	PAL1246-3	76	85	2Btk	D	244.15	210.11	1.48	25.64	0.37	0.82	1.19	Strong effervescence
1247	PAL1247-1	0	36	A		724.28	619.71	1.23	6.66	1.06	0.00	1.06	Ap/A indistinct boundary
1247	PAL1247-2	36	66	BA		652.28	548.15	1.32	1.45				Sample was accidently discarded before archive sample could be obtained.
1248	PAL1248-1	0	36	A	E	709.04	620.30	1.24	0.00	1.05	0.00	1.05	
1248	PAL1248-2	36	52	BA	E	335.77	292.75	1.32	0.00	0.70	0.00	0.70	
1248	PAL1248-3	52	75	2Btk	E	506.25	431.52	1.14	69.49	0.57	1.91	2.48	Sandy at base - effervesces
1249	PAL1249-1	0	34	A	E	655.85	556.93	1.18	1.11	1.10	0.00	1.10	Ap horizon is not visible. Prismatic structure in A horizon.
1249	PAL1249-2	34	44	BA	E	220.77	187.86	1.31	6.14	0.70	0.00	0.70	
1249	PAL1249-3	44	69	B	E	554.09	460.31	1.29	12.55	0.68	0.72	1.40	
1250	PAL1250-1	0	17	Ap		312.91	273.80	1.16	0.07	1.43	0.00	1.43	
1250	PAL1250-2	17	36	A		379.79	324.84	1.23	0.00	0.87	0.00	0.87	
1250	PAL1250-3	36	69	Bt		649.21	551.58	1.20	1.01	0.60	0.00	0.60	
1251	PAL1251-1	0	19	Ap		306.13	276.01	1.05	0.25	1.61	0.00	1.61	Ap is hillslope sediment. Btk effervesces.
1251	PAL1251-2	19	37	A		385.44	335.08	1.33	4.40	0.88	0.00	0.88	
1251	PAL1251-3	37	83	BA		937.79	799.97	1.24	10.49	0.54	0.17	0.71	
1252	PAL1252-1	0	26	Ap	E	493.74	419.52	1.16	0.35	0.92	0.00	0.92	
1252	PAL1252-2	26	45	BA	E	397.36	332.67	1.26	0.46	0.64	0.00	0.64	
1252	PAL1252-3	45	67	Bt	E	494.32	416.00	1.36	1.60	0.42	0.00	0.42	
1253	PAL1253-1	0	21	Ap	E	384.96	351.62	1.18	7.32	0.72	0.00	0.72	
1253	PAL1253-2	21	40	Bt	E	314.30	285.82	1.07	4.46	0.47	0.00	0.47	
1254	PAL1254-1	0	19	Ap	E	358.21	333.07	1.25	4.47	0.71	0.00	0.71	No A horizon - Ap horizon is in old Bt material
1254	PAL1254-2	19	50	Bt	E	552.98	507.29	1.15	13.57	0.51	0.00	0.51	
1255	PAL1255-1	0	12	Ap	E	207.22	193.11	1.15	2.53	0.72	0.00	0.72	
1255	PAL1255-2	12	38	Bw	E	512.61	476.51	1.24	29.02	0.44	0.00	0.44	
1256	PAL1256-1	0	12	Ap	E	147.70	141.28	0.85	0.27	0.97	0.00	0.97	
1256	PAL1256-2	12	36	Bt	E	437.29	413.45	1.13	37.60	0.49	0.00	0.49	
1257	PAL1257-1	0	21	Ap	E	388.18	363.57	1.24	4.15	0.77	0.00	0.77	
1257	PAL1257-2	21	56	Bt	E	695.06	644.99	1.31	10.50	0.49	0.00	0.49	
1258	PAL1258-1	0	13	Ap	E	225.04	209.00	1.09	12.53	0.84	0.00	0.84	
1258	PAL1258-2	13	40	Bt	E	527.45	488.53	1.26	16.62	0.53	0.00	0.53	
1259	PAL1259-1	0	30	Ap	E	552.19	513.56	1.23	2.46	0.57	0.00	0.57	No A horizon material
1259	PAL1259-2	30	66	Bt	E	688.41	630.31	1.26	4.32	0.42	0.00	0.42	
1260	PAL1260-1	0	19	Ap	E	329.31	303.14	1.15	0.57	0.64	0.00	0.64	Ap horizon is in B material
1260	PAL1260-2	19	48	B	E	534.44	487.72	1.16	21.71	0.42	0.00	0.42	
1260	PAL1260-3	48	64	Bt	E	350.06	319.93	1.40	9.26	0.36	0.00	0.36	
1261	PAL1261-1	0	42	B1		758.64	709.39	1.21	6.71	0.61	0.00	0.61	Eroded, short core
1261	PAL1261-2	42	72	B2		617.66	578.56	1.36	14.02	0.32	0.00	0.32	
1262	PAL1262-1	0	23	Ap	E	411.11	387.98	1.22	0.81	0.58	0.00	0.58	
1262	PAL1262-2	23	42	Bw	E	350.32	328.23	1.24	2.66	0.40	0.00	0.40	
1262	PAL1262-3	42	71	BC	E	564.60	528.02	1.29	8.47	0.28	0.00	0.28	
1263	PAL1263-1	0	21	Ap	E	373.22	347.34	1.19	1.92	0.55	0.00	0.55	
1263	PAL1263-2	21	63	B	E	812.64	748.66	1.24	29.69	0.42	0.00	0.42	
1264	PAL1264-1	0	35	Bt1	E	614.31	563.39	1.16	0.00	0.69	0.00	0.69	No A horizon
1264	PAL1264-2	35	68	Bt2	E	599.87	538.92	1.18	0.00	0.45	0.00	0.45	
1264	PAL1264-3	68	94	Bt3	E	519.76	467.68	1.30	0.00	0.30	0.00	0.30	
1265	PAL1265-1	0	29	Ap	E	499.71	466.41	1.16	0.32	0.65	0.00	0.65	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1265	PAL1265-2	29	53	BA	E	447.06	413.57	1.24	1.65	0.39	0.00	0.39	
1265	PAL1265-3	53	95	Bt	E	861.32	792.18	1.29	41.92	0.28	0.00	0.28	
1266	PAL1266-1	0	17	Ap	E	275.19	249.12	1.02	9.85	0.67	0.00	0.67	
1266	PAL1266-2	17	41	Bw	E	432.29	388.34	1.14	9.08	0.40	0.00	0.40	
1267	PAL1267-1	0	26	Ap	E	455.25	427.74	1.18	3.86	0.62	0.00	0.62	
1267	PAL1267-2	26	71	Bw	E	868.48	811.77	1.20	64.79	0.33	0.00	0.33	
1268	PAL1268-1	0	21	Ap	E	363.05	337.68	1.15	4.34	0.59	0.00	0.59	Ap horizon in ol B material
1268	PAL1268-2	21	62	Bw	E	773.07	717.63	1.23	20.42	0.40	0.00	0.40	
1269	PAL1269-1	0	13	Ap	E	223.82	209.47	1.09	13.18	0.43	0.00	0.43	
1270	PAL1270-1	0	28	Ap	D	518.97	450.32	1.15	3.67	1.30	0.00	1.30	
1270	PAL1270-2	28	60	A	D	650.54	550.14	1.23	4.38	0.75	0.00	0.75	
1271	PAL1271-1	0	22	Ap	S	376.81	319.65	1.02	8.76	2.32	0.00	2.32	Clayey
1271	PAL1271-2	22	46	AB	S	555.35	462.31	1.32	24.35	0.86	0.00	0.86	
1271	PAL1271-3	46	50	Bt	S	94.32	80.62	1.28	9.49	0.39	0.00	0.39	
1272	PAL1272-1	0	18	Ap		305.29	274.70	1.05	13.74	1.01	0.00	1.01	Hillslope sediment 0-18 cm
1272	PAL1272-2	18	44	BA		580.75	499.63	1.37	4.56	0.79	0.00	0.79	
1272	PAL1272-3	44	62	B		361.30	308.02	1.18	14.08	0.54	0.00	0.54	
1273	PAL1273-1	0	23	AB	D	436.20	384.11	1.19	5.15	0.80	0.00	0.80	Surface is hillslope sediment
1273	PAL1273-2	23	40	2A	D	389.56	329.26	1.40	0.00	0.65	0.00	0.65	
1273	PAL1273-3	40	54	2Bt	D	335.38	278.13	1.43	1.24	0.31	0.00	0.31	
1274	PAL1274-1	0	41	Ap	D	752.75	665.05	1.12	27.37	0.97	0.00	0.97	Surface appears to be sediments from upslope
1274	PAL1274-2	41	64	AB	D	513.75	440.42	1.35	11.02	0.67	0.00	0.67	
1274	PAL1274-3	64	80	2A	D	345.28	294.69	1.30	6.90	0.55	0.00	0.55	
1275	PAL1275-1	0	21	Ap	D	385.70	339.76	1.16	2.76	0.83	0.00	0.83	
1275	PAL1275-2	21	51	A	D	597.56	511.90	1.18	21.17	0.83	0.00	0.83	
1277	PAL1277-1	0	22	A		458.40	395.84	1.05	74.92	2.38	0.00	2.38	Short core
1277	PAL1277-2	22	34	AB		296.03	235.59	1.05	60.43	0.53	0.00	0.53	
1277	PAL1277-3	34	48	B		318.54	255.49	1.30	3.01	0.38	0.00	0.38	
1278	PAL1278-1	0	12	Ap	E	217.15	195.81	1.18	0.00	1.91	0.00	1.91	Core was loose in tube. Bulk density will be problematic.
1278	PAL1278-1	0	36	Ap	D	747.75	646.74	1.22	36.80	1.51	0.00	1.51	
1278	PAL1278-2	12	31	A	E	376.35	317.70	1.21	0.00	1.16	0.00	1.16	
1279	PAL1279-1	0	23	Ap	E	476.40	432.59	1.18	55.90	0.91	0.00	0.91	Red soil
1279	PAL1279-2	23	54	Bt	E	713.91	624.48	1.29	71.38	0.77	0.00	0.77	
1280	PAL1280-1	0	16	Ap	E	305.44	283.91	1.24	8.11	0.95	0.00	0.95	
1280	PAL1280-2	16	24	Bt	E	134.20	126.28	1.10	4.72	0.72	0.00	0.72	
1281	PAL1281-1	0	28	Ap	D	498.42	436.84	1.07	22.38	1.08	0.00	1.08	Core ended at basalt fragment
1281	PAL1281-2	28	61	A	D	709.66	601.77	1.15	77.80	0.61	0.00	0.61	
1282	PAL1282-1	0	24	Ap	E	510.40	478.90	1.44	0.00	1.42	0.00	1.42	Red soil
1282	PAL1282-2	24	45	Bt	E	452.13	411.47	1.41	0.00	0.62	0.00	0.62	
1282	PAL1282-3	45	85	2Bt	E	833.61	700.47	1.26	0.00	0.43	0.00	0.43	Profile "stretched" from 45 cm to base of core
1283	PAL1283-1	0	21	Ap		359.44	323.48	1.08	8.74	1.39	0.00	1.39	Erosional surface
1283	PAL1283-2	21	43	AB		423.76	375.92	1.22	4.45	0.85	0.00	0.85	
1284	PAL1284-1	0	24	Ap	E	391.64	355.33	0.94	42.19	2.57	0.00	2.57	Dry - no picture
1285	PAL1285-1	0	14	Ap		204.16	184.55	0.93	3.51	2.86	0.00	2.86	
1285	PAL1285-2	14	39	Bt1		425.29	379.87	1.00	33.34	2.19	0.00	2.19	
1286	PAL1286-1	0	38	Ap	D	626.88	543.13	0.93	54.51	2.61	0.00	2.61	Sample ended at basalt fragment
1287	PAL1287-1	0	18	Ap	E	294.15	264.67	1.06	1.34	2.28	0.00	2.28	Very dry - uniform color throughout

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1287	PAL1287-2	18	34	B	E	273.04	244.78	1.04	15.15	1.85	0.00	1.85	
1288	PAL1288-1	0	23	Ap		364.50	329.03	1.03	0.00	1.70	0.00	1.70	Hillslope sediment on surface 23 cm
1288	PAL1288-2	23	51	A		557.77	489.61	1.26	0.00	0.90	0.00	0.90	
1288	PAL1288-3	51	80	AB		690.94	601.49	1.50	0.00	0.38	0.00	0.38	
1289	PAL1289-1	0	25	Ap	U	439.45	402.60	1.12	14.72	1.46	0.00	1.46	Granite pebble at base of sample
1290	PAL1290-1	0	30	Ap	D	496.29	461.69	1.11	1.29	1.97	0.00	1.97	No color or texture difference between Ap and A1 horizons
1290	PAL1290-2	30	43	A1	D	269.13	248.89	1.38	0.00	0.95	0.00	0.95	
1291	PAL1291-1	0	20	A1	D	298.67	254.31	0.82	28.30	2.81	0.00	2.81	Many angular coarse fragments of basalt - core "stretched"
1291	PAL1291-2	20	60	A2	D	857.98	721.17	0.92	210.20	1.71	0.00	1.71	
1291	PAL1291-3	60	80	A3	D	390.04	329.16	0.95	64.96	1.00	0.00	1.00	
1292	PAL1292-1	0	25	Ap	D	462.95	388.81	0.90	78.68	3.68	0.00	3.68	Basalt fragments
1292	PAL1292-2	25	64	A1	D	771.28	641.90	0.91	147.69	2.97	0.00	2.97	
1293	PAL1293-1	0	17	Ap		294.57	273.28	1.12	9.92	1.85	0.00	1.85	Severely eroded - 5YR red color
1293	PAL1293-2	17	44	Bt		507.59	455.98	1.19	10.82	0.93	0.00	0.93	
1294	PAL1294-1	0	29	AB1		397.23	360.05	0.90	0.00	0.94	0.00	0.94	Severely eroded
1294	PAL1294-2	29	55	AB2		368.50	328.77	0.91	0.00	0.59	0.00	0.59	
1294	PAL1294-3	55	84	Btc		440.79	398.22	0.99	0.00	0.38	0.00	0.38	
1295	PAL1295-1	0	15	Ap	U	264.04	246.34	1.06	26.73	1.40	0.00	1.40	Core was loose in tube. Bulk density will be problematic.
1295	PAL1295-1	0	22	Ap	E	347.29	326.19	1.07	0.00	0.79	0.12	0.91	
1295	PAL1295-2	22	60	B	E	603.22	551.77	1.05	0.00	0.48	0.00	0.48	
1295	PAL1295-3	60	81	BC	E	293.71	265.78	0.91	0.00	0.24	0.00	0.24	
1296	PAL1296-1	0	25	Ap	D	350.87	328.00	0.95	0.00	1.04	0.00	1.04	
1296	PAL1296-2	25	50	Bw	D	449.00	428.23	1.24	0.22	0.44	0.00	0.44	
1296	PAL1296-3	50	86	C	D	584.20	551.72	1.11	0.21	0.33	0.04	0.37	C horizon has alternating bands - appears to be aeolian - particle size of C horizon feels like fine sand
1298	PAL1298-1	0	21	Ap	E	293.69	265.17	0.91	0.00	1.31	0.00	1.31	
1298	PAL1298-2	21	43	Bt	E	442.89	399.92	1.22	28.76	0.61	0.00	0.61	
1299	PAL1299-1	0	17	Ap	D	275.75	256.25	0.99	23.26	0.82	0.00	0.82	Volcanic ash in Ap horizon
1299	PAL1299-2	17	47	Bw	D	632.84	591.45	1.11	129.82	0.67	0.00	0.67	Large basalt pebble at base of core tube
1300	PAL1300-1	0	16	Ap		279.91	259.31	1.05	26.74	0.83	0.00	0.83	Severely eroded Ap in in the B
1300	PAL1300-2	16	22	Bt1		86.03	80.76	0.69	23.44	0.56	0.00	0.56	
1301	PAL1301-1	0	14	Ap	E	201.81	189.12	0.96	3.31	1.29	0.00	1.29	Appears to be recent ash
1301	PAL1301-2	14	41	B	E	502.03	465.77	1.15	34.40	0.84	0.00	0.84	
1302	PAL1302-1	0	22	Ap	E	328.42	302.38	0.93	19.42	1.05	0.00	1.05	Ap horizon is in old B material
1302	PAL1302-2	22	59	Bw	E	696.21	637.61	1.18	32.18	0.64	0.00	0.64	
1302	PAL1302-3	59	76	Bk	E	306.73	278.79	1.13	12.26	0.54	0.12	0.66	Weak effervescence
1303	PAL1303-1	0	8	BA		147.99	134.88	0.88	37.01	0.78	0.00	0.78	
1303	PAL1303-2	8	20	B		209.08	192.10	1.13	3.56	0.71	0.00	0.71	
1304	PAL1304-1	0	8	BA		150.78	140.10	1.25	1.29	0.51	0.00	0.51	
1304	PAL1304-2	8	29	B		379.79	354.20	1.20	4.65	0.87	0.00	0.87	
1305	PAL1305-1	0	33	B1	E	513.28	475.68	1.01	15.10	1.40	0.00	1.40	No Ap horizon
1305	PAL1305-2	33	55	B2	E	467.65	436.81	1.37	19.57	0.66	0.00	0.66	
1305	PAL1305-3	55	79	Bk	E	474.17	443.57	1.22	38.48	0.57	0.00	0.57	Weak effervescence
1306	PAL1306-1	0	14	Ap		194.49	176.98	0.91	0.00	1.48	0.00	1.48	Hillslope sediment 0-14 cm
1306	PAL1306-2	14	44	Bt1		520.78	473.49	1.12	7.87	0.65	0.00	0.65	
1307	PAL1307-1	0	16	Ap	E	273.28	254.66	1.07	18.04	1.02	0.00	1.02	Dry - uniform color
1307	PAL1307-2	16	43	Bt	E	556.69	511.83	1.25	42.71	0.58	0.00	0.58	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1308	PAL1308-1	0	21	Ap	E	349.13	320.84	1.09	4.75	0.74	0.00	0.74	
1308	PAL1308-2	21	34	Bt	E	277.88	254.03	1.22	33.65	0.50	0.00	0.50	
1309	PAL1309-1	0	12	Ap	E	240.71	213.47	1.28	0.00	0.97	0.00	0.97	
1309	PAL1309-2	12	30	Bt	E	345.70	301.39	1.21	0.00	0.39	0.00	0.39	
1310	PAL1310-1	0	25	Ap	S	426.23	366.37	1.06	0.00	1.38	0.00	1.38	
1310	PAL1310-2	25	50	BA	S	444.75	387.72	1.12	0.00	0.57	0.00	0.57	
1310	PAL1310-3	50	88	Bt	S	793.60	691.67	1.31	0.00	0.25	0.00	0.25	
1311	PAL1311-1	0	25	Ap	D	370.88	322.04	0.87	19.89	2.94	0.00	2.94	
1311	PAL1311-2	25	50	AB	D	486.15	425.80	1.07	56.10	0.91	0.00	0.91	
1312	PAL1312-1	0	23	Ap	D	333.53	304.96	0.80	49.39	1.76	0.00	1.76	
1312	PAL1312-2	23	40	AB	D	361.72	329.43	1.24	36.99	0.74	0.00	0.74	
1313	PAL1313-1	0	37	Ap	S	600.26	553.66	0.87	109.41	3.28	0.00	3.28	Core ended at basalt fragment
1314	PAL1314-1	0	34	Ap	D	561.25	509.22	1.00	38.22	2.34	0.00	2.34	
1314	PAL1314-2	34	61	A1	D	531.93	460.90	1.19	14.50	1.09	0.00	1.09	
1314	PAL1314-3	61	80	A2	D	371.30	317.25	1.15	14.69	0.79	0.00	0.79	
1315	PAL1315-1	0	16	Ap	D	244.67	224.14	0.95	13.69	2.78	0.00	2.78	
1316	PAL1316-1	0	38	Bw	E	696.51	654.99	1.15	49.05	1.08	0.00	1.08	
1317	PAL1317-1	0	20	Ap	D	311.49	265.50	0.88	20.57	2.36	0.00	2.36	
1318	PAL1318-1	0	23	Ap	S	358.77	306.85	0.93	9.09	3.08	0.00	3.08	
1318	PAL1318-2	23	41	AB	S	338.27	285.58	1.14	2.14	1.03	0.00	1.03	
1318	PAL1318-3	41	66	Bt	S	537.79	457.14	1.32	1.55	0.54	0.00	0.54	
1319	PAL1319-1	0	30	Ap	D	476.04	425.22	0.98	17.88	2.08	0.00	2.08	Ap horizon is hillslope sediment
1319	PAL1319-2	30	54	A	D	414.64	363.24	1.08	2.68	1.34	0.00	1.34	
1319	PAL1319-3	54	88	B	D	667.24	579.68	1.21	8.80	0.60	0.00	0.60	
1320	PAL1320-1	0	17	Ap	U	220.67	194.15	0.77	12.11	4.35	0.00	4.35	
1321	PAL1321-1	0	15	Ap	E	237.55	223.52	1.07	0.80	1.39	0.00	1.39	
1321	PAL1321-2	15	41	Ck	E	442.09	410.34	1.13	1.52	0.74	0.17	0.91	
1322	PAL1322-1	0	28	Ap	E	433.99	398.20	1.03	0.08	0.92	0.00	0.92	
1322	PAL1322-2	28	55	BA	E	439.48	399.89	1.07	1.45	0.73	0.00	0.73	
1322	PAL1322-3	55	82	Bw	E	473.77	431.71	1.13	8.45	0.36	0.00	0.36	
1323	PAL1323-1	0	22	C1k	E	409.37	394.15	1.29	2.13	0.44	0.70	1.14	Strong effervescence - "varved"
1323	PAL1323-2	22	44	C1k	E	388.87	366.25	1.20	0.00	0.15	0.86	1.01	
1323	PAL1323-3	44	71	C1k	E	535.27	502.50	1.34	0.60	0.14	0.49	0.63	
1324	PAL1324-1	0	22	Ap	U	437.73	421.93	1.04	104.56	0.14	0.11	0.25	Loose, gravelly sand at base of core
1325	PAL1325-1	0	23	Ap	E	438.42	423.87	1.33	0.00	0.60	0.00	0.60	Appears to be recent ash
1325	PAL1325-2	23	37	Bw	E	259.39	248.57	1.28	0.00	0.34	0.00	0.34	Varving between 28 & 73 cm
1325	PAL1325-3	37	73	Ck	E	747.92	710.24	1.42	0.00	0.29	0.23	0.52	Effervesces weakly
1326	PAL1326-1	0	27	Bw	E	487.28	470.19	1.26	0.00	0.65	0.00	0.65	Looks like recent ash
1326	PAL1326-2	27	75	C	E	909.98	866.97	1.30	0.06	0.32	0.07	0.39	Varving 29 to 75 cm
1327	PAL1327-1	0	21	Ap	S	373.08	358.31	1.23	0.00	0.64	0.00	0.64	Appears to be fresh ash - "varving"
1327	PAL1327-2	21	34	Bw	S	258.69	244.54	1.36	0.00	0.50	0.46	0.96	
1327	PAL1327-3	34	82	C	S	928.31	872.30	1.31	0.00	0.20	1.11	1.31	
1328	PAL1328-1	0	33	Ap	E	559.59	519.98	1.14	0.00	0.46	0.00	0.46	
1328	PAL1328-2	33	56	Bw	E	437.24	396.28	1.24	0.00	0.13	0.52	0.65	
1328	PAL1328-3	56	76	Ck	E	421.95	386.00	1.39	0.00	0.08	0.52	0.60	
1329	PAL1329-1	0	26	Ap	E	450.78	407.71	1.13	0.00	0.87	0.17	1.04	
1329	PAL1329-2	26	54	Btk	E	512.51	453.26	1.17	0.00	0.47	0.91	1.38	Effervesces

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
1330	PAL1330-1	0	16	Ap	D	306.24	288.00	1.30	0.00	0.54	0.00	0.54	
1330	PAL1330-2	16	51	Bk	D	632.33	586.04	1.21	0.00	0.49	0.33	0.82	Strong effervescence
1330	PAL1330-3	51	83	Ck	D	584.77	539.32	1.22	0.00	0.25	0.90	1.15	Varving in C horizon
1331	PAL1331-1	0	28	Bw	E	502.47	474.08	1.22	0.00	0.47	0.00	0.47	Looks like recent ash
1331	PAL1331-2	28	55	C1	E	542.80	507.38	1.36	0.00	0.36	0.00	0.36	Varving 37 to 74 cm
1331	PAL1331-3	55	74	C2	E	358.63	335.52	1.27	0.00	0.25	0.24	0.49	Effervesces 55 to 74 cm
1332	PAL1332-1	0	25	Ap	E	455.79	429.21	1.24	0.00	0.65	0.05	0.70	
1332	PAL1332-2	25	58	Bwk	E	610.46	560.96	1.23	0.00	0.38	0.60	0.98	Violent effervescence
1332	PAL1332-3	58	83	Ck	E	486.83	447.77	1.29	0.00	0.20	0.83	1.03	
1333	PAL1333-1	0	32	Ap	D	606.23	576.97	1.30	0.00	0.44	0.00	0.44	Ash deposit - varving
1333	PAL1333-2	32	54	Bwk	D	443.18	417.71	1.37	0.27	0.34	0.03	0.37	
1333	PAL1333-3	54	74	Ck	D	399.00	373.34	1.35	0.00	0.31	0.54	0.85	
1334	PAL1334-1	0	24	BCk	E	362.55	344.09	1.03	0.00	0.41	0.71	1.12	"Varved" appearance - looks like fresh parent material - free carbonates throughout
1334	PAL1334-2	24	60	Ck1	E	606.56	568.91	1.14	0.00	0.20	0.95	1.15	
1334	PAL1334-3	60	82	Ck2	E	417.55	395.40	1.30	0.00	0.14	0.63	0.77	
1335	PAL1335-1	0	26	C1	E	483.30	462.10	1.28	0.00	0.36	0.08	0.44	Looks like fresh ash - varving and calcareous throughout
1335	PAL1335-2	26	52	C2	E	494.83	464.47	1.29	0.00	0.33	0.07	0.40	
1335	PAL1335-3	52	79	C3	E	493.69	460.24	1.23	0.00	0.29	0.42	0.71	
1336	PAL1336-1	0	33	Bw	E	563.71	541.88	1.17	5.48	0.55	0.33	0.88	"Varving" in Bw horizon appears to be recent ash
1336	PAL1336-2	33	50	C	E	324.00	307.41	1.23	17.08	0.39	1.10	1.49	
1337	PAL1337-1	0	23	Ap	E	392.38	371.64	1.17	0.00	0.50	0.00	0.50	Varving
1337	PAL1337-2	23	53	Bw	E	568.29	531.60	1.28	0.00	0.38	0.01	0.39	
1337	PAL1337-3	53	72	Ck	E	355.26	335.06	1.27	0.00	0.20	0.60	0.80	
1338	PAL1338-1	0	33	Ap	D	507.44	477.63	1.01	14.21	1.70	0.00	1.70	No picture
1338	PAL1338-2	33	56	BA	D	381.85	356.61	1.11	3.51	0.97	0.00	0.97	
1338	PAL1338-3	56	76	2A	D	315.78	291.40	1.05	0.64	1.33	0.00	1.33	
1339	PAL1339-1	0	25	Ap	S	454.25	430.68	1.23	4.62	1.91	0.00	1.91	
1339	PAL1339-2	25	54	A	S	563.23	517.32	1.20	36.48	1.05	0.00	1.05	
1339	PAL1339-3	54	94	BA	S	1039.30	868.60	1.54	15.40	0.24	0.00	0.24	
1340	PAL1340-1	0	44	Ap	D	625.00	568.52	0.79	88.22	3.34	0.00	3.34	
1341	PAL1341-1	0	24	Ap	U	387.81	363.43	1.08	4.25	1.81	0.00	1.81	
1342	PAL1342-1	0	25	Ap	D	453.72	409.89	1.18	0.00	1.06	0.00	1.06	Core stretched
1342	PAL1342-2	25	55	A	D	577.14	482.76	1.16	0.00	0.52	0.00	0.52	
1342	PAL1342-3	55	88	BA	D	715.49	588.92	1.29	0.00	0.22	0.00	0.22	
1343	PAL1343-1	0	27	Ap	D	404.74	364.91	0.97	1.58	1.11	0.00	1.11	Surface is hillslope sediment
1343	PAL1343-2	27	55	2AB	D	519.60	456.15	1.18	0.00	0.42	0.00	0.42	
1344	PAL1344-1	0	39	Ap	D	459.68	403.09	0.74	4.38	2.30	0.00	2.30	
1344	PAL1344-2	39	92	BA	D	911.56	768.18	1.04	3.63	0.62	0.00	0.62	
1345	PAL1345-1	0	17	Ap	S	236.10	196.69	0.84	0.00	2.67	0.00	2.67	
1345	PAL1345-2	17	49	A	S	550.37	453.01	1.02	0.00	2.02	0.00	2.02	
1345	PAL1345-3	49	82	BA	S	666.52	542.21	1.19	0.00	0.72	0.00	0.72	
1346	PAL1346-1	0	36	A	S	636.23	543.57	1.09	0.00	2.40	0.00	2.40	
1346	PAL1346-2	36	54	BA	S	357.35	304.54	1.22	0.00	0.87	0.00	0.87	
1347	PAL1347-1	0	44	Ap	D	688.06	620.43	1.02	0.00	1.81	0.00	1.81	Hillslope sediments on surface
1347	PAL1347-2	44	72	A	D	475.27	414.50	1.07	0.00	0.83	0.00	0.83	
1347	PAL1347-3	72	98	BA	D	518.47	443.63	1.23	0.00	0.52	0.00	0.52	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2000	PAL2000-1	0	18	Ap		260.48	213.96	0.85	2.74	3.57	0.00	3.57	Smells of cattle
2000	PAL2000-2	18	39	A		416.77	340.12	1.13	10.88	2.27	0.00	2.27	
2000	PAL2000-3	39	57	BA		328.57	273.39	0.91	47.37	1.49	0.00	1.49	
2001	PAL2001-1	0	25	Ap	S	506.15	409.11	1.18	0.00	1.80	0.00	1.80	
2001	PAL2001-2	25	38	AB	S	300.36	236.61	1.31	0.00	1.02	0.00	1.02	
2001	PAL2001-3	38	79	B	S	1030.98	850.09	1.50	0.00	0.37	0.00	0.37	
2002	PAL2002-1	0	30	A	S	653.90	515.41	1.24	0.00	1.64	0.00	1.64	Ap horizon not visible - clayey
2002	PAL2002-2	30	52	BA	S	522.22	418.81	1.37	0.00	0.72	0.00	0.72	
2002	PAL2002-3	52	92	Bt	S	1047.65	864.82	1.56	0.00	0.31	0.00	0.31	
2003	PAL2003-1	0	24	A		506.83	391.97	1.18	0.00	2.24	0.00	2.24	Surface smells of cattle
2003	PAL2003-2	24	42	BAg		409.29	305.49	1.21	2.63	1.10	0.00	1.10	
2004	PAL2004-1	0	40	A	D	892.79	691.97	1.25	0.00	1.76	0.00	1.76	No visible Ap horizon
2004	PAL2004-2	40	56	AB	D	387.78	314.95	1.42	0.00	0.52	0.00	0.52	
2004	PAL2004-3	56	83	BA	D	747.21	609.00	1.63	0.00	0.35	0.00	0.35	Organic matter coating faces of peds in BAg - clayey
2005	PAL2005-1	0	34	A	S	774.63	647.32	1.37	0.00	1.29	0.00	1.29	No visible Ap horizon - clayey
2005	PAL2005-2	34	49	AB	S	412.08	334.64	1.61	0.00	0.71	0.00	0.71	
2005	PAL2005-3	49	79	B	S	803.25	663.16	1.60	0.00	0.37	0.00	0.37	
2006	PAL2006-1	0	30	A	D	691.27	558.07	1.34	0.00	0.97	0.00	0.97	Clayey
2006	PAL2006-2	30	46	E	D	433.31	354.57	1.60	0.00	0.32	0.00	0.32	
2006	PAL2006-3	46	82	Btg	D	933.48	753.10	1.51	0.00	0.25	0.00	0.25	
2007	PAL2007-1	0	27	Ap	D	618.64	512.31	1.37	0.00	1.69	0.00	1.69	Clayey
2007	PAL2007-2	27	60	A	D	729.57	559.73	1.22	0.00	2.05	0.00	2.05	
2007	PAL2007-3	60	90	AB	D	681.13	518.01	1.25	0.00	1.31	0.00	1.31	
2008	PAL2008-1	0	47	A	D	1112.34	909.32	1.40	0.00	1.52	0.00	1.52	No photo
2008	PAL2008-2	47	67	AB	D	527.76	429.70	1.55	0.00	0.53	0.00	0.53	
2008	PAL2008-3	67	87	B	D	531.44	440.07	1.59	0.32	0.29	0.00	0.29	
2009	PAL2009-1	0	23	Ap		496.10	396.41	1.24	0.00	1.86	0.00	1.86	
2009	PAL2009-2	23	59	A		771.71	582.15	1.17	0.00	1.61	0.00	1.61	
2009	PAL2009-3	59	88	Bg		679.02	520.96	1.30	0.00	0.54	0.00	0.54	
2009	PAL2009-4	88	99	Btc		283.97	223.56	1.47	0.00	0.21	0.00	0.21	
2010	PAL2010-1	0	36	A1		881.05	709.86	1.42	0.19	1.78	0.00	1.78	
2010	PAL2010-2	36	60	A2		626.06	490.40	1.47	0.00	1.44	0.00	1.44	
2010	PAL2010-3	60	96	A3		852.70	645.69	1.29	0.00	0.94	0.00	0.94	
2011	PAL2011-1	0	23	Ap		513.86	412.59	1.29	0.00	1.83	0.00	1.83	
2011	PAL2011-2	23	40	AB		351.42	268.83	1.14	0.00	0.99	0.00	0.99	
2011	PAL2011-3	40	93	Bt		1313.04	1057.48	1.44	0.00	0.45	0.00	0.45	
2012	PAL2012-1	0	15	Ap	E	344.26	290.75	1.17	46.79	0.77	0.00	0.77	Clayey - very thick clay films on prism surfaces
2012	PAL2012-2	15	34	BA	E	480.49	394.77	1.50	0.00	0.37	0.00	0.37	
2012	PAL2012-3	34	88	Bt	E	1391.40	1166.75	1.56	0.00	0.19	0.00	0.19	
2013	PAL2013-1	0	56	A		1103.08	847.46	1.09	0.00	1.71	0.00	1.71	Core was very wet and hard to remove from the tube. Surface smells of cattle.
2013	PAL2013-2	56	75	Bg		618.04	497.97	1.89	0.00	0.37	0.00	0.37	
2013	PAL2013-3	75	96	Btg		504.46	404.47	1.39	0.00	0.22	0.00	0.22	
2014	PAL2014-1	0	27	A		550.27	445.54	1.19	0.00	1.47	0.00	1.47	Short core
2014	PAL2014-2	27	64	B		967.39	784.01	1.53	0.00	0.29	0.00	0.29	
2015	PAL2015-1	0	41	A	S	908.45	730.50	1.29	0.00	1.60	0.00	1.60	Clayey
2015	PAL2015-2	41	71	AB	S	766.14	616.15	1.48	0.00	0.57	0.00	0.57	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2015	PAL2015-3	71	96	B	S	688.84	554.39	1.60	0.00	0.31	0.00	0.31	
2016	PAL2016-1	0	39	A		829.25	654.33	1.21	0.00	1.71	0.00	1.71	Core is very wet. Smells of cattle.
2016	PAL2016-2	39	64	BA		598.83	466.76	1.35	0.09	0.78	0.00	0.78	
2016	PAL2016-3	64	95	B		814.15	668.54	1.56	0.00	0.29	0.00	0.29	
2017	PAL2017-1	0	21	Ap	D	450.52	392.26	1.35	0.00	1.70	0.00	1.70	
2017	PAL2017-2	21	55	A	D	767.14	619.27	1.31	0.00	0.90	0.00	0.90	
2017	PAL2017-3	55	93	Bt	D	977.65	807.54	1.53	0.24	0.35	0.00	0.35	Bt horizon contains krotovinas - clayey
2018	PAL2018-1	0	28	A1	D	574.34	445.70	1.13	6.04	2.53	0.00	2.53	Mica throughout
2018	PAL2018-2	28	58	A2	D	648.60	491.63	1.18	0.00	2.30	0.00	2.30	
2018	PAL2018-3	58	90	AB	D	834.87	654.23	1.46	5.91	1.11	0.00	1.11	
2019	PAL2019-1	0	17	A	E	339.45	284.56	1.21	0.00	1.15	0.00	1.15	
2019	PAL2019-2	17	61	Bt	E	1174.08	942.94	1.55	0.00	0.24	0.00	0.24	
2020	PAL2020-1	0	24	Ap		554.32	445.20	1.33	3.75	1.88	0.00	1.88	
2020	PAL2020-2	24	52	BA		613.05	476.33	1.23	0.93	1.13	0.00	1.13	
2020	PAL2020-3	52	95	B		1163.03	939.51	1.57	6.29	0.34	0.00	0.34	
2021	PAL2021-1	0	26	Ap		459.12	375.45	1.04	0.00	2.59	0.00	2.59	Cow manure smell. Ap is hillslope sediment.
2021	PAL2021-2	26	45	A1		436.50	350.03	1.33	0.00	2.06	0.00	2.06	
2021	PAL2021-3	45	82	AB		891.64	687.10	1.34	0.00	0.90	0.00	0.90	
2022	PAL2022-1	0	25	Ap	D	514.86	421.72	1.22	0.00	2.38	0.00	2.38	Ap horizon is lighter in color than the A horizon - clayey
2022	PAL2022-2	25	45	A	D	469.50	367.22	1.33	0.00	1.75	0.00	1.75	
2022	PAL2022-3	45	69	AB	D	604.28	463.35	1.39	0.00	0.83	0.00	0.83	
2023	PAL2023-1	0	41	A1	D	849.03	667.18	1.17	0.00	1.95	0.00	1.95	Wet - A5 clayey
2023	PAL2023-2	41	68	A2	D	593.45	460.83	1.23	0.00	1.71	0.00	1.71	
2023	PAL2023-3	68	96	A3	D	659.41	497.34	1.28	0.00	1.84	0.00	1.84	
2024	PAL2024-1	0	31	A1		645.51	510.36	1.19	0.00	2.14	0.00	2.14	A4 is darkest horizon. Appears to be multiple depositional events.
2024	PAL2024-2	31	70	A2		958.45	748.17	1.38	0.00	1.71	0.00	1.71	
2024	PAL2024-3	70	94	A3		456.12	349.61	1.05	0.00	1.82	0.00	1.82	
2025	PAL2025-1	0	41	A1	D	943.27	730.21	1.29	0.00	2.45	0.00	2.45	Clayey
2025	PAL2025-2	41	73	A2	D	751.32	557.88	1.26	0.00	1.16	0.00	1.16	
2025	PAL2025-3	73	88	AB	D	346.76	259.00	1.25	0.00	0.76	0.00	0.76	
2026	PAL2026-1	0	28	A	D	582.56	472.45	1.22	0.00	1.67	0.00	1.67	No Ap horizon
2026	PAL2026-2	28	57	AB	D	629.24	500.33	1.25	0.00	0.69	0.00	0.69	
2026	PAL2026-3	57	92	Bt	D	864.04	698.06	1.44	0.00	0.38	0.00	0.38	
2027	PAL2027-1	0	39	A1	D	811.07	615.46	1.14	0.00	2.13	0.00	2.13	
2027	PAL2027-2	39	86	A2	D	1036.01	779.91	1.20	0.00	0.88	0.00	0.88	
2027	PAL2027-3	86	98	BA	D	340.55	266.87	1.61	0.00	0.36	0.00	0.36	
2028	PAL2028-1	0	22	A1	D	450.28	357.66	1.17	0.00	2.26	0.00	2.26	No distinct Ap horizon - clayey
2028	PAL2028-2	22	52	A2	D	604.00	481.54	1.16	0.00	1.70	0.00	1.70	
2028	PAL2028-3	52	86	A3	D	694.51	521.14	1.11	0.00	1.46	0.00	1.46	
2029	PAL2029-1	0	18	Ap	E	392.35	320.18	1.28	0.00	1.64	0.00	1.64	
2029	PAL2029-2	18	48	A	E	705.76	553.33	1.33	0.00	0.93	0.00	0.93	
2029	PAL2029-3	48	87	Bg	E	1061.87	864.65	1.60	0.00	0.30	0.00	0.30	
2030	PAL2030-1	0	22	Ap	S	510.64	413.56	1.36	0.00	1.41	0.00	1.41	Ap horizon is lighter in color than the A horizon - clayey
2030	PAL2030-2	22	34	A	S	287.66	224.60	1.35	0.00	1.14	0.00	1.14	
2030	PAL2030-3	34	80	BA	S	1194.79	960.00	1.51	0.00	0.44	0.00	0.44	
2031	PAL2031-1	0	13	Ap	E	255.65	211.26	1.17	0.00	0.71	0.00	0.71	Concretions include iron

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2031	PAL2031-2	13	36	Bt	E	569.75	459.56	1.44	0.00	0.20	0.00	0.20	
2031	PAL2031-3	36	75	Btc	E	1036.15	829.86	1.54	0.00	0.08	0.00	0.08	
2032	PAL2032-1	0	19	Ap	E	464.59	384.58	1.46	0.00	0.65	0.00	0.65	
2032	PAL2032-2	19	69	Bt	E	1252.39	1012.97	1.46	0.00	0.15	0.00	0.15	
2033	PAL2033-1	0	25	Ap	D	517.22	405.98	1.17	0.00	2.04	0.00	2.04	
2033	PAL2033-2	25	48	A	D	477.00	367.99	1.15	0.00	0.95	0.00	0.95	
2033	PAL2033-3	48	80	BA	D	770.59	615.42	1.39	0.00	0.58	0.00	0.58	
2034	PAL2034-1	0	24	Ap	E	525.37	443.14	1.33	0.00	1.32	0.00	1.32	
2034	PAL2034-2	24	46	A	E	502.11	415.52	1.36	0.00	0.59	0.00	0.59	
2034	PAL2034-3	46	96	Bt	E	1194.68	984.60	1.42	0.00	0.22	0.00	0.22	
2035	PAL2035-1	0	36	A	D	854.18	713.01	1.43	0.00	1.21	0.00	1.21	Krotovinas
2035	PAL2035-2	36	56	B	D	461.69	386.12	1.39	0.00	0.28	0.00	0.28	
2035	PAL2035-3	56	92	2BA	D	909.82	751.35	1.51	0.00	0.21	0.00	0.21	
2036	PAL2036-1	0	23	Ap	S	448.63	380.39	1.19	0.00	1.85	0.00	1.85	Krotovinas
2036	PAL2036-2	23	40	BA	S	325.04	270.46	1.15	0.00	0.77	0.00	0.77	
2036	PAL2036-3	40	96	Bt	S	1204.04	995.85	1.28	0.00	0.38	0.00	0.38	
2037	PAL2037-1	0	19	Ap		400.81	324.52	1.23	0.00	1.90	0.00	1.90	
2037	PAL2037-2	19	69	A		1227.79	992.23	1.43	0.00	1.27	0.00	1.27	
2037	PAL2037-3	69	89	BA		527.96	427.36	1.54	0.00	0.58	0.00	0.58	
2038	PAL2038-1	0	14	Ap	D	315.70	255.43	1.32	0.00	1.77	0.00	1.77	
2038	PAL2038-2	14	67	A	D	1278.00	1030.64	1.40	0.00	1.26	0.00	1.26	
2038	PAL2038-3	67	91	B	D	614.69	491.52	1.48	0.00	0.57	0.00	0.57	
2039	PAL2039-1	0	19	Ap		402.00	341.17	1.30	0.00	2.22	0.00	2.22	
2039	PAL2039-2	19	48	A1		539.35	444.63	1.11	0.00	1.68	0.00	1.68	
2039	PAL2039-3	48	94	A2		885.12	722.51	1.13	0.00	1.09	0.00	1.09	
2040	PAL2040-1	0	35	A1	D	678.81	563.36	1.16	0.00	2.14	0.00	2.14	Weak Ap horizon
2040	PAL2040-2	35	74	A2	D	799.10	647.79	1.20	0.00	1.31	0.00	1.31	
2040	PAL2040-3	74	94	2A	D	397.22	328.53	1.19	0.00	1.33	0.00	1.33	
2041	PAL2041-1	0	18	Ap		342.58	287.81	1.15	0.00	2.08	0.00	2.08	
2041	PAL2041-2	18	43	AB		522.39	440.75	1.27	0.00	1.13	0.00	1.13	
2041	PAL2041-3	43	94	Bt		1185.67	1000.88	1.42	0.00	0.40	0.00	0.40	
2042	PAL2042-1	0	33	A		627.76	531.29	1.16	0.00	1.50	0.00	1.50	No distinct Ap horizon
2042	PAL2042-2	33	61	BA		598.49	506.77	1.31	0.00	0.63	0.00	0.63	
2042	PAL2042-3	61	96	Btc		843.94	717.10	1.48	0.00	0.29	0.00	0.29	
2043	PAL2043-1	0	31	Ap	E	699.21	572.54	1.33	0.00	0.88	0.00	0.88	Ap horizon is in BA material
2043	PAL2043-2	31	78	Bt1	E	1179.24	981.85	1.51	0.00	0.16	0.00	0.16	
2043	PAL2043-3	78	90	Bt2	E	328.00	276.01	1.66	0.00	0.10	0.00	0.10	Bt3 horizon appears to have increased organic matter (darker)
2044	PAL2044-1	0	51	A		1056.87	849.90	1.20	0.00	1.50	0.00	1.50	Btk effervesces
2044	PAL2044-2	51	77	AB		566.95	461.88	1.28	0.00	0.63	0.00	0.63	
2044	PAL2044-3	77	95	Btk		381.10	313.50	1.26	0.00	0.23	0.12	0.35	
2046	PAL2046-1	0	21	Ap		507.21	422.64	1.45	0.00	1.27	0.00	1.27	Clayey
2046	PAL2046-2	21	38	A		412.59	341.77	1.45	0.00	0.78	0.00	0.78	
2046	PAL2046-3	38	98	Bt		1533.34	1280.88	1.54	0.00	0.37	0.00	0.37	
2047	PAL2047-1	0	16	A	E	362.34	306.56	1.38	0.00	1.49	0.00	1.49	No photo - krotovinas
2047	PAL2047-2	16	47	BA	E	685.26	582.18	1.36	0.00	0.71	0.00	0.71	
2047	PAL2047-3	47	96	B	E	1038.82	867.63	1.28	0.00	0.32	0.00	0.32	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2048	PAL2048-1	0	21	Ap	D	437.15	349.87	1.20	0.00	2.34	0.00	2.34	
2048	PAL2048-2	21	68	A	D	904.41	723.43	1.11	0.00	1.75	0.00	1.75	
2048	PAL2048-3	68	95	AB	D	546.73	437.12	1.17	0.00	1.02	0.00	1.02	
2049	PAL2049-1	0	32	A	D	605.09	493.33	1.11	0.00	2.49	0.00	2.49	No visible Ap horizon. Core is full of krotovinas.
2049	PAL2049-2	32	63	AB	D	574.32	474.42	1.10	0.00	1.23	0.00	1.23	
2049	PAL2049-3	63	90	Bt	D	534.83	449.52	1.20	0.00	0.55	0.00	0.55	
2050	PAL2050-1	0	42	A	D	839.25	681.64	1.17	0.00	2.00	0.00	2.00	No visible Ap horizon
2050	PAL2050-2	42	61	AB	D	391.80	329.47	1.25	0.00	0.76	0.00	0.76	
2050	PAL2050-3	61	94	B	D	752.25	629.99	1.38	0.00	0.34	0.00	0.34	
2051	PAL2051-1	0	40	A	S	812.46	655.17	1.18	0.00	1.52	0.00	1.52	
2051	PAL2051-2	40	70	BA	S	650.52	538.61	1.30	0.00	0.61	0.00	0.61	
2051	PAL2051-3	70	99	2Btk	S	623.83	489.75	1.14	30.03	0.52	3.59	4.11	Effervesces
2052	PAL2052-1	0	29	A		489.21	412.34	1.03	0.00	1.46	0.00	1.46	
2052	PAL2052-2	29	47	BA		374.83	323.91	1.30	0.00	0.66	0.00	0.66	
2053	PAL2053-1	0	23	Ap	D	491.79	389.22	1.22	0.00	1.57	0.00	1.57	Clayey
2053	PAL2053-2	23	66	A1	D	898.62	675.58	1.13	0.00	1.49	0.00	1.49	
2053	PAL2053-3	66	93	A2	D	597.55	403.15	1.08	0.00	1.82	0.00	1.82	
2054	PAL2054-1	0	52	Bt	E	966.17	876.80	1.22	0.00	0.62	0.00	0.62	
2054	PAL2054-2	52	63	2A	E	211.25	184.37	1.21	0.00	0.51	0.30	0.81	
2054	PAL2054-3	63	99	2Btk	E	784.21	653.50	1.31	0.00	0.13	2.25	2.38	
2055	PAL2055-1	0	31	A		683.03	546.67	1.27	0.00	1.55	0.00	1.55	Ap is very indistinct
2055	PAL2055-2	31	57	AB		570.41	460.34	1.28	0.00	0.61	0.00	0.61	
2055	PAL2055-3	57	96	Bt		955.21	771.79	1.43	0.00	0.20	0.00	0.20	
2056	PAL2056-1	0	18	Ap		325.91	275.21	1.10	0.00	2.09	0.00	2.09	Hillslope 0-18 cm (Ap). Krotovina 65-97 cm
2056	PAL2056-2	18	47	A		549.39	455.41	1.13	0.00	1.30	0.00	1.30	
2056	PAL2056-3	47	97	Bt1		1106.08	921.30	1.33	0.00	0.43	0.00	0.43	
2057	PAL2057-1	0	32	A		611.84	528.30	1.19	0.00	1.07	0.00	1.07	2Btk effervesces
2057	PAL2057-2	32	48	BA		331.71	289.54	1.31	0.00	0.41	0.00	0.41	
2057	PAL2057-3	48	95	Bt		980.22	841.74	1.29	0.00	0.22	0.10	0.32	
2058	PAL2058-1	0	31	A		560.57	485.74	1.13	0.00	1.15	0.00	1.15	
2058	PAL2058-2	31	51	BA		457.00	400.02	1.44	0.00	0.51	0.00	0.51	
2058	PAL2058-3	51	97	Bt		966.52	844.65	1.33	0.00	0.33	0.00	0.33	
2059	PAL2059-1	0	20	Ap	E	358.05	329.20	1.19	0.45	0.38	1.00	1.38	Appears to be ash layer on surface
2060	PAL2060-1	0	13	Ap		220.10	205.35	1.14	0.00	1.42	0.45	1.87	
2060	PAL2060-2	13	25	Bk		232.18	210.91	1.27	0.00	0.70	1.43	2.13	
2061	PAL2061-1	0	25	A		478.11	411.92	1.19	0.00	1.07	0.00	1.07	Color changes from 2B2 7.5YR 4/4 to 10YR 5/8
2061	PAL2061-2	25	66	BA		831.14	723.13	1.27	0.00	0.45	0.00	0.45	
2061	PAL2061-3	66	85	B1		418.56	364.96	1.39	0.00	0.30	0.05	0.35	
2061	PAL2061-4	85	97	B2		231.15	180.75	1.09	0.00	0.43	4.65	5.08	
2062	PAL2062-1	0	21	Ap	E	374.67	336.32	1.16	0.00	0.68	0.00	0.68	
2062	PAL2062-2	21	47	BA	E	508.74	455.54	1.26	0.00	0.44	0.00	0.44	
2062	PAL2062-3	47	95	Bt	E	997.99	894.82	1.35	0.00	0.31	0.00	0.31	
2063	PAL2063-1	0	33	A		586.69	519.07	1.14	0.00	0.66	0.00	0.66	No distinct Ap horizon
2063	PAL2063-2	33	58	BA		471.86	424.75	1.23	0.00	0.44	0.00	0.44	
2063	PAL2063-3	58	96	Bt		741.64	672.03	1.28	0.00	0.36	0.00	0.36	
2064	PAL2064-1	0	27	Ap	E	501.00	444.84	1.19	0.00	0.69	0.00	0.69	
2064	PAL2064-2	27	60	Bt1	E	653.95	588.46	1.29	0.00	0.41	0.00	0.41	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2064	PAL2064-3	60	93	Bt2	E	666.30	601.29	1.32	0.00	0.31	0.00	0.31	
2065	PAL2065-1	0	18	Ap		307.45	273.99	1.10	0.00	0.92	0.00	0.92	Eroded, then a deposit of B over what looks like an eroded A
2065	PAL2065-2	18	46	A1		549.38	488.79	1.26	0.00	0.60	0.00	0.60	
2065	PAL2065-3	46	97	Bt		981.73	877.60	1.24	0.00	0.42	0.00	0.42	
2066	PAL2066-1	0	17	Ap		333.20	297.27	1.26	0.00	0.74	0.00	0.74	Eroded
2066	PAL2066-2	17	52	Bt1		669.60	600.75	1.24	0.00	0.44	0.00	0.44	
2066	PAL2066-3	52	93	Btk		808.94	730.07	1.29	0.00	0.39	0.00	0.39	
2067	PAL2067-1	0	26	Ap	E	492.77	445.85	1.24	0.00	0.72	0.00	0.72	Ap horizon appears to be hillslope sediment
2067	PAL2067-2	26	49	2A	E	434.64	393.23	1.23	0.00	0.55	0.00	0.55	Enrichment 26-38 cm
2067	PAL2067-3	49	93	2B	E	878.02	799.34	1.31	0.00	0.37	0.00	0.37	
2068	PAL2068-1	0	18	Ap		342.50	310.76	1.25	0.00	0.69	0.00	0.69	Eroded
2068	PAL2068-2	18	50	BA		570.11	514.07	1.16	0.00	0.58	0.00	0.58	
2068	PAL2068-3	50	95	Bt		886.76	802.56	1.29	0.00	0.35	0.00	0.35	
2069	PAL2069-1	0	33	Ap	E	479.72	434.26	0.95	0.00	0.73	0.00	0.73	Ap horizon in old B material
2069	PAL2069-2	33	63	Bt1	E	683.57	618.07	1.49	0.00	0.48	0.00	0.48	
2069	PAL2069-3	63	95	Bt2	E	674.60	608.28	1.37	0.00	0.36	0.56	0.92	
2070	PAL2070-1	0	34	BAk		564.13	504.53	1.07	0.00	0.69	0.40	1.09	Severely eroded. All but upper 11 cm effervesces. Visible powdered calcium carbonate from 28 cm to bottom of core.
2070	PAL2070-2	34	78	Bk		839.32	745.88	1.22	0.00	0.47	0.89	1.36	
2070	PAL2070-3	78	98	2Bk		395.08	352.95	1.27	0.00	0.24	2.96	3.20	
2071	PAL2071-1	0	19	Ap	E	279.09	254.11	0.97	0.00	0.55	0.00	0.55	Ap horizon in old B material
2071	PAL2071-2	19	42	BA	E	547.07	490.69	1.54	0.00	0.44	0.04	0.48	
2071	PAL2071-3	42	97	Btk	E	970.87	862.96	1.13	0.27	0.28	0.66	0.94	Effervesces
2072	PAL2072-1	0	16	Ap		234.45	207.69	0.94	0.00	0.97	0.00	0.97	Ap Hillslope sediment
2072	PAL2072-2	16	61	BA		877.93	779.70	1.25	0.00	0.45	0.00	0.45	
2072	PAL2072-3	61	92	3C		621.70	564.96	1.32	0.00	0.38	0.00	0.38	64-92 cm varved - Platey on surface - Eroded
2073	PAL2073-1	0	18	Ap		334.43	299.18	1.20	0.00	0.75	0.00	0.75	Severely eroded - Ap horizon is in old Bt
2073	PAL2073-2	18	59	Bt1		686.98	613.13	1.08	0.00	0.39	0.00	0.39	
2073	PAL2073-3	59	93	Bt2		676.44	603.95	1.28	0.00	0.33	0.00	0.33	
2074	PAL2074-1	0	21	B1	E	352.90	323.96	1.11	0.00	0.62	0.00	0.62	
2074	PAL2074-2	21	70	B2	E	894.92	811.35	1.20	0.00	0.48	0.00	0.48	
2074	PAL2074-3	70	98	Btc	E	594.25	539.68	1.39	0.00	0.28	0.43	0.71	
2075	PAL2075-1	0	17	Ap		286.58	252.74	1.07	0.00	1.00	0.00	1.00	
2075	PAL2075-2	17	35	A		353.93	313.54	1.26	0.00	0.61	0.00	0.61	
2075	PAL2075-3	35	61	BA		508.21	450.01	1.25	0.00	0.48	0.00	0.48	
2075	PAL2075-4	61	96	Bt		726.18	642.51	1.33	0.00	0.36	0.00	0.36	
2077	PAL2077-1	0	19	Ap		317.71	285.26	1.08	0.00	0.72	0.00	0.72	Eroded
2077	PAL2077-2	19	56	BA		715.11	639.87	1.25	0.00	0.50	0.00	0.50	
2077	PAL2077-3	56	99	Bt		835.88	749.49	1.26	0.00	0.34	0.27	0.61	
2078	PAL2078-1	0	17	Ap		280.84	257.35	1.09	0.00	0.81	0.00	0.81	Eroded - Ap is hillslope sediments
2078	PAL2078-2	17	58	BA		782.60	703.12	1.24	0.00	0.49	0.00	0.49	
2078	PAL2078-3	58	97	Bt		785.17	706.48	1.31	0.00	0.36	0.00	0.36	
2079	PAL2079-1	0	45	A		823.06	728.71	1.17	0.00	0.68	0.00	0.68	Hillslope sediment 0-3 cm
2079	PAL2079-1	0	26	A		457.59	420.24	1.17	0.00	0.71	0.00	0.71	Eroded - hillslope sediment on surface 26 cm
2079	PAL2079-2	45	67	Bt1		383.98	343.52	1.13	0.00	0.46	0.00	0.46	
2079	PAL2079-2	26	61	2BA		653.53	588.06	1.21	0.00	0.46	0.00	0.46	
2079	PAL2079-3	67	97	Bt2		582.37	525.61	1.26	0.00	0.39	0.00	0.39	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2079	PAL2079-3	61	96	2Bt		690.28	624.51	1.29	0.00	0.34	0.00	0.34	
2080	PAL2080-1	0	36	Ap	D	660.01	582.42	1.17	0.00	0.63	0.00	0.63	
2080	PAL2080-2	36	73	BA	D	719.63	638.99	1.25	0.00	0.45	0.00	0.45	
2080	PAL2080-3	73	94	Btk	D	420.55	363.88	1.25	0.00	0.24	0.90	1.14	Moderate effervescence
2081	PAL2081-1	0	17	Ap		302.46	269.64	1.14	0.00	0.95	0.00	0.95	No A horizon - Severely eroded
2081	PAL2081-2	17	55	BA		745.50	661.55	1.26	0.00	0.48	0.00	0.48	
2081	PAL2081-3	55	96	Bt		832.08	747.26	1.32	0.00	0.33	0.00	0.33	
2082	PAL2082-1	0	24	Ap	E	492.01	426.67	1.28	0.00	0.56	0.00	0.56	Weak A horizon
2082	PAL2082-2	24	46	BA	E	463.21	406.54	1.33	0.00	0.20	0.00	0.20	
2082	PAL2082-3	46	94	Btk	E	1008.99	881.64	1.33	0.37	0.08	0.52	0.60	Effervesces
2083	PAL2083-1	0	19	Ap	S	374.29	325.19	1.24	0.00	0.71	0.00	0.71	
2083	PAL2083-2	19	52	BA	S	650.92	570.94	1.25	0.33	0.24	0.02	0.26	
2083	PAL2083-3	52	87	Btk	S	694.36	605.68	1.24	2.27	0.10	0.95	1.05	
2084	PAL2084-1	0	21	Ap		379.76	338.56	1.16	0.00	0.61	0.00	0.61	Severely eroded, no A, very silty - OM stains on Bt ped faces. Coarse, weak SBK.
2084	PAL2084-2	21	47	Bt1		500.07	450.37	1.25	0.00	0.32	0.00	0.32	
2084	PAL2084-3	47	96	Bt2		928.83	840.71	1.24	0.00	0.23	0.06	0.29	
2085	PAL2085-1	0	21	Ap	E	329.41	291.25	1.00	0.00	0.73	0.00	0.73	No A horizon
2085	PAL2085-2	21	65	Bt1	E	763.52	675.08	1.11	0.00	0.44	0.00	0.44	
2085	PAL2085-3	65	97	Bt2	E	670.99	606.41	1.37	0.00	0.32	0.00	0.32	
2086	PAL2086-1	0	33	A1		387.17	327.86	0.72	0.00	1.46	0.00	1.46	Ap horizon is very indistinct
2086	PAL2086-2	33	48	A2		403.24	333.01	1.60	0.00	1.30	0.00	1.30	
2086	PAL2086-3	48	96	B		748.11	627.56	0.94	0.00	0.88	0.00	0.88	
2087	PAL2087-1	0	17	Ap		310.44	264.26	1.12	0.00	1.14	0.00	1.14	Eroded A horizon in previous Bt - Btk effervesces
2087	PAL2087-2	17	44	BA		492.92	426.98	1.14	0.00	0.56	0.00	0.56	
2087	PAL2087-3	44	96	Bt		1064.23	926.98	1.29	0.00	0.28	0.00	0.28	
2088	PAL2088-1	0	25	Ap	E	514.16	448.11	1.29	0.00	1.00	0.00	1.00	No picture - effervesces
2088	PAL2088-2	25	49	Btk	E	512.77	412.16	1.24	0.00	0.22	1.77	1.99	
2089	PAL2089-1	0	9	Ap	E	150.38	127.98	1.03	0.00	1.65	0.00	1.65	
2089	PAL2089-2	9	46	BA	E	736.72	641.28	1.25	0.00	0.53	0.00	0.53	
2089	PAL2089-3	46	92	Bt	E	895.54	781.22	1.23	0.00	0.24	0.00	0.24	
2090	PAL2090-1	0	32	A	D	706.60	596.70	1.35	0.00	1.12	0.00	1.12	
2090	PAL2090-2	32	70	BA	D	771.33	662.17	1.26	0.00	0.40	0.00	0.40	
2090	PAL2090-3	70	91	B	D	449.95	384.97	1.32	0.00	0.24	0.10	0.34	Effervesces at base
2091	PAL2091-1	0	16	Ap	S	353.11	300.96	1.36	0.00	1.20	0.00	1.20	
2091	PAL2091-2	16	43	A	S	512.13	437.90	1.17	0.00	1.02	0.00	1.02	
2091	PAL2091-3	43	92	Bt	S	964.79	843.66	1.24	0.00	0.33	0.03	0.36	Effervesces
2092	PAL2092-1	0	33	A	S	573.94	479.88	1.05	0.00	1.08	0.00	1.08	
2092	PAL2092-2	33	58	AB	S	492.74	418.77	1.21	0.00	0.58	0.00	0.58	
2092	PAL2092-3	58	96	Bt	S	780.31	691.01	1.31	0.09	0.23	0.00	0.23	
2093	PAL2093-1	0	41	A		741.67	619.62	1.09	0.00	1.10	0.00	1.10	
2093	PAL2093-2	41	67	AB		492.44	421.91	1.17	1.02	0.51	0.00	0.51	
2093	PAL2093-3	67	96	Btk		591.41	530.37	1.32	0.36	0.21	0.17	0.38	
2094	PAL2094-1	0	41	A		797.85	683.64	1.20	0.00	0.81	0.00	0.81	Hillslope sediment on surface. A horizon is an old B horizon.
2094	PAL2094-2	41	74	Bt		708.36	613.69	1.34	0.00	0.25	0.00	0.25	
2094	PAL2094-3	74	96	2A		407.83	350.52	1.15	0.00	0.51	0.00	0.51	
2095	PAL2095-1	0	31	BA		635.16	542.14	1.26	0.00	0.78	0.00	0.78	Eroded profile - Ap and BA same color

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2095	PAL2095-2	31	63	Bt1		657.79	563.37	1.27	0.00	0.42	0.00	0.42	
2095	PAL2095-3	63	95	Bt2		708.72	603.57	1.36	0.00	0.39	0.00	0.39	
2096	PAL2096-1	0	32	Ap	D	561.97	486.41	1.10	0.00	1.16	0.00	1.16	
2096	PAL2096-2	32	68	BA	D	673.03	587.20	1.18	0.00	0.55	0.00	0.55	
2096	PAL2096-3	68	95	Bt	D	511.05	441.38	1.18	0.00	0.45	0.16	0.61	
2097	PAL2097-1	0	22	Ap	E	397.94	343.00	1.13	0.00	1.26			
2097	PAL2097-2	22	48	BA	E	475.03	414.35	1.15	0.00	0.65			
2097	PAL2097-3	48	93	Btk	E	854.81	734.21	1.18	0.00	0.42		0.57	
2098	PAL2098-1	0	15	Bk1	E	315.62	275.48	1.32	1.19	0.86	0.35	1.21	Effervesces - no A horizon
2098	PAL2098-2	15	47	Btk1	E	692.14	584.80	1.32	0.00	0.37	0.91	1.28	
2098	PAL2098-3	47	63	Btk2	E	313.34	266.09	1.15	11.01	0.17	2.47	2.64	
2099	PAL2099-1	0	20	Ap		339.31	285.44	1.03	0.00	1.23	0.00	1.23	Noticeable plow pan with weak E above it
2099	PAL2099-2	20	67	A		943.36	793.20	1.22	0.00	0.73	0.00	0.73	
2099	PAL2099-3	67	97	Bt		577.72	522.70	1.26	0.00	0.27	0.00	0.27	Siltans on Bt clay films
2100	PAL2100-1	0	33	A		584.85	506.15	1.11	0.00	0.84	0.00	0.84	No obvious Ap
2100	PAL2100-2	33	64	Bt1		619.16	538.10	1.25	0.00	0.34	0.00	0.34	
2100	PAL2100-3	64	98	Bt2		649.73	555.11	1.18	0.00	0.35	0.00	0.35	
2101	PAL2101-1	0	39	A		655.96	563.69	1.04	0.00	0.83	0.00	0.83	Eroded - indistinct Ap horizon
2101	PAL2101-2	39	65	Bt1		498.71	433.47	1.20	0.00	0.32	0.00	0.32	
2101	PAL2101-3	65	98	Bt2		649.17	554.75	1.21	0.00	0.29	0.00	0.29	Lower Bt (Bt2) darker than upper (Bt1)
2102	PAL2102-1	0	23	Ap	S	454.09	383.77	1.20	0.00	1.09	0.00	1.09	Effervesces
2102	PAL2102-2	23	56	A	S	599.43	480.80	1.05	0.00	0.99	0.00	0.99	
2102	PAL2102-3	56	94	AB	S	919.18	787.26	1.50	0.00	0.37	0.00	0.37	
2103	PAL2103-1	0	21	Ap	D	438.65	366.01	1.26	0.00	1.14	0.00	1.14	Effervesces
2103	PAL2103-2	21	50	A	D	532.11	426.00	1.06	0.00	1.17	0.00	1.17	
2103	PAL2103-3	50	95	BA	D	998.56	846.10	1.36	0.00	0.36	0.00	0.36	
2104	PAL2104-1	0	38	A		731.70	603.44	1.15	0.00	0.98	0.00	0.98	Eroded A horizon is in old AB horizon. Paleo A horizon at 67 cm?
2104	PAL2104-2	38	57	AB		381.11	319.87	1.22	0.00	0.44	0.00	0.44	
2104	PAL2104-3	57	93	Bt		760.95	638.09	1.28	0.00	0.28	0.00	0.28	
2105	PAL2105-1	0	27	Ap	D	527.83	438.42	1.17	0.00	1.25			
2105	PAL2105-2	27	62	AB	D	729.14	608.58	1.26	0.00	0.58			
2105	PAL2105-3	62	93	Bt	D	721.68	641.30	1.49	0.00	0.24			
2106	PAL2106-1	0	22	Ap	S	398.89	334.24	1.10	0.00	1.42	0.00	1.42	
2106	PAL2106-2	22	47	A	S	451.20	371.35	1.07	0.00	1.42	0.00	1.42	
2106	PAL2106-3	47	97	BA	S	953.16	810.91	1.17	0.00	0.56	0.00	0.56	
2107	PAL2107-1	0	29	Ap	D	508.91	426.38	1.06	0.00	1.45	0.00	1.45	Ap horizon has enrichment layer at 24-29 cm
2107	PAL2107-2	29	64	BA	D	575.89	478.64	0.99	0.00	1.10	0.00	1.10	
2107	PAL2107-3	64	98	2AB	D	676.42	574.62	1.22	0.00	0.52	0.00	0.52	Buried A horizon
2108	PAL2108-1	0	17	Ap		314.87	268.82	1.14	0.00	1.17	0.19	1.36	Eroded
2108	PAL2108-2	17	55	A		750.89	636.57	1.21	0.00	0.86	0.00	0.86	
2108	PAL2108-3	55	99	Bt		850.45	714.59	1.17	0.89	0.61	0.11	0.72	
2109	PAL2109-1	0	24	Apk	D	454.47	388.10	1.17	0.00	1.20	0.19	1.39	Whole profile effervesces
2109	PAL2109-2	24	62	A1k	D	693.98	591.05	1.12	0.00	0.83	0.07	0.90	
2109	PAL2109-3	62	99	A2k	D	709.99	598.46	1.17	0.00	0.63	0.12	0.75	Darkest A horizon at base of core
2110	PAL2110-1	0	36	A	S	663.11	547.56	1.10	0.00	1.50	0.00	1.50	No visible Ap horizon
2110	PAL2110-2	36	55	AB	S	322.12	269.56	1.02	0.00	0.78	0.00	0.78	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2110	PAL2110-3	55	98	Btc	S	914.87	805.59	1.35	0.00	0.34	0.00	0.34	
2111	PAL2111-1	0	46	AB	E	888.45	758.92	1.19	0.00	0.95			No distinct Ap horizon
2111	PAL2111-2	46	78	BA	E	633.39	545.93	1.23	0.03	0.41			
2111	PAL2111-3	78	95	Bt	E	327.45	279.64	1.19	0.00	0.29		0.87	
2112	PAL2112-1	0	25	Ap	E	492.41	424.27	1.22	0.45	0.96			
2112	PAL2112-2	25	59	BA	E	666.97	580.12	1.23	0.33	0.40			
2112	PAL2112-3	59	96	Bt	E	775.84	675.53	1.32	0.00	0.25			
2113	PAL2113-1	0	24	Ap	D	473.74	413.98	1.24	0.59	0.61	0.51	1.12	Hillslope sediment from Bt over A horizon
2113	PAL2113-2	24	64	A1	D	751.02	650.39	1.17	0.00	0.84	0.00	0.84	
2113	PAL2113-3	64	98	AB	D	707.78	606.35	1.29	0.00	0.49	0.00	0.49	
2114	PAL2114-1	0	26	Ap	E	443.76	379.47	1.05	0.00	1.25	0.00	1.25	
2114	PAL2114-2	26	61	AB	E	659.40	564.81	1.16	0.00	0.62	0.00	0.62	
2114	PAL2114-3	61	95	B	E	684.63	588.53	1.25	0.00	0.41	0.00	0.41	
2115	PAL2115-1	0	41	A	S	830.82	687.28	1.21	1.00	0.88	0.00	0.88	Ap horizon not distinct
2115	PAL2115-2	41	58	BA	S	361.81	297.31	1.26	0.00	0.44	0.00	0.44	
2115	PAL2115-3	58	96	Bt	S	940.92	779.78	1.48	0.00	0.21	0.00	0.21	
2116	PAL2116-1	0	19	Ap		338.99	288.75	1.10	0.00	1.07	0.00	1.07	Eroded
2116	PAL2116-2	19	53	BA		674.03	570.43	1.21	0.07	0.50	0.00	0.50	
2116	PAL2116-3	53	96	Bt		920.42	785.91	1.32	0.00	0.31	0.00	0.31	
2117	PAL2117-1	0	32	A	D	558.36	478.21	1.08	0.34	0.84	0.00	0.84	Alternating A and B horizons
2117	PAL2117-2	32	52	BA	D	386.22	330.33	1.19	0.00	0.48	0.00	0.48	
2117	PAL2117-3	52	97	2BAk	D	884.34	724.71	1.16	0.00	0.47	1.04	1.51	
2118	PAL2118-1	0	27	A	S	484.49	416.10	1.11	0.76	1.38	0.00	1.38	Ap horizon is not distinct
2118	PAL2118-2	27	64	BA	S	684.78	586.66	1.14	0.24	0.71	0.00	0.71	
2118	PAL2118-3	64	96	Bt	S	706.26	612.76	1.38	0.07	0.22	0.00	0.22	
2119	PAL2119-1	0	25	Ap		519.07	407.06	1.17	0.37	1.90	0.00	1.90	
2119	PAL2119-2	25	60	A1		650.61	435.05	0.90	0.00	2.63	0.00	2.63	
2119	PAL2119-3	60	94	A2		704.34	431.09	0.92	0.00	1.80	0.00	1.80	
2120	PAL2120-1	0	34	AB	E	757.52	615.16	1.31	0.00	0.79	0.34	1.13	Effervesces into AB horizon
2120	PAL2120-2	34	72	Bt	E	859.50	681.90	1.30	0.00	0.30	0.98	1.28	Abundant, soft calcium carbonate masses
2120	PAL2120-3	72	99	Bt2	E	641.65	536.81	1.43	1.38	0.10	0.15	0.25	Btk3 horizon is darker than overlying Btk1 and Btk2 horizons
2121	PAL2121-1	0	18	Ap		368.28	313.35	1.26	0.00	0.81	0.29	1.10	Red, eroded - powdery carbonate concentrations at structural discontinuities
2121	PAL2121-2	18	57	BAk		1007.08	836.05	1.54	5.86	0.33	0.21	0.54	
2121	PAL2121-3	57	97	Btck		929.93	775.48	1.40	0.00	0.09	0.47	0.56	
2122	PAL2122-1	0	26	BA	E	618.40	513.04	1.42	0.00	0.43	0.00	0.43	
2122	PAL2122-2	26	54	Bt	E	646.41	539.67	1.39	0.00	0.19	0.15	0.34	
2122	PAL2122-3	54	90	Btk	E	842.93	689.12	1.38	0.00	0.06	0.15	0.21	Effervesces - free carbonates on ped faces
2123	PAL2123-1	0	40	A1	D	836.67	686.59	1.24	0.00	1.66	0.00	1.66	
2123	PAL2123-2	40	71	A2	D	579.03	419.46	0.98	0.00	2.60	0.00	2.60	
2123	PAL2123-3	71	96	AB	D	489.31	355.00	1.02	0.00	1.18	0.00	1.18	
2124	PAL2124-1	0	37	A1		774.43	622.33	1.21	0.00	1.68	0.00	1.68	A horizon with fresh A overburden. Heavier and slightly sticky.
2124	PAL2124-2	37	68	A2		631.51	444.40	1.03	0.00	2.64	0.00	2.64	
2124	PAL2124-3	68	95	A3		610.12	435.73	1.16	0.00	1.04	0.00	1.04	
2125	PAL2125-1	0	36	A1	D	749.11	595.00	1.19	0.00	1.76	0.00	1.76	
2125	PAL2125-2	36	64	A2	D	572.41	426.47	1.10	0.21	1.55	0.00	1.55	
2125	PAL2125-3	64	93	BA	D	707.84	582.81	1.45	0.00	0.41	0.00	0.41	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2126	PAL2126-1	0	24	Ap	D	471.13	372.89	1.12	0.00	1.89	0.00	1.89	
2126	PAL2126-2	24	67	A	D	893.74	666.83	1.12	0.00	1.71	0.00	1.71	
2126	PAL2126-3	67	96	BA	D	668.21	541.40	1.35	0.89	0.42	0.00	0.42	
2127	PAL2127-1	0	24	Ap	D	551.30	437.53	1.32	0.00	1.57	0.00	1.57	
2127	PAL2127-2	24	59	A	D	697.52	477.84	0.99	0.04	1.79	0.00	1.79	
2127	PAL2127-3	59	94	Bt	D	845.85	644.61	1.30	13.66	0.56	0.00	0.56	
2128	PAL2128-1	0	28	BA	E	522.92	473.94	1.22	0.00	0.59	0.19	0.78	Ap horizon is in old B horizon
2128	PAL2128-2	28	61	B1	E	623.36	565.74	1.24	0.00	0.44	0.60	1.04	Effervescent in every part of profile except Ap horizon
2128	PAL2128-3	61	93	B2	E	611.76	559.31	1.26	0.00	0.23	1.55	1.78	
2129	PAL2129-1	0	19	Ap		347.21	311.73	1.18	0.00	0.69	0.00	0.69	Eroded - Ap horizon is in old Bt
2129	PAL2129-2	19	39	Bt		363.50	327.64	1.18	0.06	0.63	0.09	0.72	
2129	PAL2129-3	39	92	Btk		998.50	905.31	1.22	11.18	0.33	1.24	1.57	Btk effervesces
2130	PAL2130-1	0	17	Ap		291.90	255.97	1.09	0.00	1.00	0.00	1.00	
2130	PAL2130-2	17	44	AB		525.43	458.90	1.23	0.00	0.58	0.00	0.58	
2130	PAL2130-3	44	74	BA		532.45	467.67	1.13	0.00	0.61	0.00	0.61	
2130	PAL2130-4	74	95	B		373.52	330.07	1.13	0.00	0.44	0.14	0.58	
2131	PAL2131-1	0	28	Ap	E	476.14	418.11	1.08	0.00	0.67	0.00	0.67	
2131	PAL2131-2	28	77	Bt1	E	892.85	795.08	1.17	0.00	0.43	0.00	0.43	
2131	PAL2131-3	77	96	Bt2	E	393.82	357.09	1.36	0.00	0.34	0.00	0.34	
2132	PAL2132-1	0	25	Ap	E	451.97	395.27	1.14	0.00	0.64	0.00	0.64	Ap horizon is original BA material
2132	PAL2132-2	25	49	BA	E	416.90	370.15	1.11	0.00	0.53	0.00	0.53	
2132	PAL2132-3	49	93	Bt	E	847.29	764.16	1.25	0.00	0.40	0.00	0.40	
2133	PAL2133-1	0	40	AB	E	676.14	594.20	1.07	0.00	0.58	0.00	0.58	
2133	PAL2133-2	40	77	BA	E	687.44	615.19	1.20	0.00	0.38	0.00	0.38	
2133	PAL2133-3	77	95	Bt	E	356.24	324.19	1.30	0.00	0.26	0.00	0.26	
2134	PAL2134-1	0	17	Ap	E	301.39	266.68	1.13	0.00	0.81	0.00	0.81	
2134	PAL2134-2	17	68	BA	E	912.06	820.82	1.16	0.00	0.42	0.00	0.42	
2134	PAL2134-3	68	95	Bt	E	537.56	487.55	1.30	0.00	0.33	0.00	0.33	
2135	PAL2135-1	0	19	Ap	E	316.56	277.00	1.05	0.00	0.83	0.00	0.83	
2135	PAL2135-2	19	62	Bt1	E	818.34	729.41	1.22	0.00	0.42	0.00	0.42	
2135	PAL2135-3	62	95	Bt2	E	583.54	525.60	1.15	0.00	0.26	0.00	0.26	
2136	PAL2136-1	0	19	Ap		318.64	276.28	1.05	0.00	0.84	0.00	0.84	Eroded
2136	PAL2136-2	19	45	BA		416.21	369.94	1.03	0.00	0.61	0.00	0.61	
2136	PAL2136-3	45	95	Bt		924.68	828.67	1.20	0.00	0.34	0.00	0.34	
2137	PAL2137-1	0	26	A		570.22	487.51	1.35	0.12	1.19	0.00	1.19	
2137	PAL2137-2	26	59	Bt1		747.83	651.68	1.43	0.00	0.51	0.00	0.51	
2137	PAL2137-3	59	91	Bt2		713.46	630.93	1.42	0.00	0.33	0.00	0.33	
2138	PAL2138-1	0	30	Ap		631.35	528.85	1.27	0.03	1.12	0.00	1.12	No picture taken
2138	PAL2138-2	30	50	A		362.79	288.42	1.04	0.00	1.71	0.00	1.71	
2138	PAL2138-3	50	94	BA		786.80	639.84	1.05	0.00	1.04	0.00	1.04	
2139	PAL2139-1	0	31	A	E	597.78	501.15	1.17	0.00	0.91	0.00	0.91	
2139	PAL2139-2	31	48	AB	E	391.22	330.08	1.40	0.00	0.53	0.00	0.53	
2139	PAL2139-3	48	94	Bt	E	1076.65	909.73	1.43	0.00	0.28	0.00	0.28	
2140	PAL2140-1	0	44	A		957.50	754.84	1.21	15.77	1.24	0.00	1.24	Looks to be floodplain
2140	PAL2140-2	44	61	2A		533.94	403.08	1.71	0.94	1.30	0.00	1.30	
2140	PAL2140-3	61	78	3A		318.41	247.96	0.93	29.11	0.78	0.00	0.78	
2141	PAL2141-1	0	20	Ap		389.56	333.25	1.18	5.71	0.93	0.25	1.18	Hillslope sediments on surface

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2141	PAL2141-2	20	61	A		729.05	584.67	1.03	0.00	1.01	0.00	1.01	
2141	PAL2141-3	61	96	Bt		684.01	565.42	1.17	0.00	0.50	0.00	0.50	
2142	PAL2142-1	0	34	A1		851.58	710.64	1.50	4.44	0.88	0.00	0.88	Hillslope sediment 0-34 cm. BAg perched water table over 2A
2142	PAL2142-2	34	68	A2		845.08	694.29	1.46	6.40	0.82	0.00	0.82	
2142	PAL2142-3	68	76	Bg		220.09	179.25	1.60	1.46	0.77	0.00	0.77	
2142	PAL2142-4	76	99	2A		583.86	467.40	1.45	5.04	0.95	0.00	0.95	
2143	PAL2143-1	0	28	A	S	623.00	513.20	1.32	0.66	1.22	0.00	1.22	Mica throughout
2143	PAL2143-2	28	51	BA	S	589.34	502.43	1.57	0.92	0.33	0.00	0.33	
2143	PAL2143-3	51	88	Bt	S	1056.37	897.55	1.74	4.91	0.10	0.00	0.10	Fine silt texture in B horizon
2144	PAL2144-1	0	32	A		686.24	548.20	1.24	0.00	1.23	0.00	1.23	
2144	PAL2144-2	32	64	B1		741.61	621.78	1.40	0.00	0.34	0.07	0.41	
2144	PAL2144-3	64	98	Bk		781.26	640.41	1.36	0.00	0.10	0.21	0.31	
2145	PAL2145-1	0	15	Ap	E	341.13	284.51	1.28	18.36	1.26	0.00	1.26	
2145	PAL2145-2	15	34	Bt	E	437.75	383.24	0.93	138.63	0.34	0.00	0.34	2Bt horizon is clay and coarse quartz crystals
2146	PAL2146-1	0	15	Ap	E	355.63	305.25	1.24	46.77	1.54	0.00	1.54	
2146	PAL2146-2	15	23	Btx	E	159.20	150.02	0.57	87.37	0.35	0.00	0.35	Btx horizon coarse (sandy) - strongly cemented aggregates with bright red clay paleosol.
2147	PAL2147-1	0	11	A		278.41	230.44	1.50	2.32	1.05	0.00	1.05	No picture. BA has high clay Erosional surface. Loose gravel/sand at base. Sand carbonate free. Sand not sampled.
2147	PAL2147-2	11	42	BA		728.41	601.23	1.31	38.10	0.49	0.00	0.49	
2148	PAL2148-1	0	16	A	D	337.24	279.22	1.26	0.00	1.29	0.00	1.29	Alternating A and B horizons
2148	PAL2148-2	16	61	B1	D	1006.43	819.99	1.32	0.00	0.44	0.00	0.44	Medium clay
2148	PAL2148-3	61	97	B2	D	797.16	657.92	1.32	0.00	0.26	0.13	0.39	Effervescence in Btk horizon
2149	PAL2149-1	0	13	A		288.98	237.14	1.32	0.00	1.33	0.00	1.33	
2149	PAL2149-2	13	71	Bt1		1373.85	1132.30	1.41	0.00	0.21	0.00	0.21	
2149	PAL2149-3	71	97	Bt2		606.24	490.77	1.36	0.21	0.15	0.00	0.15	
2150	PAL2150-1	0	13	A	E	263.12	218.62	1.21	0.00	1.22	0.00	1.22	Medium clay
2150	PAL2150-2	13	56	B1	E	1016.72	844.97	1.42	0.00	0.19	0.00	0.19	
2150	PAL2150-3	56	98	B2	E	988.85	809.73	1.39	0.00	0.14	0.00	0.14	
2151	PAL2151-1	0	25	Ap	E	599.58	483.99	1.40	0.33	0.52	0.15	0.67	
2151	PAL2151-2	25	52	Bt1	E	690.40	550.61	1.47	0.24	0.11	0.17	0.28	
2151	PAL2151-3	52	82	Bt2	E	727.93	581.74	1.40	0.00	0.05	0.02	0.07	
2152	PAL2152-1	0	48	A	S	1202.51	1036.50	1.42	90.56	0.91	0.00	0.91	
2152	PAL2152-2	48	59	E	S	278.79	230.45	1.51	0.00	0.34	0.00	0.34	
2152	PAL2152-3	59	98	CB	S	1026.61	802.04	1.48	0.00	0.22	0.00	0.22	2CBg is banded clay 8.5YR 4/6 and 10YR 8/1 - striking color - clayey
2153	PAL2153-1	0	31	A	S	602.06	452.46	1.05	0.00	1.88	0.00	1.88	No visible Ap horizon
2153	PAL2153-2	31	57	BA	S	627.33	509.70	1.41	0.00	0.36	0.00	0.36	
2153	PAL2153-3	57	97	Bt	S	1029.53	838.06	1.51	0.00	0.13	0.00	0.13	
2154	PAL2154-1	0	21	Ap		469.16	362.88	1.25	0.00	2.09	0.00	2.09	
2154	PAL2154-2	21	35	A		312.72	240.68	1.24	0.00	1.23	0.00	1.23	
2154	PAL2154-3	35	53	AB		453.28	344.64	1.38	0.00	1.05	0.00	1.05	
2154	PAL2154-4	53	68	B		376.49	295.33	1.42	0.00	0.57	0.00	0.57	
2155	PAL2155-1	0	31	A	D	653.72	505.01	1.18	0.00	1.92	0.00	1.92	
2155	PAL2155-2	31	51	AB	D	458.71	351.10	1.27	0.00	1.09	0.00	1.09	
2155	PAL2155-3	51	63	BA	D	317.52	244.42	1.47	0.00	0.95	0.00	0.95	
2156	PAL2156-1	0	39	A		880.01	723.56	1.34	0.00	1.10	0.00	1.10	No distinct Ap horizon

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2156	PAL2156-2	39	63	BA		559.54	460.63	1.39	0.00	0.48	0.00	0.48	
2156	PAL2156-3	63	95	Btc		839.54	687.59	1.55	0.00	0.17	0.00	0.17	Upper Bt saturated
2157	PAL2157-1	0	30	A		620.81	498.56	1.20	0.00	1.29	0.00	1.29	Btk effervesces
2157	PAL2157-2	30	57	B		586.42	489.79	1.31	0.16	0.34	0.08	0.42	
2157	PAL2157-3	57	71	2A		263.59	214.89	1.11	0.00	0.46	0.29	0.75	
2157	PAL2157-4	71	96	2B		543.11	432.14	1.25	0.00	0.23	0.92	1.15	
2158	PAL2158-1	0	14	A	D	257.39	213.95	1.10	0.33	1.46	0.00	1.46	
2158	PAL2158-2	14	63	ABk	D	1067.48	868.43	1.28	1.25	0.12	1.00	1.12	
2158	PAL2158-3	63	97	Btk	D	791.67	622.22	1.32	0.00	0.12	0.59	0.71	
2159	PAL2159-1	0	11	Ap	E	238.70	197.82	1.29	0.73	1.44	0.00	1.44	Whole core effervesces
2159	PAL2159-2	11	46	Btk1	E	811.18	668.74	1.38	0.00	0.23	0.74	0.97	
2159	PAL2159-3	46	95	Btk2	E	1147.64	897.56	1.32	0.00	0.22	0.55	0.77	
2160	PAL2160-1	0	36	A	D	625.80	453.81	0.91	0.00	2.35	0.00	2.35	Ap horizon not distinct
2160	PAL2160-2	36	72	BA	D	661.41	440.44	0.88	0.00	0.62	0.00	0.62	
2160	PAL2160-3	72	95	Bt	D	427.51	275.84	0.87	0.00	0.23	0.00	0.23	
2161	PAL2161-1	0	18	Ap		347.52	269.23	1.06	4.02	1.95	0.00	1.95	Short core
2161	PAL2161-2	18	24	B		129.56	111.66	1.29	4.03	0.56	0.00	0.56	
2162	PAL2162-1	0	22	Ap	E	411.69	352.14	1.16	0.00	0.94	0.00	0.94	
2162	PAL2162-2	22	54	BA	E	625.77	545.36	1.23	0.04	0.51	0.00	0.51	
2162	PAL2162-3	54	97	Btk	E	941.95	814.96	1.37	0.00	0.22	0.08	0.30	Effervesces
2163	PAL2163-1	0	26	Ap	E	504.83	437.00	1.21	0.00	0.85	0.00	0.85	
2163	PAL2163-2	26	53	BA	E	488.48	426.30	1.14	0.00	0.52	0.00	0.52	
2163	PAL2163-3	53	96	Bt	E	947.86	821.65	1.38	0.00	0.22	0.15	0.37	
2164	PAL2164-1	0	27	Ap	D	466.67	401.51	1.07	0.00	0.90	0.00	0.90	
2164	PAL2164-2	27	58	AB	D	574.14	494.39	1.15	0.52	0.68	0.00	0.68	
2164	PAL2164-3	58	95	B	D	679.86	571.08	1.06	25.51	0.45	0.80	1.25	Strong effervescence
2165	PAL2165-1	0	23	Ap	E	393.84	354.68	1.11	0.00	0.77	0.00	0.77	
2165	PAL2165-2	23	57	BA	E	664.06	596.41	1.27	0.00	0.51	0.00	0.51	
2165	PAL2165-3	57	93	Btk	E	689.06	608.20	1.22	0.00	0.31	0.45	0.76	Effervesces
2166	PAL2166-1	0	26	Ap	E	491.77	424.79	1.18	0.60	0.66	0.00	0.66	
2166	PAL2166-2	26	56	BA	E	620.58	546.86	1.31	0.78	0.36	0.00	0.36	
2166	PAL2166-3	56	96	Bt	E	830.35	736.92	1.33	0.00	0.21	0.00	0.21	
2167	PAL2167-1	0	24	A	E	445.90	383.06	1.15	0.00	0.94	0.00	0.94	Mica throughout
2167	PAL2167-2	24	61	BA	E	797.43	697.44	1.36	0.00	0.32	0.00	0.32	
2167	PAL2167-3	61	96	B	E	722.65	639.48	1.32	0.00	0.21	0.00	0.21	
2168	PAL2168-1	0	12	Ap		235.79	200.16	1.20	0.00	1.28	0.00	1.28	Btk effervesces - Eroded soil
2168	PAL2168-2	12	51	AB		916.13	776.42	1.44	0.00	0.74	0.00	0.74	
2168	PAL2168-3	51	93	Btk		717.35	602.33	1.03	0.63	0.42	0.53	0.95	
2169	PAL2169-1	0	40	A		764.27	645.71	1.17	0.00	0.90	0.00	0.90	Plant debris at 64 cm - Old erosion surface? - Btk effervesces
2169	PAL2169-2	40	63	AB		430.99	366.15	1.15	0.00	0.70	0.00	0.70	
2169	PAL2169-3	63	87	Btk		516.36	435.21	1.31	0.00	0.49	0.64	1.13	
2170	PAL2170-1	0	19	Ap		389.40	314.07	1.19	0.00	0.60	0.18	0.78	Ap hillslope sediment
2170	PAL2170-2	19	30	A		257.96	208.09	1.36	1.12	0.55	0.36	0.91	
2170	PAL2170-3	30	60	BA		724.26	562.35	1.33	8.31	0.35	0.53	0.88	
2171	PAL2171-1	0	36	A	S	676.86	581.28	1.17	0.00	0.93	0.00	0.93	
2171	PAL2171-2	36	61	Btk1	S	507.98	441.62	1.28	0.00	0.37	0.00	0.37	Strong effervescence
2171	PAL2171-3	61	93	Btk2	S	570.74	487.29	1.10	0.00	0.39	0.80	1.19	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2172	PAL2172-1	0	19	Ap	E	335.09	301.30	1.11	8.39	0.92	0.00	0.92	Effervescent into lower Ap horizon
2172	PAL2172-2	19	41	BAk	E	425.22	377.41	1.22	4.99	0.69	0.90	1.59	
2172	PAL2172-3	41	51	Bk	E	183.54	165.71	1.14	7.63	0.40	2.27	2.67	
2173	PAL2173-1	0	30	A	E	526.58	459.47	1.11	0.00	0.81	0.00	0.81	
2173	PAL2173-2	30	47	Bt	E	325.41	284.38	1.21	0.00	0.61	0.00	0.61	
2173	PAL2173-3	47	71	Btk	E	501.68	430.81	1.30	0.00	0.44	0.72	1.16	Effervesces
2174	PAL2174-1	0	21	A	E	346.03	315.82	1.00	23.79	1.01	0.00	1.01	
2174	PAL2174-2	21	41	Bt	E	301.55	278.60	0.86	41.55	0.64	0.00	0.64	
2174	PAL2174-3	41	50	2Btk	E	292.07	264.77	1.06	132.70	0.94	1.59	2.53	Effervesces - 2Btk horizon is cemented
2175	PAL2175-1	0	32	A	D	551.54	467.95	1.05	1.11	0.86	0.00	0.86	No visible Ap horizon
2175	PAL2175-2	32	48	A	D	301.77	254.15	1.13	3.75	0.59	0.00	0.59	
2175	PAL2175-3	48	69	AB	D	404.20	339.81	0.80	107.59	0.62	0.14	0.76	Caliche at base of core - strong effervescence
2176	PAL2176-1	0	32	Ap	D	598.15	512.87	1.16	0.00	0.80	0.00	0.80	
2176	PAL2176-2	32	67	AB	D	687.88	599.30	1.24	0.00	0.43	0.00	0.43	
2176	PAL2176-3	67	95	2AB	D	623.54	552.96	1.42	0.23	0.33	0.00	0.33	
2177	PAL2177-1	0	20	Ap	D	328.53	254.96	0.92	0.11	1.57	0.43	2.00	
2177	PAL2177-2	20	46	Bt	D	474.99	369.15	1.02	0.00	0.57	0.67	1.24	
2177	PAL2177-3	46	76	2A	D	588.21	445.84	1.07	0.21	0.46	1.55	2.01	
2177	PAL2177-4	76	96	2E	D	439.38	345.76	1.25	0.00	0.42	3.36	3.78	
2178	PAL2178-1	0	35	B	D	619.58	473.20	0.98	0.00	1.25	0.21	1.46	Gleyed
2178	PAL2178-2	35	52	2E	D	324.99	254.66	1.08	0.00	0.54	0.24	0.78	
2178	PAL2178-3	52	96	3A	D	900.93	663.59	1.09	0.00	0.61	2.40	3.01	
2179	PAL2179-1	0	16	Ap		225.46	198.70	0.89	0.47	1.36	0.00	1.36	Hillslope sediment 0-16 cm
2179	PAL2179-2	16	41	A		490.62	426.44	1.23	0.25	0.90	0.00	0.90	
2179	PAL2179-3	41	90	Bt		946.53	834.90	1.23	0.00	0.51	0.00	0.51	
2180	PAL2180-1	0	15	Ap		294.75	255.47	1.23	0.00	1.09	0.00	1.09	
2180	PAL2180-2	15	40	AB		475.14	419.45	1.21	0.00	0.70	0.00	0.70	
2180	PAL2180-3	40	97	B		1147.77	1009.10	1.28	0.00	0.36	0.15	0.51	
2181	PAL2181-1	0	27	Ap	E	490.93	448.61	1.20	0.00	0.84	0.00	0.84	
2181	PAL2181-2	27	52	BA	E	489.02	443.21	1.28	0.00	0.41	0.00	0.41	
2181	PAL2181-3	52	95	Bt	E	900.31	809.60	1.36	0.00	0.31	0.00	0.31	
2182	PAL2182-1	0	18	Ap		345.18	301.52	1.21	0.00	0.92	0.00	0.92	
2182	PAL2182-2	18	72	BA		995.21	879.91	1.18	0.00	0.57	0.00	0.57	
2182	PAL2182-3	72	94	Btk		427.89	376.83	1.24	0.00	0.33	0.23	0.56	
2183	PAL2183-1	0	37	A	S	676.07	593.94	1.16	0.00	0.98	0.00	0.98	
2183	PAL2183-2	37	53	BA	S	308.67	279.15	1.26	0.00	0.55	0.00	0.55	
2183	PAL2183-3	53	97	Bt	S	912.30	815.69	1.34	0.00	0.34	0.00	0.34	
2184	PAL2184-1	0	37	A		600.14	516.88	1.01	0.00	1.08	0.00	1.08	
2184	PAL2184-2	37	65	BA		645.67	565.39	1.46	0.00	0.39	0.00	0.39	
2184	PAL2184-3	65	98	Bt		690.69	607.47	1.33	0.00	0.28	0.00	0.28	
2185	PAL2185-1	0	31	A		545.02	475.51	1.11	0.00	1.03	0.00	1.03	Ap indistinct
2185	PAL2185-2	31	51	BA		377.69	335.59	1.21	0.00	0.67	0.00	0.67	
2185	PAL2185-3	51	96	Bt		918.82	815.18	1.31	0.00	0.44	0.00	0.44	
2186	PAL2186-1	0	31	A		578.87	495.98	1.15	0.00	1.05	0.00	1.05	No visible Ap
2186	PAL2186-2	31	55	BA		501.58	441.63	1.33	0.00	0.55	0.00	0.55	
2186	PAL2186-3	55	89	Bt		694.85	613.63	1.30	0.00	0.43	0.00	0.43	
2187	PAL2187-1	0	28	A		520.82	463.69	1.20	0.00	0.81	0.26	1.07	13 cm hillslope sediment

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2187	PAL2187-2	28	67	Btk		805.52	684.03	1.27	0.00	0.49	1.66	2.15	
2188	PAL2188-1	0	36	A		646.48	560.02	1.12	0.00	1.02	0.00	1.02	
2188	PAL2188-2	36	57	BA		407.87	361.71	1.24	0.00	0.53	0.00	0.53	
2188	PAL2188-3	57	93	Bt		747.50	665.79	1.33	0.00	0.25	0.00	0.25	
2189	PAL2189-1	0	28	Ap	S	483.24	418.93	1.08	0.00	1.13	0.00	1.13	
2189	PAL2189-2	28	44	AB	S	312.62	276.36	1.25	0.00	0.71	0.00	0.71	
2189	PAL2189-3	44	93	Bt	S	1050.07	931.40	1.37	0.00	0.36	0.00	0.36	
2190	PAL2190-1	0	27	Apk		520.12	462.04	1.22	6.78	0.47	0.59	1.06	Ap in B material
2190	PAL2190-2	27	69	Ak		824.54	713.91	1.22	4.68	0.88	0.39	1.27	
2190	PAL2190-3	69	92	2Bk		461.71	401.46	1.25	3.46	0.70	1.01	1.71	
2191	PAL2191-1	0	22	Ap		361.85	302.51	0.99	0.00	1.45	0.00	1.45	
2191	PAL2191-2	22	50	BA		471.19	395.32	1.02	0.00	0.72	0.00	0.72	
2191	PAL2191-3	50	97	Bt		971.71	839.07	1.29	0.00	0.33	0.00	0.33	
2192	PAL2192-1	0	22	Ap		366.24	316.10	1.04	0.00	1.34	0.00	1.34	Ap is lighter that A horizon - hill slope sediments - Btk effervesces
2192	PAL2192-2	22	54	A		591.19	504.90	1.14	0.00	1.10	0.00	1.10	
2192	PAL2192-3	54	97	Bt		881.75	760.60	1.28	0.00	0.53	0.17	0.70	
2193	PAL2193-1	0	19	Ap		408.70	342.58	1.30	0.00	0.64	0.00	0.64	Severely eroded. Light colored Ap with Bt characteristics. Lower Bt3 has Ab features.
2193	PAL2193-2	19	64	Bt1		1017.42	853.25	1.37	0.00	0.28	0.00	0.28	
2193	PAL2193-3	64	92	Bt3		708.18	588.58	1.52	0.00	0.19	0.00	0.19	
2194	PAL2194-1	0	26	A1		502.30	404.24	1.12	0.00	1.43	0.00	1.43	Light surface
2194	PAL2194-2	26	74	A2		873.11	628.15	0.94	0.00	1.53	0.00	1.53	
2194	PAL2194-3	74	91	BA		369.40	264.21	1.12	0.00	0.60	0.00	0.60	
2195	PAL2195-1	0	24	Ap		580.45	483.01	1.45	0.00	0.71	0.00	0.71	Manganese concretions
2195	PAL2195-2	24	46	Bt1		557.71	461.87	1.52	0.00	0.32	0.00	0.32	
2195	PAL2195-3	46	97	Bt2		1253.89	1046.05	1.48	0.00	0.15	0.00	0.15	
2196	PAL2196-1	0	29	A		660.60	538.63	1.34	0.00	1.16	0.00	1.16	Low clay in lower part of profile
2196	PAL2196-2	29	53	2A1		536.72	422.01	1.27	0.00	1.57	0.00	1.57	
2196	PAL2196-3	53	93	2A2		817.72	559.18	1.01	0.00	1.52	0.00	1.52	
2197	PAL2197-1	0	22	A		452.54	377.21	1.23	1.24	1.64	0.00	1.64	No visible Ap.
2197	PAL2197-2	22	40	AB		445.33	378.38	1.52	0.21	0.41	0.00	0.41	
2197	PAL2197-3	40	76	Bt		849.75	729.77	1.46	0.00	0.21	0.00	0.21	Bt ped faces are being leached
2198	PAL2198-1	0	21	Ap		426.04	355.91	1.22	1.91	1.73	0.00	1.73	Strongly structural Bt with thick clay & OM coatings on block faces
2198	PAL2198-2	21	32	AB		261.86	222.83	1.46	0.15	0.54	0.00	0.54	
2198	PAL2198-3	32	71	B		946.88	818.28	1.51	2.14	0.27	0.00	0.27	
2199	PAL2199-1	0	21	Ap	S	460.16	383.66	1.31	1.07	1.27	0.00	1.27	Short core
2199	PAL2199-2	21	33	AB	S	252.45	212.18	1.28	0.17	0.71	0.00	0.71	
2199	PAL2199-3	33	46	Bt	S	296.74	252.16	1.39	1.29	0.41	0.00	0.41	
2200	PAL2200-1	0	15	Ap	S	347.95	291.10	1.38	3.99	1.50	0.00	1.50	
2200	PAL2200-2	15	36	A	S	346.15	289.47	0.99	0.22	1.12	0.00	1.12	
2200	PAL2200-3	36	96	Bt	S	1436.09	1218.33	1.46	0.83	0.37	0.20	0.57	Strong effervescence - large krotovina in Bt horizon
2201	PAL2201-1	0	30	A		592.80	456.61	1.06	14.30	1.66	0.00	1.66	No distinct Ap
2201	PAL2201-2	30	51	Bt1		444.50	371.50	0.98	85.65	0.71	0.00	0.71	
2202	PAL2202-1	0	28	A	S	531.20	440.08	1.09	16.96	1.16	0.00	1.16	No Ap horizon
2202	PAL2202-2	28	66	BA	S	936.74	794.91	1.49	10.83	0.33	0.00	0.33	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2202	PAL2202-3	66	86	2BC	S	472.09	427.77	1.18	102.02	0.12	0.04	0.16	2BC horizon is sandy
2203	PAL2203-1	0	21	Ap		379.02	297.05	0.98	10.55	2.15	0.00	2.15	
2203	PAL2203-2	21	54	A1		541.69	403.49	0.82	27.30	2.46	0.00	2.46	
2203	PAL2203-3	54	70	AB		322.82	236.16	1.03	6.94	1.89	0.00	1.89	
2203	PAL2203-4	70	92	Bt1		446.33	371.50	1.17	14.38	0.53	0.00	0.53	
2204	PAL2204-1	0	10	Ap		170.54	148.94	1.07	0.63	1.30	0.00	1.30	Eroded Ap
2204	PAL2204-2	10	44	A		737.24	643.96	1.37	0.34	0.92	0.00	0.92	
2204	PAL2204-3	44	94	Bt		1125.61	1013.97	1.46	0.00	0.36	0.00	0.36	
2205	PAL2205-1	0	32	A	S	674.03	560.51	1.26	0.00	1.42	0.00	1.42	
2205	PAL2205-2	32	57	AB	S	473.60	394.63	1.14	0.12	0.87	0.00	0.87	
2205	PAL2205-3	57	90	BA	S	675.53	570.13	1.25	0.09	0.49	0.00	0.49	
2206	PAL2206-1	0	27	A	S	518.46	412.92	1.10	0.28	1.76	0.00	1.76	
2206	PAL2206-2	27	58	AB	S	603.34	491.92	1.14	1.43	0.65	0.00	0.65	
2206	PAL2206-3	58	98	BA	S	939.75	774.44	1.40	0.00	0.28	0.00	0.28	
2207	PAL2207-1	0	35	A		700.59	575.79	1.19	0.30	1.12	0.00	1.12	
2207	PAL2207-2	35	55	BA		451.70	382.29	1.38	0.00	0.39	0.00	0.39	
2207	PAL2207-3	55	87	Bt		783.35	664.92	1.50	0.68	0.18	0.00	0.18	
2208	PAL2208-1	0	24	A	E	476.32	401.22	1.18	8.58	0.71	0.00	0.71	
2208	PAL2208-2	24	38	BA	E	300.85	266.69	1.31	12.57	0.40	0.00	0.40	
2208	PAL2208-3	38	54	2B	E	415.38	367.52	1.50	34.91	0.25	0.00	0.25	2Bt horizon has basalt pebbles
2209	PAL2209-1	0	38	A	S	758.11	641.88	1.21	4.08	1.23	0.00	1.23	Mica throughout
2209	PAL2209-2	38	57	AB	S	435.86	373.52	1.41	1.82	0.62	0.00	0.62	
2209	PAL2209-3	57	94	B	S	932.76	822.63	1.59	9.63	0.25	0.00	0.25	
2210	PAL2210-1	0	22	Ap		442.19	360.70	1.18	0.90	1.33	0.00	1.33	2Bt3 very sandy
2210	PAL2210-2	22	47	A		498.35	385.00	1.11	0.00	1.26	0.00	1.26	
2210	PAL2210-3	47	88	Bt		954.08	776.95	1.29	44.78	0.30	0.00	0.30	
2211	PAL2211-1	0	34	A	S	722.19	591.72	1.23	10.98	1.67	0.00	1.67	No picture - no visible Ap horizon
2211	PAL2211-2	34	61	BA	S	534.21	461.75	1.19	17.38	0.64	0.00	0.64	
2212	PAL2212-1	0	15	Ap	E	247.93	192.13	0.92	0.53	1.60	0.00	1.60	Core is "stretched"
2212	PAL2212-2	15	35	AB	E	461.55	356.69	1.26	6.77	0.87	0.00	0.87	
2212	PAL2212-3	35	49	Bt	E	355.24	291.24	1.45	9.80	0.39	0.00	0.39	
2213	PAL2213-1	0	23	A		422.69	328.40	1.03	0.00	1.53	0.00	1.53	Eroded
2213	PAL2213-2	23	33	AB		211.03	160.34	1.15	0.67	0.86	0.00	0.86	
2213	PAL2213-3	33	50	Btc		438.10	367.82	1.41	35.76	0.36	0.00	0.36	
2214	PAL2214-1	0	13	Ap		219.16	177.88	0.98	0.71	2.15	0.00	2.15	
2214	PAL2214-2	13	32	A		422.21	354.83	1.34	2.82	0.91	0.00	0.91	
2214	PAL2214-3	32	64	B		811.22	699.55	1.51	29.54	0.37	0.00	0.37	
2215	PAL2215-1	0	24	A		440.21	354.06	1.05	4.46	1.99	0.00	1.99	
2215	PAL2215-2	24	38	BA		302.17	253.68	1.29	3.70	0.77	0.00	0.77	
2215	PAL2215-3	38	56	B		443.53	390.43	1.37	48.02	0.35	0.00	0.35	
2216	PAL2216-1	0	28	A	E	453.36	360.48	0.91	7.90	2.19	0.00	2.19	
2216	PAL2216-2	28	50	B	E	459.62	377.58	1.12	35.45	0.48	0.00	0.48	Large basalt fragments at base of core
2217	PAL2217-1	0	22	Ap		482.46	402.83	1.31	3.37	1.70	0.00	1.70	Ap is hillslope sediment
2217	PAL2217-2	22	58	A		627.10	471.62	0.94	4.64	2.41	0.00	2.41	
2217	PAL2217-3	58	97	AB		721.65	561.16	1.04	1.91	0.82	0.00	0.82	
2218	PAL2218-1	0	37	A		710.14	598.62	1.15	10.69	1.37	0.00	1.37	Ap indistinct
2218	PAL2218-2	37	62	BA		503.23	420.80	1.19	7.41	0.81	0.00	0.81	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2218	PAL2218-3	62	98	Bt		797.95	684.85	1.35	11.97	0.82	0.00	0.82	
2219	PAL2219-1	0	41	A	D	836.50	760.06	1.31	14.17	1.20	0.00	1.20	Ap is indistinct
2219	PAL2219-2	41	62	AB	D	470.37	398.59	1.35	4.61	0.65	0.00	0.65	
2219	PAL2219-3	62	95	Bt	D	776.86	664.84	1.43	8.92				No archive sample - sample was accidently dumped
2220	PAL2220-1	0	21	A		419.64	369.45	1.27	0.00	1.08	0.00	1.08	Eroded Ap
2220	PAL2220-2	21	57	BA		842.01	767.29	1.54	0.49	0.28	0.00	0.28	
2220	PAL2220-3	57	97	Bt		906.50	812.54	1.46	3.21	0.16	0.00	0.16	
2221	PAL2221-1	0	19	A	D	436.63	363.71	1.38	1.59	1.71	0.00	1.71	
2221	PAL2221-2	19	60	BA	D	965.28	823.58	1.45	0.72	0.41	0.00	0.41	
2221	PAL2221-3	60	98	2B	D	1021.45	888.39	1.69	0.10	0.22	0.04	0.26	Bottom of core absent - separated at caliche - effervescence at base
2222	PAL2222-1	0	20	Ap		423.45	352.99	1.27	1.54	1.61	0.00	1.61	
2222	PAL2222-2	20	50	AB		698.00	603.53	1.45	0.00	0.39	0.00	0.39	
2222	PAL2222-3	50	64	2Ab		365.67	311.08	1.60	0.72	0.49	0.00	0.49	
2222	PAL2222-4	64	93	2Bk		634.82	558.51	1.39	0.00	0.28	0.26	0.54	
2223	PAL2223-1	0	31	A	D	658.03	541.51	1.25	4.38	1.52	0.00	1.52	No Ap horizon
2223	PAL2223-2	31	48	AB	D	337.04	279.34	1.18	1.47	1.02	0.00	1.02	
2223	PAL2223-3	48	93	BA	D	915.45	765.96	1.22	2.78	0.59	0.00	0.59	
2224	PAL2224-1	0	22	Ap		385.20	326.81	1.06	2.78	1.20	0.00	1.20	
2224	PAL2224-2	22	46	A1		535.73	452.61	1.35	3.50	1.02	0.00	1.02	
2224	PAL2224-3	46	72	A2		570.79	462.55	1.28	2.48	1.28	0.00	1.28	
2224	PAL2224-4	72	98	A3		517.97	413.01	1.14	2.68	0.82	0.00	0.82	
2225	PAL2225-1	0	27	A		541.27	434.27	1.16	0.00	1.61	0.00	1.61	No visible Ap
2225	PAL2225-2	27	45	AB		382.89	310.94	1.25	0.00	0.84	0.00	0.84	
2225	PAL2225-3	45	66	BA		456.43	382.67	1.32	0.00	0.44	0.00	0.44	
2225	PAL2225-4	66	91	Bt		595.04	496.50	1.43	0.00	0.25	0.00	0.25	
2226	PAL2226-1	0	21	A	S	458.07	374.81	1.29	0.00	1.39	0.00	1.39	No distinct Ap horizon
2226	PAL2226-2	21	43	BA	S	483.98	407.12	1.33	0.57	0.56	0.00	0.56	
2226	PAL2226-3	43	50	2BC	S	180.81	157.94	0.69	91.25	0.46	0.00	0.46	
2227	PAL2227-1	0	23	A		488.62	396.83	1.24	0.64	1.40	0.00	1.40	
2227	PAL2227-2	23	46	B1		515.89	436.12	1.36	1.58	0.54	0.00	0.54	
2228	PAL2228-1	0	25	BA	D	440.58	392.00	1.13	0.95	1.74	0.00	1.74	Surface is hillslope sediment
2228	PAL2228-2	25	62	2A	D	625.52	526.20	1.03	0.00	1.82	0.00	1.82	
2228	PAL2228-3	62	95	2BA	D	565.54	478.18	1.05	0.00	0.98	0.00	0.98	
2229	PAL2229-1	0	19	Ap		343.91	302.75	1.15	0.49	1.76	0.00	1.76	
2229	PAL2229-2	19	52	A		549.19	463.70	1.01	0.14	2.03	0.00	2.03	
2229	PAL2229-3	52	99	Bt		767.21	644.62	0.99	0.00	1.02	0.00	1.02	
2230	PAL2230-1	0	18	Ap		355.18	293.15	1.18	0.00	1.77	0.00	1.77	Effervescence in Btk
2230	PAL2230-2	18	52	BA		671.21	562.26	1.19	2.60	0.88	0.00	0.88	
2230	PAL2230-3	52	94	Btk		1037.07	893.09	1.51	15.67	0.22	0.21	0.43	
2231	PAL2231-1	0	19	Ap		369.20	305.51	1.16	0.60	1.82	0.00	1.82	Free carbonates at bottom of profile
2231	PAL2231-2	19	40	A		398.04	334.60	1.15	0.78	0.99	0.00	0.99	
2231	PAL2231-3	40	64	B1		538.78	467.41	1.41	0.00	0.48	0.00	0.48	
2231	PAL2231-4	64	95	Bk		734.46	636.18	1.46	9.25	0.14	0.24	0.38	
2232	PAL2232-1	0	24	Ap		459.52	380.86	1.15	0.00	1.99	0.00	1.99	
2232	PAL2232-2	24	50	AB		453.77	373.17	1.04	0.34	1.36	0.00	1.36	
2232	PAL2232-3	50	78	B1		623.79	554.49	1.40	9.46	0.25	0.00	0.25	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2232	PAL2232-4	78	98	B2		516.79	399.41	1.44	0.00	0.23	0.00	0.23	
2233	PAL2233-1	0	39	A1		703.92	585.50	1.08	1.52	1.73	0.00	1.73	5 cm hillslope sediment on surface. Mn concretions and high clay content in 2Bt.
2233	PAL2233-2	39	57	A2		331.87	279.69	1.12	0.86	0.92	0.00	0.92	
2233	PAL2233-3	57	98	2Bt		1029.80	835.27	1.47	2.93	0.23	0.07	0.30	
2234	PAL2234-1	0	16	Ap	E	302.98	254.74	1.15	0.24	1.68	0.00	1.68	
2234	PAL2234-2	16	36	BA	E	383.16	324.64	1.17	0.29	0.83	0.00	0.83	
2234	PAL2234-3	36	83	Bt	E	1020.99	864.83	1.33	0.44	0.43	0.36	0.79	Effervesces
2235	PAL2235-1	0	23	Ap	E	502.37	436.74	1.37	0.72	1.02	0.00	1.02	Clayey
2235	PAL2235-2	23	55	BA	E	792.61	693.55	1.56	0.00	0.31	0.00	0.31	
2235	PAL2235-3	55	93	Bt	E	988.24	865.32	1.64	0.57	0.12	0.00	0.12	
2236	PAL2236-1	0	21	Ap		457.10	393.39	1.35	0.39	0.95	0.00	0.95	
2236	PAL2236-2	21	37	BA		365.89	318.58	1.44	0.09	0.43	0.00	0.43	
2236	PAL2236-3	37	97	Bt		1471.23	1279.48	1.54	0.76	0.21	0.00	0.21	
2237	PAL2237-1	0	29	A		564.52	514.31	1.28	1.06	0.73	0.00	0.73	Very sandy
2237	PAL2237-2	29	43	BA		314.05	288.72	1.49	0.42	0.17	0.00	0.17	
2237	PAL2237-3	43	94	B		1148.80	1035.66	1.46	1.41	0.07	0.00	0.07	
2238	PAL2238-1	0	18	Ap	E	414.75	386.37	1.43	30.90	0.56	0.00	0.56	Very coarse texture - gleyed throughout
2238	PAL2238-2	18	52	Bg1	E	897.76	850.68	1.53	128.77	0.07	0.00	0.07	
2238	PAL2238-3	52	80	Bg2	E	629.90	604.23	1.28	109.11	0.02	0.00	0.02	
2239	PAL2239-1	0	19	Ap		442.78	415.39	1.39	49.77	0.69	0.00	0.69	Loamy sand, distinct Ap, no sorting of sands
2239	PAL2239-2	19	65	B		1141.10	1085.81	1.44	169.47	0.05	0.00	0.05	
2240	PAL2240-1	0	18	Ap	E	402.53	364.51	1.35	27.33	0.66	0.00	0.66	Sandy throughout
2240	PAL2240-2	18	42	BA	E	642.89	587.65	1.51	84.20	0.21	0.00	0.21	
2240	PAL2240-3	42	78	CB	E	935.41	885.97	1.39	191.77	0.03	0.00	0.03	Coarse sand at base mica & quartz
2241	PAL2241-1	0	25	Ap	S	564.87	527.08	1.39	47.06	0.45	0.00	0.45	Sandy profile - subangular sand - quartz, mica, & basalt
2241	PAL2241-2	25	43	E	S	458.00	432.36	1.57	41.16	0.09	0.00	0.09	
2241	PAL2241-3	43	87	Bcg	S	1057.84	1015.24	1.48	113.57	0.01	0.00	0.01	
2242	PAL2242-1	0	47	A	S	901.14	755.96	1.01	97.74	1.12	0.00	1.12	
2242	PAL2242-2	47	81	2BA	S	803.56	686.86	1.29	80.20	0.35	0.00	0.35	Sandy in lower 2/3 of core
2242	PAL2242-3	81	88	2C	S	168.62	161.12	1.06	57.89	0.07	0.00	0.07	Base is 10YR 6/8, coarse sand - quartz, mica, & basalt
2243	PAL2243-1	0	39	A	D	746.68	619.73	1.04	55.10	1.29	0.00	1.29	
2243	PAL2243-1	0	16	Ap	E	305.54	266.58	1.20	0.00	1.32	0.00	1.32	
2243	PAL2243-2	39	60	BA	D	432.92	370.63	1.18	27.67	0.35	0.00	0.35	
2243	PAL2243-2	16	35	A	E	442.34	375.91	1.43	0.00	0.91	0.00	0.91	
2243	PAL2243-3	60	93	Bt	D	785.85	687.12	1.26	108.79	0.14	0.00	0.14	2BC appears to be glacial till (oxidized)
2243	PAL2243-3	35	97	Bt	E	1452.95	1211.48	1.41	0.00	0.21	0.00	0.21	
2244	PAL2244-1	0	24	Ap	S	481.81	400.71	1.21	0.00	1.51	0.00	1.51	
2244	PAL2244-2	24	43	AB	S	423.29	364.06	1.37	4.14	0.60	0.00	0.60	
2244	PAL2244-3	43	97	Btk	S	1268.43	1093.90	1.46	0.00	0.25	0.07	0.32	Strong effervescence - soft calcium carbonate masses
2245	PAL2245-1	0	24	Ap	E	415.49	368.45	1.11	0.00	1.75	0.00	1.75	
2245	PAL2245-2	24	42	BA	E	308.20	280.50	1.12	0.00	0.74	0.00	0.74	
2245	PAL2245-3	42	96	Bt	E	1114.47	991.55	1.33	0.15	0.31	0.00	0.31	
2246	PAL2246-1	0	23	A		448.42	374.06	1.17	0.00	1.25	0.00	1.25	Free mica throughout profile. 2Btk effervesces.
2246	PAL2246-2	23	58	BA		842.61	736.99	1.52	0.00	0.34	0.00	0.34	
2246	PAL2246-3	58	98	Bt		1001.48	864.52	1.56	0.51	0.12	0.00	0.12	
2247	PAL2247-1	0	29	A	S	601.37	506.37	1.26	0.12	1.27	0.00	1.27	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2247	PAL2247-2	29	75	BA	S	1114.81	973.11	1.53	0.53	0.22	0.00	0.22	
2247	PAL2247-3	75	98	Btk	S	576.50	501.51	1.57	1.32	0.06	0.04	0.10	Effervesces
2248	PAL2248-1	0	48	A		931.97	785.58	1.15	21.71	1.02	0.00	1.02	0-9 cm hillslope sediment
2248	PAL2248-2	48	70	BA		490.98	426.03	1.31	25.64	0.62	0.00	0.62	
2248	PAL2248-3	70	94	Btc		493.98	430.74	1.19	33.78	0.43	0.00	0.43	
2249	PAL2249-1	0	35	A	S	690.21	585.58	1.20	4.22	1.14	0.00	1.14	No Ap horizon
2249	PAL2249-2	35	56	BA	S	464.45	403.48	1.38	1.14	0.49	0.00	0.49	
2249	PAL2249-3	56	92	Bt	S	885.49	783.46	1.54	17.37	0.34	0.13	0.47	Effervesces
2250	PAL2250-1	0	16	Ap		308.48	258.08	1.16	0.42	1.98	0.00	1.98	Deposit of high OM material at 78"
2250	PAL2250-2	16	36	A		345.30	286.46	1.03	0.20	1.62	0.00	1.62	
2250	PAL2250-3	36	98	Bt		1293.21	1089.02	1.27	0.65	0.39	0.00	0.39	
2251	PAL2251-1	0	45	A	D	772.70	650.06	1.04	0.00	1.65	0.00	1.65	Ap horizon not visible
2251	PAL2251-2	45	74	Bt	D	606.04	529.76	1.32	0.83	0.31	0.00	0.31	
2251	PAL2251-3	74	97	2BA	D	472.64	399.98	1.25	0.55	0.29	0.00	0.29	
2252	PAL2252-1	0	30	A1		550.80	442.91	1.06	2.07	1.91	0.41	2.32	
2252	PAL2252-2	30	49	A2		389.71	290.82	1.10	0.07	1.95	0.66	2.61	
2252	PAL2252-3	49	98	AB		918.69	659.66	0.97	1.38	1.55	1.14	2.69	
2253	PAL2253-1	0	28	Ap	D	588.43	479.72	1.24	0.58	1.65	0.00	1.65	Mica throughout and much fine sand
2253	PAL2253-2	28	66	A	D	827.07	662.71	1.26	1.12	0.79	0.34	1.13	
2253	PAL2253-3	66	96	AB	D	694.28	567.39	1.36	0.82	0.46	0.00	0.46	
2254	PAL2254-1	0	24	Ap	S	424.33	344.02	1.03	1.37	1.75	0.00	1.75	
2254	PAL2254-2	24	38	AB	S	280.34	227.34	1.15	4.52	1.27	0.00	1.27	
2254	PAL2254-3	38	60	B	S	515.75	439.53	1.36	23.58	0.62	0.00	0.62	Basalt fragments at base of core
2255	PAL2255-1	0	33	A		556.68	445.66	0.97	1.63	1.55	0.00	1.55	No visible Ap. Distinct smell of cattle.
2255	PAL2255-2	33	49	BA		323.99	260.88	1.17	2.11	0.86	0.00	0.86	
2255	PAL2255-3	49	67	Bt1		458.02	403.30	1.56	14.56	0.29	0.00	0.29	
2256	PAL2256-1	0	22	A		425.66	347.22	1.14	0.27	1.27	0.00	1.27	
2256	PAL2256-2	22	55	Bt		768.40	667.87	1.42	16.57	0.36	0.00	0.36	
2257	PAL2257-1	0	49	A	D	1020.50	880.30	1.30	0.00	1.49	0.00	1.49	
2257	PAL2257-2	49	65	E	D	366.29	309.45	1.40	0.00	0.46	0.00	0.46	
2257	PAL2257-3	65	99	Btc	D	912.66	725.02	1.54	0.00	0.26	0.00	0.26	Btc horizon is clayey
2258	PAL2258-1	0	23	Ap	E	479.87	427.31	1.34	0.00	0.88	0.00	0.88	Clayey
2258	PAL2258-2	23	78	Bt	E	1346.36	1166.31	1.53	0.00	0.23	0.00	0.23	
2258	PAL2258-3	78	99	Btc	E	566.07	488.05	1.68	0.00	0.11	0.01	0.12	
2259	PAL2259-1	0	32	A1		667.59	567.98	1.27	3.45	1.73	0.00	1.73	2 cm hillslope sediment on top of A1
2259	PAL2259-2	32	50	A2		390.11	327.76	1.26	12.80	0.89	0.00	0.89	
2259	PAL2259-3	50	97	AB		1181.67	964.48	1.40	53.94	0.65	0.00	0.65	
2260	PAL2260-1	0	17	BA		301.64	265.39	1.11	3.33	1.77	0.00	1.77	Hillslope sediment 0-17 cm
2260	PAL2260-2	17	58	A		982.85	828.19	1.36	54.36	1.07	0.00	1.07	
2260	PAL2260-3	58	95	BA2		942.16	757.08	1.39	43.35	0.60	0.00	0.60	
2261	PAL2261-1	0	28	Ap	D	626.55	530.46	1.35	6.55	1.74	0.00	1.74	Ap horizon is hillslope sediment
2261	PAL2261-2	28	74	A1	D	844.67	682.03	1.06	8.70	2.59	0.00	2.59	
2261	PAL2261-3	74	98	A2	D	458.45	356.44	1.07	2.00	1.92	0.00	1.92	
2262	PAL2262-1	0	34	Ap	D	651.66	558.24	1.16	10.32	2.05	0.00	2.05	Ap and A1 horizons lighter than underlying A horizon
2262	PAL2262-2	34	62	A2	D	565.14	461.34	1.19	0.00	1.53	0.00	1.53	
2262	PAL2262-3	62	95	B	D	878.21	729.97	1.60	0.00	0.44	0.00	0.44	
2263	PAL2263-1	0	42	A	D	843.09	682.61	1.17	1.16	2.59	0.00	2.59	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2263	PAL2263-2	42	59	BA	D	404.92	325.69	1.38	0.23	1.03	0.00	1.03	
2263	PAL2263-3	59	94	Bt	D	912.98	764.28	1.55	13.61	0.54	0.00	0.54	
2264	PAL2264-1	0	21	Ap		458.52	363.89	1.24	2.58	2.35	0.00	2.35	Ap/AB boundary indistinct
2264	PAL2264-2	21	55	AB		775.08	637.13	1.35	0.00	1.11	0.00	1.11	
2264	PAL2264-3	55	76	Eg		552.58	458.59	1.57	0.46	0.34	0.00	0.34	
2264	PAL2264-4	76	98	Bt		577.87	482.11	1.58	0.00	0.23	0.00	0.23	
2265	PAL2265-1	0	24	A	D	530.73	440.02	1.32	0.00	2.15	0.00	2.15	No Ap horizon
2265	PAL2265-2	24	62	BA	D	904.67	733.83	1.39	0.00	0.87	0.00	0.87	
2265	PAL2265-3	62	96	E	D	931.74	773.59	1.63	6.89	0.22	0.00	0.22	
2266	PAL2266-1	0	23	A1		467.53	379.41	1.19	0.00	2.41	0.00	2.41	
2266	PAL2266-2	23	55	A2		606.92	465.66	1.05	0.00	2.46	0.00	2.46	
2266	PAL2266-3	55	77	AB		422.90	313.10	1.03	0.00	1.74	0.00	1.74	
2266	PAL2266-4	77	99	Btg		514.71	408.33	1.34	0.00	0.83	0.00	0.83	
2267	PAL2267-1	0	46	Ap		911.61	757.93	1.19	0.00	2.28	0.00	2.28	
2267	PAL2267-2	46	71	BA		588.58	480.11	1.39	0.14	1.07	0.00	1.07	
2267	PAL2267-3	71	98	Bt		713.74	601.92	1.61	0.26	0.31	0.00	0.31	
2268	PAL2268-1	0	49	A	D	974.86	802.29	1.18	0.00	2.10	0.00	2.10	No Ap horizon
2268	PAL2268-2	49	64	BA	D	340.51	265.20	1.28	0.00	1.29	0.00	1.29	
2268	PAL2268-3	64	92	Bg	D	702.09	596.87	1.54	0.16	0.27	0.00	0.27	
2269	PAL2269-1	0	34	Ap	D	770.55	667.11	1.41	1.39	1.43	0.00	1.43	Ap horizon is brown hillslope sediment - Mica in profile
2269	PAL2269-2	34	67	A	D	721.41	609.38	1.32	6.15	1.75	0.00	1.75	
2269	PAL2269-3	67	96	AB	D	689.14	569.19	1.41	2.33	1.08	0.00	1.08	
2270	PAL2270-1	0	40	Ap	D	869.80	755.32	1.36	0.84	1.25	0.00	1.25	Ap horizon is hillslope sediment
2270	PAL2270-2	40	75	2A1	D	713.23	590.32	1.20	8.21	1.55	0.00	1.55	
2270	PAL2270-3	75	98	2A2	D	532.10	434.91	1.34	6.69	0.97	0.00	0.97	
2271	PAL2271-1	0	26	A		561.99	437.01	1.21	0.23	1.84	0.00	1.84	Btc iron & manganese concretions - Eg gleyed
2271	PAL2271-2	26	44	B		379.96	278.55	1.12	0.00	0.79	0.00	0.79	
2271	PAL2271-3	44	67	Eg		589.66	486.27	1.53	0.08	0.32	0.00	0.32	
2271	PAL2271-4	67	98	Btc		815.71	677.62	1.55	13.22	0.11	0.00	0.11	
2272	PAL2272-1	0	33	A	S	638.40	544.45	1.16	15.32	1.87	0.00	1.87	No Ap horizon - roots throughout
2272	PAL2272-2	33	59	AB	S	524.92	443.83	1.22	5.42	0.86	0.00	0.86	
2272	PAL2272-3	59	70	Bt	S	262.56	223.54	1.44	4.28	0.44	0.00	0.44	
2273	PAL2273-1	0	28	A		592.57	490.16	1.26	0.18	1.88	0.00	1.88	
2273	PAL2273-2	28	62	B		757.60	641.07	1.36	1.56	0.62	0.00	0.62	
2273	PAL2273-3	62	99	Bt		952.31	802.76	1.56	5.44	0.35	0.00	0.35	
2274	PAL2274-1	0	41	A	D	782.67	594.38	1.05	0.00	2.96	0.00	2.96	
2274	PAL2274-2	41	66	BA	D	547.98	424.62	1.23	0.00	1.12	0.00	1.12	
2274	PAL2274-3	66	98	E	D	817.08	671.68	1.52	0.00	0.36	0.00	0.36	
2275	PAL2275-1	0	13	A		234.36	198.01	1.10	0.20	2.72	0.00	2.72	
2275	PAL2275-2	13	51	BA		686.93	606.18	1.15	1.54	1.15	0.00	1.15	
2275	PAL2275-3	51	99	Bt		1152.86	984.47	1.47	5.67	0.47	0.00	0.47	
2276	PAL2276-1	0	36	A	S	738.87	604.97	1.21	1.27	1.68	0.00	1.68	
2276	PAL2276-2	36	58	BA	S	516.20	418.75	1.37	0.00	0.76	0.00	0.76	
2276	PAL2276-3	58	98	E	S	1069.02	882.60	1.59	0.86	0.29	0.00	0.29	
2277	PAL2277-1	0	28	Ap	S	579.99	501.66	1.29	0.00	1.06	0.00	1.06	
2277	PAL2277-2	28	74	Bt	S	1153.44	949.32	1.49	0.00	0.33	0.00	0.33	
2277	PAL2277-3	74	93	2Btk	S	474.86	393.93	1.50	0.00	0.17	0.30	0.47	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2278	PAL2278-1	0	28	Ap	E	519.96	445.85	1.14	2.57	1.60	0.00	1.60	Mica in profile
2278	PAL2278-2	28	55	A	E	574.63	481.27	1.24	17.16	0.99	0.00	0.99	
2278	PAL2278-3	55	84	B	E	695.36	594.76	1.45	12.33	0.49	0.00	0.49	Red B horizon
2279	PAL2279-1	0	31	A		608.98	496.06	1.16	0.00	1.52	0.00	1.52	Live worm at 42 cm
2279	PAL2279-2	31	50	BA		430.14	360.87	1.37	0.00	0.54	0.00	0.54	
2279	PAL2279-3	50	98	Bt		1216.61	1007.99	1.52	0.00	0.24	0.00	0.24	
2280	PAL2280-1	0	13	Ap	E	236.95	202.00	1.12	0.00	1.18	0.00	1.18	
2280	PAL2280-2	13	34	BA	E	505.09	410.73	1.41	0.00	0.31	0.00	0.31	
2280	PAL2280-3	34	69	B	E	867.09	703.95	1.45	0.00	0.10	0.02	0.12	
2281	PAL2281-1	0	10	Ap	E	196.86	166.04	1.20	0.00	1.30	0.00	1.30	
2281	PAL2281-2	10	31	BA	E	469.02	384.81	1.32	0.00	0.33	0.00	0.33	
2281	PAL2281-3	31	67	Bt	E	875.60	705.70	1.41	0.00	0.11	0.00	0.11	
2282	PAL2282-1	0	25	A1		479.88	390.05	1.13	0.00	2.58	0.00	2.58	No distinct Ap. Concretions in B.
2282	PAL2282-2	25	51	A2		702.36	574.97	1.60	0.00	1.28	0.00	1.28	
2282	PAL2282-3	51	81	AB		544.92	433.13	1.04	0.00	0.94	0.00	0.94	
2282	PAL2282-4	81	99	Bc		466.52	372.55	1.49	0.00	0.55	0.00	0.55	
2283	PAL2283-1	0	34	A	D	635.84	508.43	1.08	0.34	2.16	0.00	2.16	
2283	PAL2283-2	34	73	AB	D	774.97	575.08	1.06	0.00	1.03	0.00	1.03	
2283	PAL2283-3	73	99	Bt	D	682.19	541.63	1.50	0.00	0.26	0.00	0.26	
2284	PAL2284-1	0	38	A		709.49	558.84	1.06	0.00	2.17	0.00	2.17	
2284	PAL2284-2	38	70	BA		646.57	482.00	1.09	0.00	0.87	0.00	0.87	
2284	PAL2284-3	70	98	Bt1		703.17	566.55	1.46	0.00	0.25	0.00	0.25	
2285	PAL2285-1	0	21	Ap		364.59	302.04	1.04	0.00	1.60	0.00	1.60	Krotovina 47-76 cm
2285	PAL2285-2	21	47	BA		560.06	459.42	1.28	0.00	0.68	0.00	0.68	
2285	PAL2285-3	47	98	Bt		1191.13	970.34	1.37	0.00	0.31	0.00	0.31	
2286	PAL2286-1	0	23	Ap	S	459.26	381.41	1.20	0.00	1.51	0.00	1.51	
2286	PAL2286-2	23	47	AB	S	509.47	421.71	1.27	0.00	0.65	0.00	0.65	
2286	PAL2286-3	47	97	Bt	S	1226.35	999.68	1.44	0.00	0.33	0.00	0.33	
2287	PAL2287-1	0	17	Ap		317.10	268.74	1.14	0.00	1.61	0.00	1.61	
2287	PAL2287-2	17	53	Bt1		845.37	707.62	1.42	0.00	0.40	0.00	0.40	
2287	PAL2287-3	53	100	Bt2		1163.00	967.34	1.46	18.40	0.25	0.00	0.25	
2288	PAL2288-1	0	28	Ap	D	481.11	391.64	1.01	0.00	2.30	0.00	2.30	Ap horizon is hillslope sediment
2288	PAL2288-2	28	65	A	D	774.08	606.23	1.18	0.00	1.89	0.00	1.89	
2288	PAL2288-3	65	99	AB	D	727.21	551.20	1.17	0.00	1.00	0.00	1.00	
2289	PAL2289-1	0	20	Apk	E	391.53	324.40	1.17	0.00	0.82	0.20	1.02	Whole core has free carbonates
2289	PAL2289-2	20	45	BAk	E	575.15	482.34	1.39	0.00	0.08	0.03	0.11	
2289	PAL2289-3	45	98	Btk	E	1212.47	999.00	1.36	0.00	0.06	0.35	0.41	
2290	PAL2290-1	0	20	Ap	E	462.47	388.02	1.40	0.87	0.44	0.24	0.68	Calcareous throughout
2290	PAL2290-2	20	58	Btk1	E	875.11	734.96	1.39	1.01	0.06	0.26	0.32	
2290	PAL2290-3	58	97	Btk2	E	889.18	737.16	1.36	0.31	0.04	0.46	0.50	
2291	PAL2291-1	0	27	Ap		536.24	438.81	1.17	0.00	1.30	0.00	1.30	0 - 27 cm hillslope sediment
2291	PAL2291-2	27	57	A		625.71	505.41	1.22	0.00	1.67	0.00	1.67	
2291	PAL2291-3	57	81	AB		490.51	381.16	1.15	0.00	1.10	0.00	1.10	
2291	PAL2291-4	81	96	Bt		334.81	266.64	1.28	0.00	0.62	0.00	0.62	
2292	PAL2292-1	0	25	Ap	D	501.35	408.67	1.18	0.00	1.29	0.00	1.29	Ap horizon is hillslope sediment from higher in landscape
2292	PAL2292-2	25	71	A	D	960.41	761.99	1.20	0.00	1.46	0.00	1.46	
2292	PAL2292-3	71	95	BA	D	505.54	408.03	1.23	0.00	0.74	0.00	0.74	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2293	PAL2293-1	0	19	Ap		371.19	311.23	1.18	0.00	1.18	0.00	1.18	
2293	PAL2293-2	19	64	A		942.23	767.13	1.23	0.00	1.15	0.00	1.15	
2293	PAL2293-3	64	98	Bt		769.84	637.80	1.35	0.00	0.49	0.00	0.49	
2294	PAL2294-1	0	19	Ap	E	308.88	274.86	1.04	0.44	1.05	0.00	1.05	
2294	PAL2294-2	19	69	Btck	E	903.60	811.60	1.17	0.00	0.40	0.65	1.05	Effervesces
2294	PAL2294-3	69	98	Btk	E	558.37	505.09	1.26	0.00	0.26	0.56	0.82	
2295	PAL2295-1	0	30	A	S	566.45	477.06	1.15	0.00	1.24	0.00	1.24	
2295	PAL2295-2	30	45	BA	S	276.34	240.33	1.16	0.00	0.85	0.00	0.85	
2295	PAL2295-3	45	97	Bt	S	1009.00	879.09	1.22	0.00	0.56	0.00	0.56	
2296	PAL2296-1	0	21	Ap	E	392.23	328.65	1.13	0.00	1.23	0.00	1.23	
2296	PAL2296-2	21	45	BA	E	497.55	411.42	1.24	0.00	0.62	0.00	0.62	
2296	PAL2296-3	45	99	Btk	E	1166.86	950.86	1.27	0.00	0.24	0.66	0.90	Effervesces
2297	PAL2297-1	0	15	Ap	E	306.85	262.82	1.26	0.00	0.75	0.20	0.95	
2297	PAL2297-2	15	56	Btc	E	973.67	838.48	1.48	0.00	0.24	0.00	0.24	
2297	PAL2297-3	56	99	Bt	E	1081.00	915.57	1.54	0.00	0.12	0.05	0.17	
2298	PAL2298-1	0	46	A	D	838.29	685.83	1.08	0.00	1.39	0.00	1.39	
2298	PAL2298-2	46	65	AB	D	355.84	297.30	1.13	0.00	0.65	0.00	0.65	
2298	PAL2298-3	65	92	B	D	599.17	504.75	1.35	0.00	0.39	0.00	0.39	
2299	PAL2299-1	0	24	Ap	S	385.95	304.60	0.92	0.00	2.06	0.00	2.06	
2299	PAL2299-2	24	53	BA	S	592.40	486.79	1.21	0.00	0.59	0.00	0.59	
2299	PAL2299-3	53	91	Bt	S	866.03	721.38	1.37	0.00	0.22	0.00	0.22	
2300	PAL2300-1	0	21	Ap	E	364.10	324.80	1.12	0.00	0.56	0.31	0.87	
2300	PAL2300-2	21	64	Bk	E	924.99	757.39	1.27	0.00	0.20	1.31	1.51	Strong effervescence
2300	PAL2300-3	64	80	2Bk	E	391.08	332.47	1.50	0.00	0.10	0.20	0.30	
2301	PAL2301-1	0	19	Ap	E	319.03	276.55	1.05	0.00	0.86	0.29	1.15	
2301	PAL2301-2	19	49	Bk	E	605.95	498.21	1.20	0.00	0.23	1.41	1.64	Strong effervescence
2301	PAL2301-3	49	77	Btk	E	670.15	567.12	1.46	0.00	0.13	0.33	0.46	
2302	PAL2302-1	0	18	Ap	E	318.92	275.87	1.11	0.00	1.21	0.00	1.21	
2302	PAL2302-2	18	67	Bt1	E	932.46	827.82	1.22	0.00	0.36	0.00	0.36	
2302	PAL2302-3	67	97	Bt2	E	555.18	480.70	1.16	0.00	0.35	0.42	0.77	
2303	PAL2303-1	0	39	Ap	S	735.87	637.01	1.18	0.00	1.51	0.00	1.51	
2303	PAL2303-2	39	63	BA	S	446.35	391.15	1.18	0.00	0.42	0.00	0.42	
2303	PAL2303-3	63	95	Bt	S	654.94	571.96	1.29	0.00	0.25	0.00	0.25	
2304	PAL2304-1	0	23	Ap	D	460.42	394.81	1.24	0.00	1.30	0.00	1.30	
2304	PAL2304-2	23	71	A	D	1152.79	947.46	1.42	0.00	0.91	0.00	0.91	
2304	PAL2304-3	71	97	E	D	728.08	586.20	1.63	0.00	0.38	0.00	0.38	
2305	PAL2305-1	0	32	Ap	D	623.57	562.90	1.27	0.23	0.96	0.00	0.96	Surface is hillslope sediment
2305	PAL2305-2	32	50	2A	D	433.34	357.29	1.43	0.00	0.51	0.00	0.51	
2305	PAL2305-3	50	99	B	D	1188.22	941.31	1.39	0.00	0.16	0.00	0.16	E horizon may be ash as it overlies a buried A horizon
2306	PAL2306-1	0	46	A	D	997.31	839.20	1.32	0.17	1.47	0.00	1.47	
2306	PAL2306-2	46	69	BA	D	503.22	408.43	1.28	0.00	0.84	0.00	0.84	
2306	PAL2306-3	69	98	E	D	736.03	600.04	1.49	0.00	0.36	0.00	0.36	
2307	PAL2307-1	0	21	Ap	D	430.05	366.03	1.26	0.00	1.79	0.00	1.79	Ap horizon is hillslope sediment
2307	PAL2307-2	21	62	A	D	932.12	781.94	1.38	0.00	1.11	0.00	1.11	
2307	PAL2307-3	62	96	B	D	894.27	739.98	1.57	1.07	0.35	0.00	0.35	
2308	PAL2308-1	0	42	A	D	901.64	787.22	1.35	0.00	1.35	0.00	1.35	
2308	PAL2308-2	42	62	B	D	445.24	402.89	1.42	10.27	0.45	0.00	0.45	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2308	PAL2308-3	62	99	2Bt	D	960.12	782.47	1.53	0.45	0.28	0.00	0.28	
2309	PAL2309-1	0	24	Ap	D	493.73	455.09	1.37	0.00	1.04	0.00	1.04	Surface is hillslope sediment
2309	PAL2309-2	24	46	2A	D	408.89	374.46	1.23	0.00	0.93	0.00	0.93	
2309	PAL2309-3	46	99	2Bt	D	1306.06	1144.53	1.55	3.22	0.25	0.00	0.25	
2310	PAL2310-1	0	46	Ap	D	908.60	827.49	1.30	0.00	1.02	0.00	1.02	
2310	PAL2310-2	46	67	E	D	453.70	419.08	1.44	0.00	0.40	0.00	0.40	
2310	PAL2310-3	67	98	Bt	D	812.64	688.44	1.60	0.00	0.21	0.00	0.21	
2311	PAL2311-1	0	19	Ap	D	370.49	340.81	1.29	0.00	1.39	0.00	1.39	Surface is hillslope sediment from upslope B material
2311	PAL2311-2	19	69	2BA	D	963.38	856.79	1.24	0.09	1.25	0.00	1.25	
2311	PAL2311-3	69	98	3BA	D	677.49	593.48	1.48	0.00	0.46	0.00	0.46	
2312	PAL2312-1	0	31	Ap	D	593.97	537.81	1.25	0.00	1.27	0.00	1.27	Ap horizon is hillslope sediment
2312	PAL2312-2	31	51	A	D	367.54	320.65	1.16	0.00	1.25	0.00	1.25	
2312	PAL2312-3	51	100	B	D	1187.74	1015.02	1.50	0.00	0.38	0.00	0.38	
2313	PAL2313-1	0	32	Ap	S	638.48	538.69	1.22	0.00	1.01	0.00	1.01	
2313	PAL2313-2	32	61	BA	S	693.69	580.32	1.44	0.00	0.35	0.00	0.35	
2313	PAL2313-3	61	98	Bt	S	982.30	817.64	1.60	0.00	0.21	0.00	0.21	
2314	PAL2314-1	0	23	Ap	E	519.93	439.28	1.38	0.11	1.33	0.00	1.33	Clayey
2314	PAL2314-2	23	53	BA	E	727.22	602.41	1.45	0.00	0.30	0.00	0.30	
2314	PAL2314-3	53	91	Bt	E	1036.01	856.91	1.63	0.11	0.18	0.00	0.18	
2315	PAL2315-1	0	27	Ap	D	556.38	464.91	1.24	0.00	1.36	0.00	1.36	Ap horizon is hillslope sediment
2315	PAL2315-2	27	53	A	D	587.11	465.17	1.29	0.00	0.93	0.00	0.93	
2315	PAL2315-3	53	97	B	D	1103.38	898.59	1.47	0.00	0.33	0.00	0.33	
2316	PAL2316-1	0	28	Ap	S	611.24	499.98	1.29	0.00	1.26	0.00	1.26	
2316	PAL2316-2	28	52	BA	S	601.74	489.69	1.47	0.00	0.50	0.00	0.50	
2316	PAL2316-3	52	98	Bt	S	1222.44	1011.14	1.59	0.00	0.24	0.00	0.24	
2317	PAL2317-1	0	35	A	S	744.46	609.59	1.26	0.00	1.07	0.00	1.07	
2317	PAL2317-2	35	66	BA	S	780.63	644.55	1.50	0.00	0.36	0.00	0.36	
2317	PAL2317-3	66	97	Bt	S	884.69	732.56	1.71	0.00	0.19	0.00	0.19	
2318	PAL2318-1	0	41	A	D	849.08	721.00	1.27	0.84	1.89	0.00	1.89	
2318	PAL2318-2	41	59	BA	D	399.08	333.07	1.34	0.00	0.70	0.00	0.70	
2318	PAL2318-3	59	98	Bt	D	969.61	795.52	1.47	0.00	0.32	0.00	0.32	
2319	PAL2319-1	0	19	Ap		334.54	284.39	1.08	0.00	1.24	0.00	1.24	Krotovina in Bt3
2319	PAL2319-2	19	52	Bt1		790.17	661.18	1.45	0.00	0.40	0.00	0.40	
2319	PAL2319-3	52	98	Bt2		1215.73	987.93	1.55	0.00	0.21	0.00	0.21	
2320	PAL2320-1	0	37	A	S	806.21	669.88	1.31	0.00	0.93	0.00	0.93	No visible Ap horizon
2320	PAL2320-2	37	72	BA	S	836.66	688.60	1.42	0.00	0.30	0.00	0.30	
2320	PAL2320-3	72	100	Bt	S	728.33	598.12	1.54	0.00	0.21	0.00	0.21	
2321	PAL2321-1	0	13	BA		180.57	155.53	0.86	0.00	1.46	0.00	1.46	Hillslope sediment 0-13 cm
2321	PAL2321-2	13	32	A		413.66	348.21	1.32	0.00	1.19	0.00	1.19	
2321	PAL2321-3	32	63	BA2		736.17	611.07	1.42	0.00	0.50	0.00	0.50	
2321	PAL2321-4	63	99	Btc		962.22	797.40	1.60	0.12	0.25	0.00	0.25	
2322	PAL2322-1	0	23	Ap	E	348.53	300.34	0.94	0.00	1.13	0.00	1.13	Many krotovinas
2322	PAL2322-2	23	60	Bt1	E	774.53	648.19	1.26	0.00	0.44	0.00	0.44	
2322	PAL2322-3	60	98	Bt2	E	854.04	700.38	1.33	0.00	0.37	0.00	0.37	
2323	PAL2323-1	0	21	Ap	D	430.18	363.85	1.25	0.00	0.83	0.00	0.83	
2323	PAL2323-2	21	52	BA	D	659.88	548.92	1.28	0.00	0.30	0.02	0.32	
2323	PAL2323-3	52	96	2Btk	D	914.14	759.57	1.22	13.01	0.28	0.15	0.43	Effervesces

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2324	PAL2324-1	0	30	Ap	D	556.91	473.95	1.14	0.00	1.99	0.00	1.99	
2324	PAL2324-2	30	74	A	D	849.92	681.70	1.12	0.00	2.08	0.00	2.08	
2324	PAL2324-3	74	94	AB	D	389.22	308.01	1.11	0.00	1.53	0.00	1.53	
2325	PAL2325-1	0	29	Ap	D	553.09	441.50	1.10	0.00	2.08	0.00	2.08	Clayey
2325	PAL2325-2	29	53	A1	D	510.78	394.25	1.19	0.00	1.93	0.00	1.93	
2325	PAL2325-3	53	84	A2	D	745.32	535.00	1.25	0.00	1.41	0.00	1.41	
2326	PAL2326-1	0	28	Ap	D	441.94	346.23	0.89	0.00	2.63	0.00	2.63	
2326	PAL2326-2	28	55	AB	D	488.21	367.61	0.98	0.00	1.50	0.00	1.50	
2326	PAL2326-3	55	98	Bt	D	913.63	721.53	1.21	0.00	0.53	0.00	0.53	
2327	PAL2327-1	0	43	A	D	726.10	558.23	0.94	0.00	2.12	0.00	2.12	No Ap horizon
2327	PAL2327-2	43	69	BA	D	484.02	366.87	1.02	0.00	0.77	0.00	0.77	
2327	PAL2327-3	69	98	B	D	638.48	502.68	1.25	0.00	0.43	0.00	0.43	
2328	PAL2328-1	0	22	Ap	S	423.93	355.28	1.17	0.00	1.86	0.00	1.86	
2328	PAL2328-2	22	56	BA	S	750.70	625.00	1.33	0.00	0.54	0.00	0.54	
2328	PAL2328-3	56	97	Bt	S	979.61	810.91	1.43	0.00	0.21	0.00	0.21	
2329	PAL2329-1	0	23	Ap	E	462.87	385.87	1.21	0.00	1.58	0.00	1.58	
2329	PAL2329-2	23	50	BA	E	626.78	517.70	1.38	0.00	0.26	0.00	0.26	
2329	PAL2329-3	50	97	Bt	E	1144.59	935.04	1.44	0.00	0.15	0.00	0.15	
2330	PAL2330-1	0	21	Ap	E	452.18	378.25	1.30	0.00	1.43	0.00	1.43	Krotovinas
2330	PAL2330-2	21	46	BA	E	550.53	458.90	1.32	0.00	0.47	0.00	0.47	
2330	PAL2330-3	46	96	Bt	E	1227.88	1015.18	1.47	0.00	0.18	0.04	0.22	
2331	PAL2331-1	0	44	A	D	864.79	727.15	1.19	0.00	1.41	0.00	1.41	Krotovinas
2331	PAL2331-2	44	74	AB	D	639.81	529.92	1.27	0.00	0.75	0.00	0.75	
2331	PAL2331-3	74	100	Bt	D	639.92	532.52	1.48	0.00	0.28	0.00	0.28	
2332	PAL2332-1	0	34	Ap	S	759.41	629.62	1.34	0.00	1.14	0.00	1.14	
2332	PAL2332-2	34	60	BA	S	615.69	503.90	1.40	0.00	0.46	0.00	0.46	
2332	PAL2332-3	60	98	Bt	S	997.76	823.39	1.56	0.00	0.17	0.00	0.17	
2333	PAL2333-1	0	28	A	S	604.15	502.06	1.29	0.00	1.25	0.00	1.25	No visible Ap horizon
2333	PAL2333-2	28	52	BA	S	528.43	437.15	1.31	0.00	0.32	0.00	0.32	
2333	PAL2333-3	52	97	Bt	S	1096.78	896.11	1.44	0.00	0.14	0.00	0.14	
2334	PAL2334-1	0	33	A	S	641.43	514.87	1.13	0.00	2.09	0.00	2.09	No Ap horizon
2334	PAL2334-2	33	61	AB	S	598.11	486.41	1.25	0.00	0.93	0.00	0.93	
2334	PAL2334-3	61	97	Bt	S	896.74	726.15	1.46	0.00	0.29	0.00	0.29	
2335	PAL2335-1	0	21	Ap	E	382.52	330.84	1.14	0.00	1.06	0.00	1.06	
2335	PAL2335-2	21	53	AB	E	635.59	561.05	1.27	0.00	0.44	0.00	0.44	
2335	PAL2335-3	53	91	Bt	E	718.70	632.20	1.20	0.00	0.27	0.23	0.50	
2336	PAL2336-1	0	23	Ap	S	411.53	360.57	1.13	0.00	1.26	0.00	1.26	
2336	PAL2336-2	23	57	BA	S	660.63	590.14	1.25	0.00	0.46	0.00	0.46	
2336	PAL2336-3	57	95	Bt	S	830.55	737.00	1.40	0.00	0.19	0.00	0.19	
2337	PAL2337-1	0	36	Ap	D	525.09	461.51	0.93	0.00	1.83	0.00	1.83	
2337	PAL2337-2	36	56	A	D	381.98	332.60	1.20	0.00	0.91	0.00	0.91	
2337	PAL2337-3	56	97	BA	D	811.38	709.23	1.25	0.00	0.35	0.11	0.46	Effervesces
2338	PAL2338-1	0	21	Ap	D	338.67	290.52	1.00	0.00	1.64	0.00	1.64	
2338	PAL2338-2	21	51	AB	D	507.47	450.80	1.08	0.00	0.97	0.00	0.97	
2338	PAL2338-3	51	91	Bt	D	774.04	685.04	1.24	0.00	0.58	0.00	0.58	Buried A horizon at base of core
2339	PAL2339-1	0	36	A1	D	728.17	564.04	1.13	0.00	2.25	0.00	2.25	
2339	PAL2339-2	36	65	A2	D	580.74	424.96	1.06	0.00	1.81	0.00	1.81	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2339	PAL2339-3	65	97	AB	D	742.37	537.16	1.21	0.00	1.11	0.00	1.11	
2340	PAL2340-1	0	54	A	D	904.51	701.62	0.94	0.00	2.39	0.00	2.39	No Ap horizon
2340	PAL2340-2	54	85	BA	D	606.49	488.15	1.14	0.00	0.76	0.00	0.76	
2340	PAL2340-3	85	97	Bt	D	288.62	234.70	1.41	0.00	0.30	0.00	0.30	
2341	PAL2341-1	0	41	Ap	D	732.08	618.04	1.09	0.00	2.39	0.00	2.39	
2341	PAL2341-2	41	76	AB	D	641.40	525.42	1.08	0.00	1.13	0.00	1.13	
2341	PAL2341-3	76	98	Bt	D	461.05	385.09	1.26	0.00	0.51	0.00	0.51	
2342	PAL2342-1	0	32	A	S	646.07	564.00	1.27	0.00	1.61	0.00	1.61	
2342	PAL2342-2	32	83	Bt1	S	1081.95	913.00	1.29	0.00	0.42	0.00	0.42	
2342	PAL2342-3	83	97	2Bt	S	321.63	271.25	1.40	0.00	0.23	0.00	0.23	
2344	PAL2344-1	0	39	A	D	752.24	649.43	1.20	0.00	0.73	0.00	0.73	Ap is hillslope sediment - krotovinas
2344	PAL2344-2	39	71	BA	D	684.52	582.13	1.31	0.00	0.35	0.00	0.35	
2344	PAL2344-3	71	98	Bt	D	614.05	525.59	1.41	0.00	0.23	0.00	0.23	
2345	PAL2345-1	0	44	AB	E	935.98	809.99	1.33	0.00	0.66	0.00	0.66	Krotovinas
2345	PAL2345-2	44	64	BA	E	453.50	383.50	1.38	0.00	0.17	0.00	0.17	
2345	PAL2345-3	64	98	Bt	E	752.33	633.39	1.34	0.00	0.14	0.04	0.18	
2346	PAL2346-1	0	31	Ap	S	586.62	500.54	1.17	0.00	1.77	0.00	1.77	
2346	PAL2346-2	31	53	BA	S	479.83	414.33	1.36	0.00	0.66	0.00	0.66	
2346	PAL2346-3	53	97	Bt	S	1067.05	882.80	1.45	0.00	0.31	0.15	0.46	
2347	PAL2347-1	0	23	Ap	E	498.95	423.34	1.33	0.00	1.54	0.00	1.54	Clayey
2347	PAL2347-2	23	61	BA	E	870.14	718.76	1.37	0.00	0.38	0.00	0.38	
2347	PAL2347-3	61	97	Bt	E	934.35	757.75	1.52	0.00	0.14	0.00	0.14	
2348	PAL2348-1	0	35	Ap	S	442.58	385.65	0.72	36.59	1.90	0.00	1.90	
2348	PAL2348-2	35	66	2Bt1	S	738.94	678.21	0.95	271.82	0.19	0.00	0.19	Very rocky Bt horizon - basalt fragments
2348	PAL2348-3	66	84	2Bt2	S	366.90	321.51	1.29	0.00	0.07	0.01	0.08	
2349	PAL2349-1	0	38	A	D	451.66	348.54	0.66	2.79	3.75	0.00	3.75	Surface is hillslope sediment
2349	PAL2349-2	38	55	BA	D	277.38	215.29	0.91	0.26	1.21	0.00	1.21	
2349	PAL2349-3	55	74	2A	D	292.38	232.88	0.88	2.32	0.73	0.00	0.73	
2350	PAL2350-1	0	42	A	D	599.59	494.41	0.85	1.37	2.48	0.00	2.48	
2350	PAL2350-2	42	57	BA	D	208.19	182.30	0.88	0.42	0.52	0.00	0.52	
2350	PAL2350-3	57	76	Bt	D	353.45	312.77	1.19	0.52	0.40	0.00	0.40	Bt horizon appears to be small in diameter
2351	PAL2351-1	0	26	Ap	D	387.46	357.14	0.99	0.30	1.83	0.00	1.83	
2351	PAL2351-2	26	52	A	D	421.25	376.12	1.04	0.20	1.19	0.00	1.19	
2351	PAL2351-3	52	70	B	D	373.90	336.68	1.35	0.03	0.61	0.00	0.61	
2352	PAL2352-1	0	38	A	S	635.97	569.76	1.08	0.28	1.30	0.00	1.30	
2352	PAL2352-2	38	69	BA	S	597.76	543.87	1.27	0.26	0.51	0.00	0.51	
2352	PAL2352-3	69	93	Bt	S	495.43	453.69	1.36	0.70	0.34	0.00	0.34	
2353	PAL2353-1	0	31	Ap	D	426.78	363.48	0.85	0.56	1.61	0.00	1.61	
2353	PAL2353-2	31	65	AB	D	565.37	486.65	1.03	0.39	0.74	0.00	0.74	
2353	PAL2353-3	65	97	Bt	D	649.35	571.05	1.28	5.09	0.30	0.00	0.30	
2354	PAL2354-1	0	42	A	D	570.44	461.72	0.79	0.30	2.12	0.00	2.12	
2354	PAL2354-2	42	62	AB	D	347.11	288.06	1.04	0.21	0.83	0.00	0.83	
2354	PAL2354-3	62	94	Bt	D	682.93	595.47	1.33	4.54	0.35	0.00	0.35	
2355	PAL2355-1	0	29	Ap	D	422.44	375.13	0.93	0.63	1.70	0.00	1.70	
2355	PAL2355-2	29	51	AB	D	432.74	390.10	1.28	0.00	0.41	0.00	0.41	
2355	PAL2355-3	51	72	Btc	D	456.85	415.76	1.43	0.17	0.22	0.00	0.22	
2356	PAL2356-1	0	33	Ap	D	561.37	513.19	1.12	0.94	1.57	0.00	1.57	

pedon id	SCL Lab #	Core Top (cm)	Core Bottom (cm)	Horizon	Stability / Erodability	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm^3)	Small Coarse Fragments (g)	% Organic C	% Inorganic C	% Total C	Notes
2356	PAL2356-2	33	71	BA	D	694.74	631.51	1.20	0.78	0.88	0.00	0.88	
2356	PAL2356-3	71	90	Bt	D	371.32	343.97	1.30	1.78	0.44	0.00	0.44	
2357	PAL2357-1	0	36	Ap	D	533.14	479.28	0.96	0.30	1.37	0.00	1.37	Core is stretched
2357	PAL2357-2	36	64	BA	D	460.63	406.46	1.05	0.00	0.91	0.00	0.91	
2357	PAL2357-3	64	91	Bt	D	516.85	441.58	1.18	0.00	0.56	0.00	0.56	
2358	PAL2358-1	0	40	Ap	D	601.60	542.74	0.98	0.50	1.88	0.00	1.88	
2358	PAL2358-2	40	66	2A1	D	463.62	380.89	1.06	0.00	1.16	0.00	1.16	
2358	PAL2358-3	66	90	2A2	D	485.93	388.93	1.17	0.00	0.60	0.00	0.60	
2359	PAL2359-1	0	23	Ap	D	323.82	291.25	0.91	0.00	1.18	0.00	1.18	
2359	PAL2359-2	23	73	B	D	944.52	830.28	1.20	0.00	0.36	0.00	0.36	
2359	PAL2359-3	73	97	2A	D	528.09	448.87	1.35	0.00	0.32	0.00	0.32	
2360	PAL2360-1	0	33	Ap1	D	484.72	445.44	0.97	0.00	2.06	0.00	2.06	
2360	PAL2360-2	33	61	Ap2	D	401.09	358.47	0.92	0.00	1.50	0.00	1.50	
2360	PAL2360-3	61	84	A	D	382.54	329.88	1.04	0.00	0.94	0.00	0.94	
2361	PAL2361-1	0	52	Ap	D	778.55	700.77	0.97	0.00	1.33	0.00	1.33	Core is "stretched" - surface 52 cm is hillslope sediment - clayey
2361	PAL2361-2	52	71	BA	D	378.11	325.44	1.24	0.00	0.40	0.00	0.40	
2361	PAL2361-3	71	95	AB	D	501.37	422.22	1.27	0.00	0.33	0.00	0.33	
2362	PAL2362-1	0	31	Ap	D	485.53	431.73	1.00	0.39	1.28	0.00	1.28	
2362	PAL2362-2	31	61	AB	D	543.38	457.47	1.10	0.00	0.78	0.00	0.78	
2362	PAL2362-3	61	95	Bt	D	744.08	612.91	1.30	0.00	0.26	0.00	0.26	

Applied Ecological Services, Inc. (AES)
Semi-Annual Progress Report No. 4: January 1 – June 30th, 2013
USDA-NRCS CIG-GHG Project No. 69-3A75-11-131
September 17, 2013

PROJECT DESCRIPTION / ABSTRACT

Applied Ecological Services, Inc. (AES), in partnership with The Earth Partners, LP (TEP), and a consortium of secondary partners (the AES/TEP Team) seek to develop a large-scale agricultural carbon project in partnership with Shepherd's Grain members and surrounding farmers in the loess hills of the Palouse and Columbia Plateau region. Intensive farming across the region has resulted in the near extinction of the native grasslands, and the exhaustion of the soil and hydrological resources of the region. The introduction and widespread application of sustainable, low-carbon farming practices have the potential to restore the fertility and ensure the longevity of one of the United States' most important breadbaskets. Demonstrating the value to landowners of increased soil carbon stemming from these improved agricultural practices is a critical component in facilitating the large-scale adoption of such practices. To this end, this project seeks to provide a roadmap for developing large-scale, high-quality, and low-cost soil carbon transactions.

Building off literature reviews and preliminary sampling completed in 2009, we propose to further develop and extrapolate these models at a larger, landscape scale across the entire Columbia Plateau eco-region. Utilizing TEP's Soil Carbon Quantification Methodology, we seek to measure, monitor, validate, and monetize carbon credits stemming from low carbon agricultural practices such as no-till, direct seeding, crop rotation, and improved soil management. We believe that this project demonstrates both the importance of large-scale low carbon farming practices to Greenhouse Gas reduction policies and the role of quantitative soil carbon methodologies in creating compliance-grade offset credits. It will also provide a roadmap for aggregating landowners over large areas at low cost. We seek to demonstrate a model for marketing and monetizing the resulting carbon credits. This will be one of the largest land-based carbon projects to date.

We seek to achieve the following outcomes in this project:

- **Demonstrate the model at scale.** Our proposed project is broken into two phases: In Phase 1, we intend to develop a low-carbon agricultural partnership with landowners on 100,000 acres of Shepherd's Grain land. In Phase 2, we intend to partner with landowners on over 300,000 acres across the Palouse and larger Columbia Plateau eco-region. This can be expanded at a much larger scale because the project can build off of the analytic and technical work we will have done (GIS mapping, stratification, soil sampling, model projections, etc.).
- **Demonstrate a low-cost aggregation model**. Assembling landowners over large acreages at a relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. Through our planned work with landowners on 300,000 acres, the AES/TEP team will develop, test, and refine a low-cost aggregation model. To this end, the AES/TEP team is building on significant existing experience in aggregating landowners, developing standard partnership structures, and streamlining landowner interactions and engagement.
- **Showcase a successful land-based carbon transaction.** While agricultural carbon credits cannot currently be monetized in the marketplace, this project seeks to ensure that credits derived from this project will be accepted by the CA Air Resources Board (ARB) under AB-32 or other emerging compliance markets, as well as voluntary markets like VCS and ACR. To this end, we have developed a unique partnership of farmers, project developers, carbon investors, scientists, and government.
- **Develop data, maps and templates that will inform policy and support further research.** We will utilize GIS landform and geomorphic modeling and mapping to design, evaluate, and implement a regional, on-the-ground baseline analysis of soil carbon levels across the Palouse and Columbia Plateau eco-region. The resulting data and maps will represent a type of integrated information that is lacking in the region, which will be useful for government agencies, scientists, universities, and other researchers.

FOURTH SEMI-ANNUAL PROGRESS REPORT

1. USDA-NRCS CIG-GHG Project Number and Contract Period

69-3A75-11-131 – August 1, 2011 to July 31, 2014

2. Project Title

Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region

Project Director / Principal Investigator

Steven I. Apfelbaum, Chairman of the Board/Principal Ecologist, Applied Ecological Services, Inc.

3. Date of Report / Period Covered

September 17, 2013 for Report No. 4: January 1 – June 30, 2013

4. Executive Summary

During the first half of 2013, the Project Team focused primarily on the following tasks:

- Task 1 – Business Origination with Shepherd's Grain – The team continued developing relationships with Shepherd's Grain producers and continued the enrollment process with producers.
- Task 2 – Mapping, Screening and Stratification of the Palouse – No major activities were completed under this task. Additional data necessary for the statistical analysis was generated and provided to the team statisticians on an as-needed basis.
- Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region – No additional activities were completed under this task.
- Task 4 – Analysis and Baseline Development – This was the major activity completed during the report period. The project team worked closely with the team statisticians and technical review team to analyze the sampling dataset from the cultivated fields to develop the baseline soil carbon levels and construct a model for soil carbon accruals in no-till field in the region.
- Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers – The early draft PDD outline was discussed extensively amongst the project team to determine if the PDD remained the most appropriate path forward in the marketplace for the project.
- Task 6 – Aggregration and Farmer Engagement beyond Shepherd's Grain and Surrounding Members – Farmer engagement beyond Shepherd's Grain was focused on a conference presentation in Spokane, WA and internal strategy discussions amongst the project team.
- Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members – No major activities were completed under this task.
- Task 8 – Reporting and Knowledge Dissemination – Communication with NRCS administrative and technical contacts occurred on an as-needed basis during this reporting period. Attendance at the C-AGG meeting in Sacramento, CA occurred during this reporting period. Outreach and presentations at other regional conferences occurred during this reporting period.

5. Proposed Changes requiring Prior Approval

In accordance with the Prior Approval Requirements outlined in Section IV of CIG Contract #69-3A75-11-131, the project team proposes the following modification:

- Proposed Modifications and Justification for Request – Due to several issues documented below, Applied Ecological Services proposes to close the GHG-CIG (grant), effective December 31, 2013 unless it is able to secure additional financial cash match prior to that date. We propose that the current semi-annual report serve as a final report for the project and the activities completed before June 30, 2013 and documented in this report, and the previous semi-annual reports, serve as the body of work completed under this CIG. The proposed modifications are necessary due to a number of issues as described in the sections below, primarily stemming from the project's cash match partner requesting release and the unlikelihood of securing an alternate cash match partner due to market concerns.

    - Cash Match – AES received a letter dated January 23, 2013 from EKO Asset Management Partners (EKO), the financial investor/cash match partner on our CIG, requesting that AES release them from all future commitments on the project. Discussions and negotiations between AES, TEP and EKO have continued throughout the reporting period, however, it does not appear possible to reach an agreement allowing for continued engagement of EKO in the project. EKO has requested to be completely released from all obligations associated with the project. The correspondence letters are included in ***Appendix C: Letters from EKO Asset Management Partners Requesting Release from Cash Match Obligations***.

      After an informal discussion with USDA-NRCS program staff in late-Jan/early-Feb, a group teleconference was organized and held on February 15, 2013 with AES, TEP and NRCS representatives from Portland, OR (Adam Chambers and Steve Campbell) and Washington, DC (Marlen Eve and Carolyn Olson) to discuss the situation further and explore the options available to the project team. It was agreed that the preference by all parties was to see the project continue, and the project team has worked since that time to obtain new money (e.g. alternative investors or other creative project options) with no success.

      Without the cash match ($300,000) pledged for the project, no further work on the business development, deal packaging and outreach tasks of the project can be completed. As documented in the attached SF-425 for Quarter 8 (April 1 – June 30, 2013), all grant funds ($550,000) have been expended and in-kind funds ($256,034) in excess of those committed for the project ($250,000) have been provided.

    - Marketplace Concerns – There are a number of issues that the project is facing that affect the likelihood that a carbon deal can be completed as a part of this project, some of which have transpired or become much more of a concern since the project team was awarded the grant in 2011. These issues are no longer obstacles for the project, but rather have become barriers to successful completion of a carbon deal. These include: lack of carbon market, requirements of a Project Design Document (PDD), and the voluntary signup of participants.
        - Lack of Carbon Market – With a largely non-existent carbon market in the US and around the world, it appears unlikely that the project could attract an investor or generate carbon credits with value capable of covering the costs associated with their certification. Though the California Air Resources Board (C-ARB) is currently formalizing the rules for their carbon program, it appears unlikely that agricultural projects outside of California would qualify in the foreseeable future. This will be discussed further under Task 5.

    - Project Design Document – Due to the lack of a carbon market, development of a PDD, as originally proposed for the project, would be a hollow exercise of limited value. Additionally, it appears highly unlikely that a PDD could be developed facing the barriers of eligibility, additionality, and permanence that have become apparent, as further described in the Task 5 section below.
    - Voluntary Signup – Participation in a carbon program requires voluntary participation from both producers and landowners, where leases are involved. Both parties must be in agreement with, and committed long-term to, the goals of the program being developed. When the focus is on soil carbon accrual, this commitment may be up to 30 years to ensure "permanence" of the soil carbon resource. Throughout the US, most agricultural communities are in transition as the current generation of farmers and landowners are retiring in large numbers, their children are leaving the farm, and the land is in flux. The Palouse region is no exception. The producers who have enrolled in the program initially through Shepherd's Grain both own and lease the land they farm. Many of the leases are short-term and landowners are unwilling to commit to long-term to leases, much less to practices occurring in these fields for 30 years. Often, the fields they lease are owned by several family members (e.g. family trusts) who live far from the community and have more interest in the revenue than long-term stewardship of the soil resource. These land tenure issues are complex and create a situation that is beyond our control in recruitment for the soil carbon program.

  - Technical Issues – The technical phases of work on this project (GIS stratification, soil sampling and statistical analysis) were front-loaded and intended to be completed during the first 18-24 months by the project team. These tasks were completed successfully, though the budget required for some of these was higher than anticipated. Due to the vast size of the landscape where the work occurred (30 million acres) and the distance between participating producers, a higher cost per soil core or sample was incurred. As a result, the total number of samples collected (~750) was less than the original 1,500 proposed. However, the methods used to collect these soil cores were modified to allow for more efficient collection with a hydraulic soil probe on a John Deere Gator. A single 1m deep soil core was collected very efficiently, an improvement over the original method that proposed to collect several samples for carbon analysis and dig a small pit for collection of samples for bulk density analysis.

Many of the issues currently being faced by the Palouse Soil Carbon CIG are not unique to the suite of projects funded in the current round of GHG-CIGs. Through the ongoing Coalition on Agricultural Greenhouse Gases (C-AGG) meetings held three times / year, grant recipients have had the opportunity to remain updated on other projects status and share their challenges and successes. In August, C-AGG submitted a detailed letter documenting the successes and challenges of the GHG-CIG projects collectively and included several recommendations for USDA to consider to ensure these and future projects are successful. The C-AGG letter is provided in ***Appendix H: USDA GHG CIG Projects: C-AGG Recommendations and Feedback to USDA***.

We seek additional guidance from USDA-NRCS Conservation Innovation Grant program staff to advise whether these modifications are acceptable and in compliance with the contract terms. With significant effort expended during the first half of 2013 to find an alternate financial investor and the subsequent disappearance of any carbon marketplace, we believe our only option is to seek guidance on any additional procedures beyond this report that may be necessary to close the grant. As stated above, we will continue to seek a cash match partner through the end of the calendar year, however, we are seeking guidance now on next steps if we are not able to secure a replacement partner.

6. Accomplishments

Task 1 – Business Origination with Shepherd's Grain

TEP and AES continued to build on the relationships developed with Shepherd's Grain producers and neighboring producers. AES worked closely with the Perfect Blend, a biotic fertilizer company based west of the Palouse region in Othello, WA, to secure several loads of biotic fertilizer that could be used for yield trials on Shepherd's Grain fields. In addition, a load was delivered to Dr. David Huggins at Washington State University's Cook Farm research fields near Pullman to analyze the nitrous oxide emissions associated with this fertilizer product as compared to conventional anhydrous ammonia fertilizers.

TEP built on its relationship with the Pacific Northwest Direct Seeding Association (PNDSA), one of the largest producer groups in the Palouse region of which many Shepherd's Grain members are a part, and gave a presentation at their annual conference on the CIG soil carbon project. During this visit to the region, TEP met with several Shepherd's Grain farmers to provide an update on the status of the project. The presentation slides are provided in ***Appendix D: Pacific Northwest Direct Seed Association Presentation Slides (February 2013)***.

Task 2 – Mapping, Screening and Stratification of the Palouse

Data from the stratification process characterizing each sample point was provided to the statisticians initially for use in the statistical analysis and modeling process. The primary sample point attributes analyzed for fit in the model development phase were: slope position, aspect, precipitation, curvature, and years in no-till. As the project team delved deeper into the statistical analysis process with the team statisticians, additional data was queried from the GIS database for more precise analysis. Where available, continuous variables were utilized in the analysis process, rather than those that represented a range of values, for more precise analysis.

No other mapping or stratification activities were completed during this project period.

Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region

AES worked closely with the University of Missouri Soil Characterization Lab and project statisticians to QA/QC the laboratory analysis data and sort out several soil cores with duplicate IDs in the dataset.

No other sampling or analysis activities were completed during this project period.

Task 4 – Analysis and Baseline Development

Kevin Little, Ph.D. and Lynda Finn, M.S. of Informing Ecological Design (IED) provided statistical services through a subcontract agreement with Applied Ecological Services. AES scientists wished to develop a landscape scale model for soil carbon based on physical characteristics and years of no-till management. The expectation was that increasing years of no-till management would be associated with increased amounts of soil carbon.

AES scientists worked closely with October 2011 – March 2012 to design a sampling approach that would achieve the AES aims. The study looked across 100,000 acres in the Palouse Region, with sample cores extracted in the spring and summer of 2012 and laboratory analysis completed during summer and fall 2012.

During winter and spring 2013, IED worked with AES to examine the laboratory results and develop a landscape scale model for soil carbon based on physical characteristics and years of no-till management.

Ultimately, we wanted to show evidence that increasing the number of no-till years caused an increase in soil carbon accrual. The design and analysis focused on a related but different problem: is an increase in no-till years associated with an increase in soil carbon, when we look at a set of cores sampled in one year? In other words, we are conducting a cross-sectional study (with respect to years of no-till farming) to give us insight into a longitudinal problem, the effect of increasing no-till years on given locations.

The statisticians derived a linear model that provides an estimate of soil carbon as a function of years of no-till management. The point estimate is 0.135 kg/m2/year over the range of 0 to 20 years, with an approximate 95% confidence interval: (0.044, 0.225). This model applies to areas within the Palouse roughly above median 30-year precipitation levels and above the first quartile of a slope position parameter. See ***Appendix F: Map Showing No-till Zone of Interest***. We also analyzed an extensive set of duplicate cores that yields an estimate of core to core variation that may be used for TEP method planning.

The final statistical report summarizes the statistical analysis of soil carbon and is included in ***Appendix E: Informing Ecological Design Soil Carbon Final Report***.

Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers

Despite the positive discussions between TEP and numerous interested parties (e.g. The Carbon Neutral Company, British Gas, and The Climate Trust), the market for carbon has weakened globally over the last year—in particular the voluntary market. Overarching marketplace concerns affect the likelihood that a carbon deal can be completed as a part of this project, some of which have transpired or become much more of a concern since the project team was awarded the grant in 2011. These issues are no longer obstacles for the project, but rather have become barriers to successful completion of a carbon deal. These include: 1) lack of carbon market, 2) requirements of a Project Design Document (PDD), and 3) voluntary signup of participants.

1. Lack of Carbon Market – With a largely non-existent carbon market in the US and around the world, it appears unlikely that the project could attract an investor or generate carbon credits with value capable of covering the costs associated with their certification. Though the California Air Resources Board (C-ARB) is currently formalizing the rules for their carbon program, it appears unlikely that agricultural projects outside of California would qualify in the foreseeable future.

2. Project Design Document – Due to the lack of a carbon market, development of a PDD, as originally proposed for the project, would be a hollow exercise of limited value. Additionally, it appears highly unlikely that a PDD could be developed facing the barriers of eligibility, additionality, and permanence that have become apparent over the last year of meeting with stakeholders and considering the development of a PDD.

3. Voluntary Signup – Participation in a carbon program requires voluntary participation from both producers and landowners, where leases are involved. Both parties must be in agreement with, and committed long-term to, the goals of the program being developed. When the focus is on soil carbon accrual, this commitment may be up to 30 years to ensure "permanence" of the soil carbon resource.

   Throughout the US, most agricultural communities are in transition as the current generation of farmers and landowners are retiring in large numbers, their children are leaving the farm, and the land is in flux. The Palouse region is no exception. The producers who have enrolled in the program initially through Shepherd's Grain both own and lease the land they farm. Many of the leases are short-term and landowners are unwilling to commit to long-term to leases, much less to practices occurring in these fields for 30 years. Often, the fields they lease are owned by several family members (e.g. family trusts) who live far from the community and have more interest in the revenue than long-term stewardship of the soil resource. These land tenure issues are complex and create a situation that is beyond our control in recruitment for the soil carbon program.

Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members

At the end of 2012, the project team had approximately 100,000-acres of Shepherd's Grain producers committed and/or under contract of the Producer Enrollment Agreement. To build on this success, TEP continued to strengthen its relationship with the Pacific Northwest Direct Seeding Association (PNDSA), one of the largest producer groups in the Palouse region of which many Shepherd's Grain members are a part, and gave a presentation at their annual conference on the CIG soil carbon project. During this visit to the region, TEP met with several Shepherd's Grain farmers to provide an update on the status of the project. The presentation slides are provided in ***Appendix D: Pacific Northwest Direct Seed Association Presentation Slides***.

During early 2013, AES staff worked closely with USDA-NRCS field staff focused on the rollout of the EQIP funding being made available to support the CIG-GHG projects. Over the course of several weeks, Tom Hunt and Ry Thompson participated in numerous conference calls with Steve Campbell, Adam Chambers and Todd Peplin to craft the EQIP opportunity for the Columbia Plateau region of Oregon, Washington and Idaho to be symbiotic with the CIG project, where possible. Ry Thompson joined a conference call with NRCS field staff from Oregon, Washington and Idaho to discuss the national bulletin, the timelines for release of press materials and eligibility criteria, and the screening and ranking tools developed by AES and NRCS staff to support the CIG project. In the end, it was determined that the NRCS could not directly encourage EQIP eligible farmers to participate in the GHG-CIGs. As a result, minimal interest in the project resulted from the large pool of EQIP funding made available in the region for no-till and other soil carbon friendly management practices.

Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

Further analysis and discussions were completed regarding a potential strategy get Palouse carbon credits accepted into the California market through the California Air Resources Board. While no such protocols currently exist for California, TEP has discussed with VCS and American Carbon Registry the possibility of turning the Palouse program into an "eco-regional" protocol that could be accepted into California. No detailed discussions regarding this potential activity were completed during this project period, due to the concerns with losing the financial investor on the project.

Task 8 – Reporting and Knowledge Dissemination

Ongoing communications with USDA administrative and technical contacts continue on an as-needed basis to ensure all administrative and budget questions and issues are addressed for the CIG grant. On February 15, 2013, the project team had a conference call with representatives from the USDA-NRCS offices in Portland, OR (Adam Chambers and Steve Campbell) and Washington, DC (Carolyn Olson and Marlin Eve) to detail the technical accomplishments of the project to date and discuss the financial challenges we face with the loss of our financial investor.

Ry Thompson attended a pre-conference dinner attended by CIG-GHG grant recipients at the Coalition on Agricultural Greenhouse Gases (C-AGG) meeting in Sacramento, CA in early March, 2013, and attended the C-AGG meeting that followed.

Project team members developed a Lessons Learned document to share what the project team has learned from the first 2 years of the CIG in the areas of methodology development and implementation, stratification, on-the-ground sampling, laboratory and statistical analysis and deal packaging. The document was prepared for an international audience, but was shared domestically at a supply chain conference sponsored by Sustainable Food Lab in April 2013 and with the USDA-NRCS for internal GHG-CIG discussions in May 2013. The final 25 page document is included in ***Appendix G: Report on Lessons Learned from Soil Carbon Studies of the Palouse Region***.

7. Next Steps

As described in 5. Proposed Changes requiring Prior Approval above, the project team is facing serious challenges in attracting an alternate cash investor to provide the cash match required to complete the project. The project team proposes to continue searching for an investor through the end of 2013.

If an investor is not secured, the project team will have no other option but to close the GHG-CIG (grant), effective December 31, 2013. In that event, we would propose to provide a brief final report that builds on, and complements, the previous semi-annual reports. In sum, we proposed that these would serve as the body of work completed under this CIG.

8. Cost Status

See ***Appendix A – SF 425 Federal Financial Reports*** for the financials for this period.

9. Schedule/Milestone Status

Through the fourth bi-annual report period, the project generally progressed according to schedule. The baseline was developed for the soil carbon project. No further effort was put into the PDD, as it was determined that it was not the most appropriate tool for this project and there is no carbon market for delivery of the existing soil carbon resource.

As described in 5. Proposed Changes requiring Prior Approval above, the project team is facing serious challenges in attracting an alternate cash investor to provide the cash match required to complete the project. The project team proposes to continue searching for an investor through the end of 2013. Until additional funding is secured, no major activities will be completed on the project and the milestones will not be achieved as originally proposed. A project schedule with milestones as completed for the project is presented in ***Appendix B – Updated Project Schedule with Milestones***. Any areas beyond Q4 of Year 2 are not proposed for completion at this time.

APPENDICES

Appendix A – SF425 Federal Financial Reports for January – June 2013
Appendix B – Updated Project Schedule with Milestones
Appendix C – Letters from EKO Asset Management Partners Requesting Release from Cash Match Obligations
Appendix D – Pacific Northwest Direct Seed Association Presentation Slides – February 2013
Appendix E – Informing Ecological Design (Project Statistical Consultant) Soil Carbon Final Report
Appendix F – Map Showing No-till Zone of Interest
Appendix G – Report on Lessons Learned from Soil Carbon Studies of the Palouse Region
Appendix H – USDA GHG CIG Projects: C-AGG Recommendations and Feedback to USDA

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page of pages
USDA-NRCS, Washington DC	**69-3A75-11-131**	1 of 1

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	**39-1611274**		☒ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☒ Cash ☐ Accrual

8. Project/Grant Period (Month, Day, Year)		9. Reporting Period End Date (Month, Day, Year)
From: **January 1, 2013**	To: **March 31, 2013**	**March 31, 2013**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0**
b. Cash Disbursements	**743,079.45**
c. Cash on Hand (line a minus b)	**0**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000**
e. Federal share of expenditures	**535,827.31**
f. Federal share of unliquidated obligations	**0**
g. Total Federal share (sum of lines e and f)	**535,827.31**
h. Unobligated balance of Federal funds (line d minus g)	**14,172.69**
Recipient Share:	
i. Total recipient share required	**550,000**
j. Recipient share of expenditures	**207,252.14**
k. Remaining recipient share to be provided (line i minus j)	**342,747.86**
Program Income:	
l. Total Federal program income earned	**0**
m. Program income expended in accordance with the deduction alternative	**0**
n. Program income expended in accordance with the addition alternative	**0**
o. Unexpended program income (line l minus line m or line n)	**0**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation: AES Note: No invoices generated between 1/31/13 and 5/7/13 to accurately reflect Q1 of 2013 numbers. Therefore, the above numbers also reflect April 2013 activities.

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number, and extension)
Ry Thompson, Ecologist/Project Manager **Applied Ecological Services, Inc.**	**(608) 897-8641 ext. 57**
	d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **4/30/13 (through 7th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted **USDA-NRCS, Washington DC**	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment) **69-3A75-11-131**	Page 1 of 1 pages

4a. DUNS Number **614663276**	4b. EIN **39-1611274**	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type ☒ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	7. Basis of Accounting ☒ Cash ☐ Accrual

8. Project/Grant Period (Month, Day, Year) From: **April 1, 2013**	To: **June 30, 2013**	9. Reporting Period End Date (Month, Day, Year) **June 30, 2013**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0**
b. Cash Disbursements	**806,034.45**
c. Cash on Hand (line a minus b)	**0**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000**
e. Federal share of expenditures	**550,000.00**
f. Federal share of unliquidated obligations	**0**
g. Total Federal share (sum of lines e and f)	**550,000.00**
h. Unobligated balance of Federal funds (line d minus g)	**0.00**
Recipient Share:	
i. Total recipient share required	**550,000**
j. Recipient share of expenditures	**256,034.45**
k. Remaining recipient share to be provided (line i minus j)	**293,965.55**
Program Income:	
l. Total Federal program income earned	**0**
m. Program income expended in accordance with the deduction alternative	**0**
n. Program income expended in accordance with the addition alternative	**0**
o. Unexpended program income (line l minus line m or line n)	**0**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official **Ry Thompson, Ecologist/Project Manager** **Applied Ecological Services, Inc.**	c. Telephone (Area code, number, and extension) **(608) 897-8641 ext. 57**
	d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **7/31/13 (through 8th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

Updated Project Action Plan and Timeline

	Year 1				Year 2				Year 3				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
	Aug 15 - Sep 30, 2011	Sep 1 - Dec 31, 2011	Jan 1 - Mar 31, 2012	Apr 1 - Jun 30, 2012	Jul 1 - Sep 30, 2012	Oct 1 - Dec 31, 2012	Jan 1 - Mar 31, 2013	Apr 1 - Jun 30, 2013	Jul 1 - Sep 30, 2013	Oct 1 - Dec 31, 2013	Jan 1 - Mar 31, 2014	Apr 1 - Jun 30, 2014	Jul 1 - Jul 31, 2014
Project organization and set-up	■												
Introductory meetings		■											
Partnership development with Shepherd's Grain (SG) and surrounding landowners		■	■										
Partnership agreement finalized with farmers				◆									
Development and dissemination of educational materials		■	■	■	■								
Development of live farm field activity web site		■	■										
Mapping, screening, and stratification of the Palouse		■	■										
Mapping and stratification completed			◆										
Preparation for sampling		■	■										
Sampling across Palouse region				■	■								
Laboratory analysis of samples			■		■								
Statistical analysis and baseline development						■	■	■					
Review of analysis by experts and technical team							■						
Baseline developed for carbon project								◆					
Finalize soil method validation through VCS or other body		■	■	■									
Methodology validated						◆							
PDD drafting and review for SG and surrounding landowners							■	■	■				
Formal submittal of PDD to independent validator									■				
PDD delivered to market									◆				
Aggregation beyond SG and surrounding landowners							■	■	■	■			
Partnership agreement finalized with famers										◆			
Host meetings and discussions with high potential carbon buyers									■	■	■		
Drafting of deal structures to monetize credits											■	■	
Carbon deal structured												◆	
Engage ARB or other emerging compliance markets						■	■	■	■	■	■	■	■
USDA communications		■	■	■	■	■	■	■	■	■	■	■	■
Semi-annual Report (Due 1/31/12, 1/31/13 and 1/31/14)			◆				◆				◆		
Annual report (Due 7/31/12 and 7/31/13)					◆				◆				
Final Report (Due 10/31/14)													◆

EKO | Asset Management Partners

January 23, 2013

Carl V. Korfmacher
President, Applied Ecological Services
Manager, The Earth Partners
17921 Smith Road, PO Box 256
Brodhead, Wisconsin 53520

Dear Carl:

This is to request that EKO Asset Management Partners, LLC ("EKO") be released of all future commitments to Shepherds Grain Carbon Development, LLC ("SGCD"), under a letter dated February 10, 2011, between EKO, the Earth Partners ("TEP") and Applied Ecological Services ("AES"), effective immediately. EKO's decision is based on the fact that none of the commercial conditions necessary for EKO to make its first payment to SGCD have been or are likely to be met in accordance with the letter (herein referred to as the "Agreement").

Background

The Agreement contains terms that were to be "set forth in the Operating Agreement ('Operating Agreement') for the Shepherds Grain Carbon Development (SGCD) LLC and in its supporting documents." In addition, the Agreement contains terms specifically related to EKO's commitment to fund SGCD, including the conditions that would trigger EKO's first payment to SGCD, which conditions are found under *Commercial Terms related to Funding SGCD*, and include the following:

> "Tranche 1: Payment to be made upon execution of an Operating Agreement between EKO, TEP, and AES for SGCD and execution of Carbon Development Contracts ('Contracts'[1]) with Shepherd's Grain landowners and surrounding landowners for Phase 1 that both includes the commercial terms above and encompasses a minimum 100,000 acres by the end of year 1 of the Grant period[2]. In the event that the above-referenced commercial terms cannot be negotiated with landowners, TEP and EKO will act in good faith to negotiate an alternate set of commercial terms acceptable to EKO and TEP."

[1] Now called Producer Enrollment Agreements.

[2] While "year 1 of the Grant period" is not defined, we believe that the only reasonable liberal interpretation is that it means the 12-month period after the official granting of the SGCD Conservation Innovation Grant by the USDA, which was September 3, 2011.

ekoamp.com

1350 Avenue of the Americas
29th Floor c/o Wolfensohn & Co.
New York, NY 10019
USA

+1 646.731.2754
+1 866.279.1256 fax

Neither commercial condition was met as required for EKO to make its first payment. To date, no Operating Agreement (or any other substitute document) has been executed, and on August 10, 2012, Chas Taylor informed EKO that TEP would not successfully execute Contracts with landowners that encompass a minimum of 100,000 acres by the end of year 1 of the Grant period – September 3, 2012. In his August 10 email to EKO, Chas Taylor conceded that TEP was having difficulty signing up enough landowners, and he sought to renegotiate the commercial terms, "proposing a 50% reduction in the target acreage under contract for the triggers of first two payment tranches...." Despite the proposed changes to the terms, changes that TEP knew were material to EKO, EKO has sought "in good faith to negotiate an alternate set of commercial terms acceptable to EKO and TEP." However, EKO now believes that reaching a mutual agreement on an alternate set of commercial terms will not be possible.

EKO further believes that almost two years after signing the Agreement, it is far too late for the parties to the Agreement to agree to terms of an Operating Agreement, or any other substitute document that would clearly set forth EKO's rights and responsibilities in the context of SGCD. Despite repeated requests by EKO to have some form of a foundational agreement executed, be it the Operating Agreement or some other agreement, no such agreement was ever executed.

In addition, EKO believes that despite recent claims by TEP and AES that TEP has now executed on 100,000 acres worth of Contracts, it is undeniable that TEP did not meet the deadline set forth in the Agreement for signing such Contracts, as it so conceded in various emails dated August through November, 2012. While TEP and AES may now believe that the conditions necessary to trigger EKO's first payment were arbitrary, EKO thoughtfully agreed to these milestones in order to insure the proper management of the project and to manage its risk.

Conclusion

EKO is accordingly now invoking its right to be released from the Agreement pursuant to the following clause in the Agreement:

> "AES agrees as the administrator of the Grant that in the event that the above commercial conditions set forth in the sections of this Agreement above the step in rights are not met, then AES will either
>
> - Terminate the Grant such that any future obligations for EKO to provide cash commitments under the Grant are also terminated or
>
> - AES or TEP releases EKO of such commitments by taking on those future EKO cash obligations directly or through a third party. To the extent required, AES will inform the appropriate governmental representative administering the Grant of the change in the cash match partner and any

EKO | Asset Management Partners

rights or obligations EKO has under the Grant or Operating Agreement will be terminated."

Since the commercial conditions referenced above have not been and are not likely to be met, EKO respectfully requests that AES honor its commitment under the Agreement and release EKO of its commitments, which EKO will deem to be effective immediately.

Sincerely yours,

Eron Bloomgarden
Portfolio Manager
EKO Green Carbon Fund, L.P.

cc:
Steven I. Apfelbaum
Applied Ecological Services

ekoamp.com

1350 Avenue of the Americas
29th Floor c/o Wolfensohn & Co.
New York, NY 10019
USA

+1 646.731.2754
+1 866.279.1256 fax

Applied Ecological Services, Inc.™

February 7, 2013

Eron Bloomgarden
Portfolio Manager
EKO Green Carbon Fund, L.P.
1350 Avenue of the Americas
29th Floor c/o Wolfensohn & Co
New York, NY 10019

RE: EKO's Participation in USDA CIG grant

Mr. Bloomgarden,

I am in receipt of your letter dated January 23, 2012. Speaking for our company as well as The Earth Partners, LP (TEP) and others engaged in this exciting project, we are deeply disappointed in the stance your partnership has chosen to take.

With this letter I am attempting to change the conversation. Before doing that I feel obliged to address a couple points that you brought up in your letter. You cite a number of technical facts to justify your request. This is our position on those facts and others:

- Both parties are responsible for generating and executing the operating agreement. We have an existing draft operating agreement. EKO rejected all ideas for updating it.
- We have aggregated more than 100,000 acres within a month or so of the one year anniversary date from when the project actually started.
- We have validated our soil carbon method more than one year ahead of the suggested timeline in the tranche schedule in the existing operating agreement.
- We have the first and only defensible science and performance-based soil carbon project on the planet with unique ways to address buffering, additionality and for valuing soil carbon.

- The science results from last week's latest statistical analysis shows that this project will likely generate tens of millions of tons of verifiable carbon available for marketplace transactions.

We do not believe, as you have asserted, that EKO has negotiated in good faith. Members of TEP have carried the weight on these negotiations, proposed alternatives to EKO and have simply not found EKO a willing partner. The standard of good faith would require considerably more effort on the part of EKO.

At this time, I would prefer to drop further discussions around our disagreement on these facts. I think what is more relevant is that any objective, reasonable person knowledgeable in these matters would view this project as nearly 100% successful to date. Regardless of whether your version of the facts is correct or ours, TEP and AES have materially fulfilled their obligations to USDA and Sheppard's Grain. EKO has not.

As I said earlier, I'd like to change the conversation from what separates us to what we can accomplish together. The issue I ask you to consider is not whether EKO has the legal right to withdraw or whether we have the obligation to release, but rather how we can address the problem created by EKO's withdrawal together. We have presented ourselves as a team to USDA and Sheppard's Grain. We have many influential and powerful people waiting to see how this goes. It will not serve any of us to let them down. This is a problem we share collectively.

We don't wish to get into a legal debate. We wish to finish this project with pride. Your letter has made it clear that you want to be released from legal obligations. This would be much more palatable if the actions of EKO representatives indicated that you wish to be part of the solution to our shared problem. The spirit of this type of work is one of cooperation. This is not merely a financial transaction or a legal agreement that can be satisfied with a letter. We understand that this investment may not be a fit for you. We don't want to try to force you into something. But that does not justify washing your hands and walking away.

Yesterday, I spoke to Ricardo Bayon. I was hoping that our conversation would preclude the need to send this letter because letters like this tend to breed more letters rather than moving us toward solutions. I posed this question to him: if EKO wishes to be relieved of its legal responsibilities, why not take action to address the concerns and needs of its partners? Why not work proactively to help us find other sources of funding or means of reducing EKO's commitment? AES and TEP have fronted $90,000 for parts of the contract that are EKO's responsibility. Will you even consider reimbursing us for this? In short, if you are the savvy investors that I assume you aspire to be, why not use those skills to help us make this work before further erosion of our collective reputation occurs? Ricardo agreed to get back to us late next week with some ideas. I did not get the impression however, that he was very engaged which is why you are receiving this now.

The time is fast approaching when we will be forced to inform USDA and Sheppard's Grain of this unfortunate situation. Once that happens, the repercussions, legal and otherwise, could be far reaching and difficult to control. I respectfully request that EKO put forth its best efforts to engage in a meaningful process of problem solving with TEP and AES and become part of the solution.

Sincerely,

Carl V. Korfmacher
President
Applied Ecological Services, Inc.

c. Jason Scott, EKO
Ricardo Bayon, EKO
David Tepper, The Earth Partners, LP

EKO | Asset Management Partners

August 6, 2013

Steven I. Apfelbaum
Applied Ecological Services
P.O. Box 256
Brodhead, WI 53520

Dear Steve:

The letter that Eron Bloomgarden recently sent to you was a good faith effort on our part to support your efforts to find funding so that AES and TEP could continue with the Shepherds Grain Carbon Development project. Given the fact that AES and TEP did not accept our offer, and given the fact that AES and TEP missed milestones set forth in our original agreement of February 10, 2011, we are released from any further commitments to SGCD.

It has been a year since Chas Taylor first asked us to renegotiate the terms of the February 10th agreement. We have been trying to renegotiate the critical terms for a year, but we're clearly at an impasse. We're comfortable from both a legal and ethical perspective that we have no further obligations to SGCD due to the missed milestones and our collective inability to successfully renegotiate the terms of that original agreement.

We want to be very clear about your position that we are somehow breaking a commitment to USDA. On February 10th, EKO executed two letters: 1) a commitment letter to you in which we committed to a total cash contribution of $400,000 to SGCD on terms set forth in the "CIG-GHG 2011 proposal"; and 2) another letter to AES and TEP that set forth the details and terms of EKO's commitment to SGCD, including milestones that would trigger our payments. Our commitment was with AES and TEP alone — not with USDA — despite your assertions to the contrary. Whether you chose at the time to disclose to USDA the conditions upon which our commitment was made is unclear to us, but that responsibility sits with

ekoamp.com

1350 Avenue of the Americas
29th Floor c/o Wolfensohn & Co.
New York, NY 10019
USA

+1 646 731 2754
+1 866 279 1256 fax

you, not with EKO. Government attorneys have given us comfort that we have no commitment to USDA.

Despite our differences in this matter, we truly wish TEP and AES success in all of their endeavors, especially in regard to SGCD. We look forward to staying in touch.

Sincerely yours,

Otho E. Kerr III
Partner, COO and General Counsel

Cc:
David Tepper
Dirk Brinkman

USDA-NRCS Palouse Soil Carbon Project

The Earth Partners, LP

Applied Ecological Services, Inc.

theearthpartners

Applied Ecological Services, Inc.

Background

- Applied Ecological Services and The Earth Partners LP received a USDA-NRCS Conservation Innovation Grant
- Objective is to develop a large-scale agricultural carbon project in the Palouse region
- Shepherd's Grain partnership with over 30 producers over past two years implementing on-the-ground science
- One of the largest land-based carbon projects in the US receiving significant attention from USDA-NRCS, policy makers, and carbon investors

About us

The Earth Partners LP

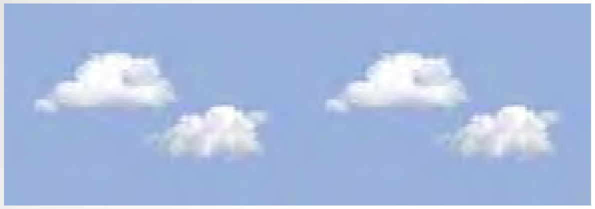
- Project development and financing to restore land of large areas
- Soil scientists, engineers, finance professionals, and bioenergy developers
- Specialty in creating methods to measure, monitor, and validate environmental assets like carbon and water over landscape-scales

Applied Ecological Services (AES)

- One of the largest ecological restoration firm since 1975
- Over 200 technical and restoration and research staff in 9 offices, working on >700 projects annually in agricultural lands, grasslands, savannas, and many other ecosystems
- Owner/operator of one of the largest native plant nurseries in the USA and elsewhere

Carbon and GHG cycle

Sources of emissions



CO_2/ GHG

- Soil disturbances from tillage
  Soil erosion from weather, mgmt practices
- Nitrous oxide from fertilizer

Soils with low or declining amounts of carbon (tons/acre)

Sources of soil carbon

CO_2

- Photosynthesis of plants as root matter dies annually
  Reduced soil erosion
- Precipitation as carbonic acid builds inorganic carbon soil

Soils with high or increasing amounts of carbon (tons/acre)

Results

Practices to regrow soil carbon / organic matter

- Direct seed / reduced till
- Crop rotation/ cover crops
- Nitrogen management (biotic fertilizers, nitrogen inhibitors, 4Rs – right source, place, timing and amount)

Benefits of increased soil carbon / organic matter

- Improved long-term yields
- Increased soil fertility
- Reduced erosion
- Water retention and efficiency
- Lower operational costs
- Long term land value

Major goals of the project

- Measure and quantify soil carbon levels through rigorous scientific process
- Aggregate landowners and develop a large-scale project
- Monetize carbon credits in the market when markets develop or buyers emerge
- Add value to the sustainable agriculture practices of Palouse producers
- Influence agricultural policy to reward producers for their sustainable practices

Soil sampling, Whitman County

Soil Carbon Method

- The Earth Partners developed a method to measure and monitor carbon stocks in agricultural systems
- Peer-reviewed by leading scientists and is validated by the Verified Carbon Standard (VCS)
- Allows producers to claim carbon from their management practices based on direct measurement — not restricted by historical research

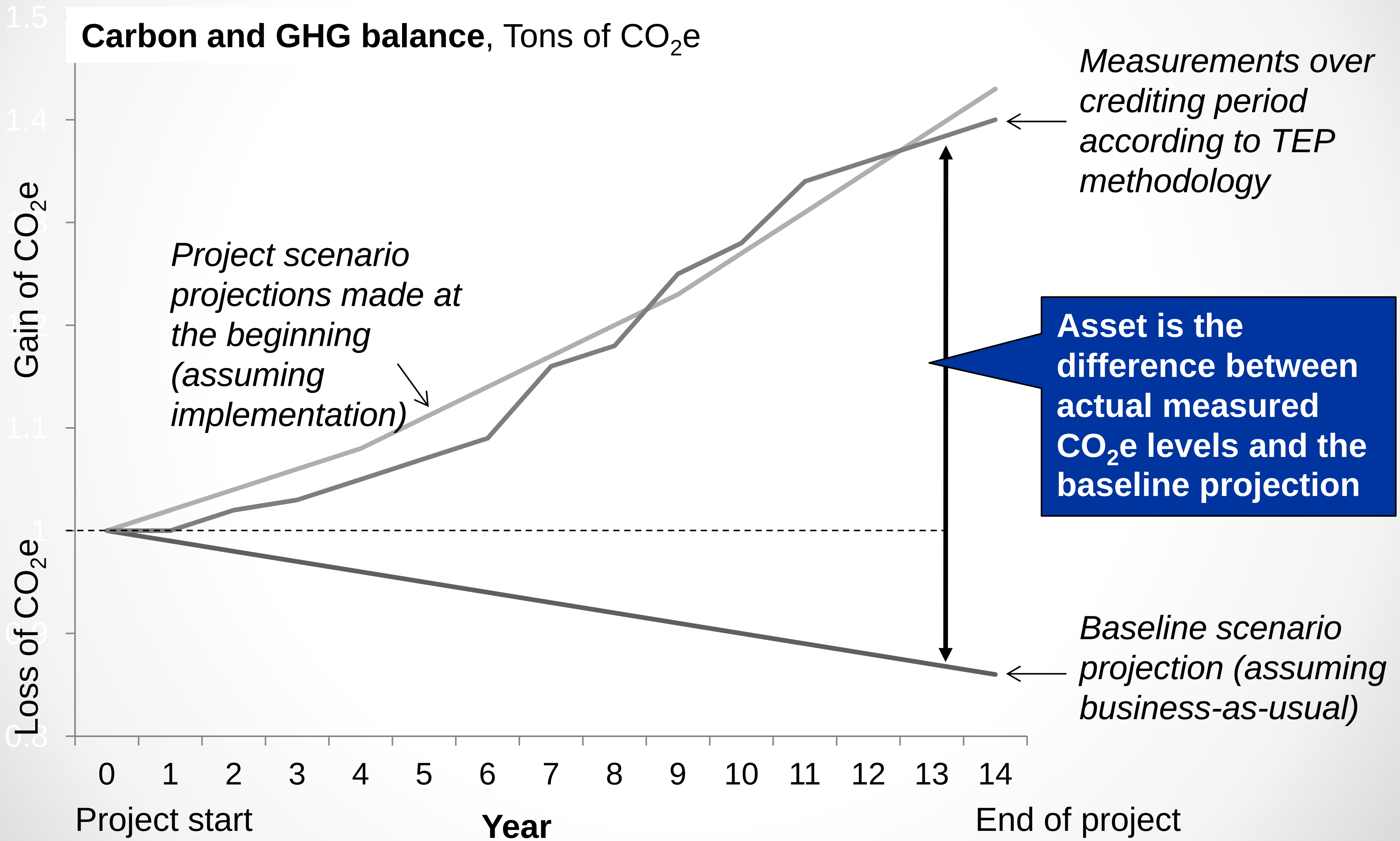
The method is built on modules

Module	Description
MODULE 1	APPLICABILITY
MODULE 2	ADDITIONALITY
MODULE 3	BOUNDARIES
MODULE 4	STRATIFICATION
MODULE 5	SOIL CARBON
MODULE 6	LIVING PLANT BIOMASS
MODULE 7	PROJECTION OF FUTURE CONDITIONS
MODULE 8	WOODY BIOMASS HARVESTING AND UTILIZATION
MODULE 9	LONG LIVED WOOD PRODUCTS
MODULE 10	ESTIMATION OF DOMESTIC ANIMAL POPULATIONS
MODULE 11	EMISSIONS FROM DOMESTIC ANIMALS
MODULE 12	EMISSIONS OF NON-CO2 GHG'S FROM SOILS
MODULE 13	SUMMATION OF GHG POOLS, REMOVALS AND EMISSIONS
MODULE 14	EMISSIONS OF GHG'S FROM POWER EQUIPMENT
MODULE 15	DISPLACEMENT LEAKAGE
MODULE 16	MONITORING PLAN
MODULE 17	NON-CO2 EMISSIONS FROM BURNING
MODULE 18	ESTIMATION OF LITTER POOLS
MODULE 19	ESTIMATION OF DEAD WOOD POOLS
MODULE 20	MARKET LEAKAGE

- Selection of sub-sets of applicable modules as determined by project characteristics

- Each module stands alone, containing detailed instructions, definitions, tailored catalogue, etc.

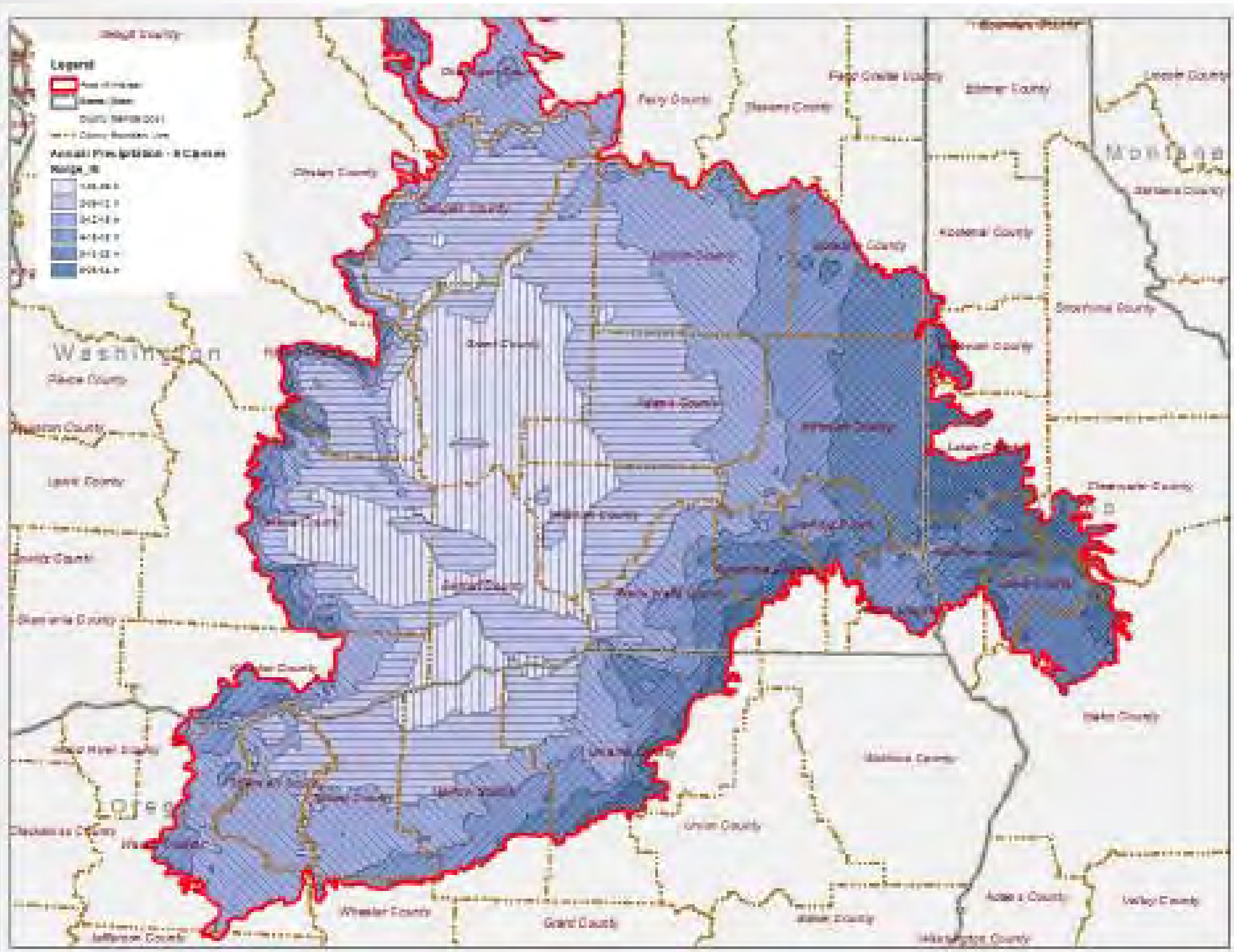
How carbon assets are created



Implementation of the method

- **In Fall/Winter 2011,** team engaged in pre-sampling and mapping and stratification of the landscape
- **In Spring 2012,** the team implemented a sampling plan that collected over seven hundred 1-meter depth soil cores from conventional and direct seed acreage across the landscape
- **In Fall 2012,** the University of Missouri Soils Lab tested bulk density and soil carbon on all cores, as well as pH, nitrogen and a suite of other soil tests on a subset of soil cores
- **In Winter 2013:** team statisticians analyzing results to develop science-based projections for current and future carbon levels across the Palouse

Mapping/stratifying the landscape



Over 7 million acres stratified

- Incorporating results of pre-sampling
- Integrating variables like Elevation, Precipitation, Soil Type

PACIFIC NORTHWEST direct seed ASSOCIATION

Sample Allocation

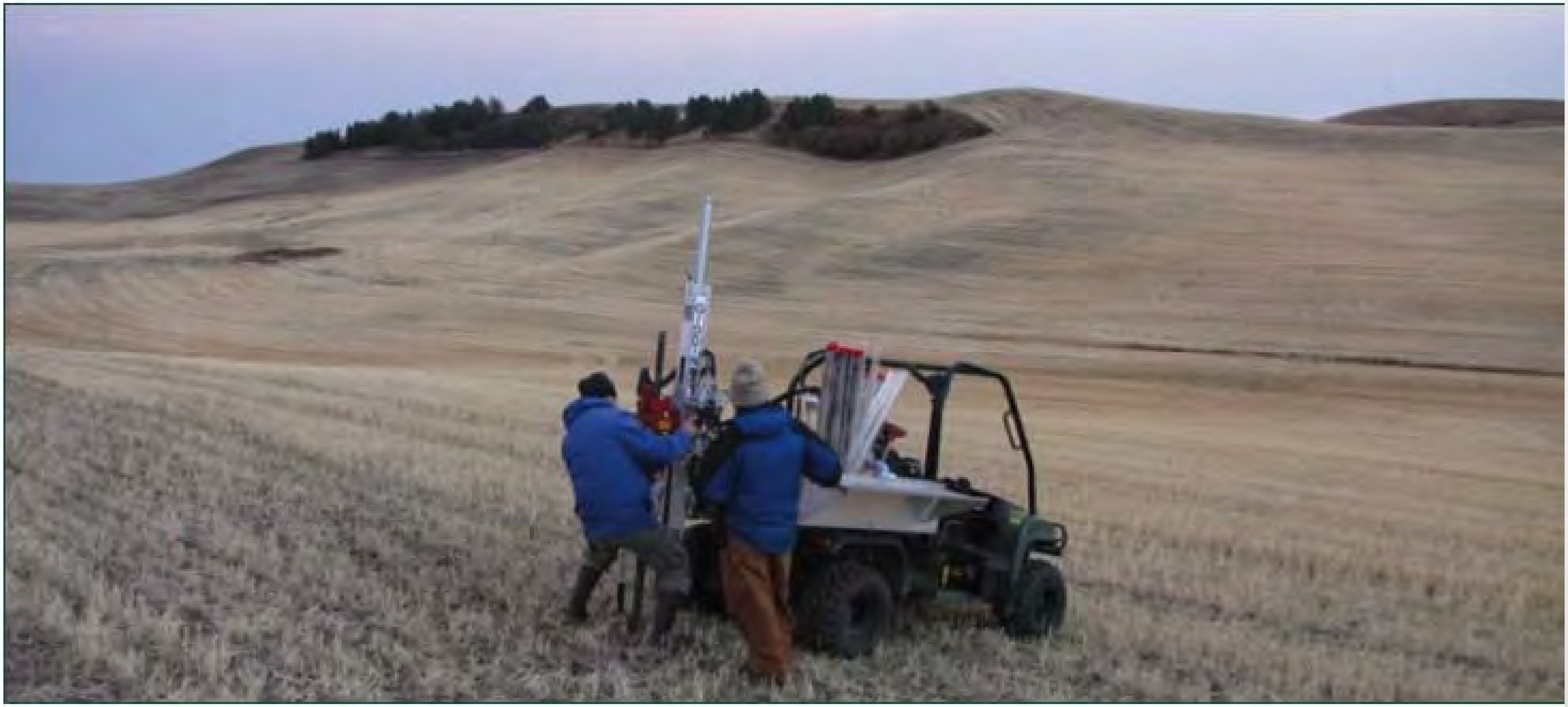
PACIFIC NORTHWEST direct seed ASSOCIATION

Sample Locations by Strata

Direct Seed History

Precip Zone	Slope Position	Aspect	2011 or None Conventional H1 Allocated	Sampled	2007-2010 1-5 Yrs H2 Allocated	Sampled	2000-2006 6-12 Yrs H3 Allocated	Sampled	1992-1999 13-20 Yrs H4 Allocated	Sampled	1990 or earlier 21 + Yrs H5 Allocated	Sampled	CRP Any H6 Allocated	Sampled	MISC (Irrigated) H7 Sampled	REFERENCE H9 Sampled
P2	UP	SW		4			5	5	1	1			5	6		1
P2	UP	NE					5	5	1	1			5	5		3
P2	LO	SW		2			5	5	1	1			5	6		7
P2	LO	NE		2			5	5	1	1			5	5		11
P3	UP	SW	1	3	5	5	5	5	5	5	1	1	5	3		3
P3	UP	NE	1	5	5	5	5	5	5	5	1	1	5	5		2
P3	LO	SW	1	8	5	5	5	5	5	5	5	5	5	4		9
P3	LO	NE	1	5	5	5	5	5	5	5	5	5	5	5		8
P4	UP	SW	2	2	5	4	5	5	5	5	5	5	5	4	1	4
P4	UP	NE	2	4	5	2	5	5	5	5	5	5	5	6	1	8
P4	LO	SW	2	5	5	3	5	5	5	5	5	5	5	6	5	5
P4	LO	NE	2	3	5	4	5	5	5	5	5	5	5	5	1	4
P5	UP	SW		3	5	5	5	5	5	5	5	5	5	5		6
P5	UP	NE		7	5	5	5	5	5	5	5	5	5	7		4
P5	LO	SW		2	5	5	5	5	5	6	5	5	5	4		6
P5	LO	NE		4	5	5	5	5	5	5	5	5	5	4		7
P6	UP	SW		4	5	5	5	5	5	5			5	5		5
P6	UP	NE		6	5	5	5	5	5	5			5	5		5
P6	LO	SW		7	5	5	5	5	5	4			5	6		7
P6	LO	NE		5	5	5	5	5	5	5			5	5		4
Pre-Allocated or Sampled Plots			12	81	80	73	100	100	84	84	52	52	100	101	8	109
Target # of Plots			100		100		100		100		100		100			100

The actual sampling



Analysis

Number of Cores and Samples Collected
608 sampled locations +
102 total duplicates
710 cores total, 2062 lab samples (~3/core)

Samples by type

H1 – Conventional	(81 samples)
H2 – 1-5 yrs No-till	(73 samples)
H3 – 6-12 yrs No-till	(100 samples)
H4 – 13-20 yrs No-till	(84 samples)
H5 – 21+ yrs No-till	(52 samples)
H6 – CRP	(101 samples)
H7 – Misc/Irrigated	(8 samples)
H9 – Reference Area	(109 samples)

Then further allocated by several strata categories: slope position, aspect, precipitation zone, etc.

Soils Lab Analysis

- Core description & splitting by horizon
- Course Fragments
- Bulk Density
- % Organic Carbon
- % Inorganic Carbon
- % Total Carbon

Preliminary findings

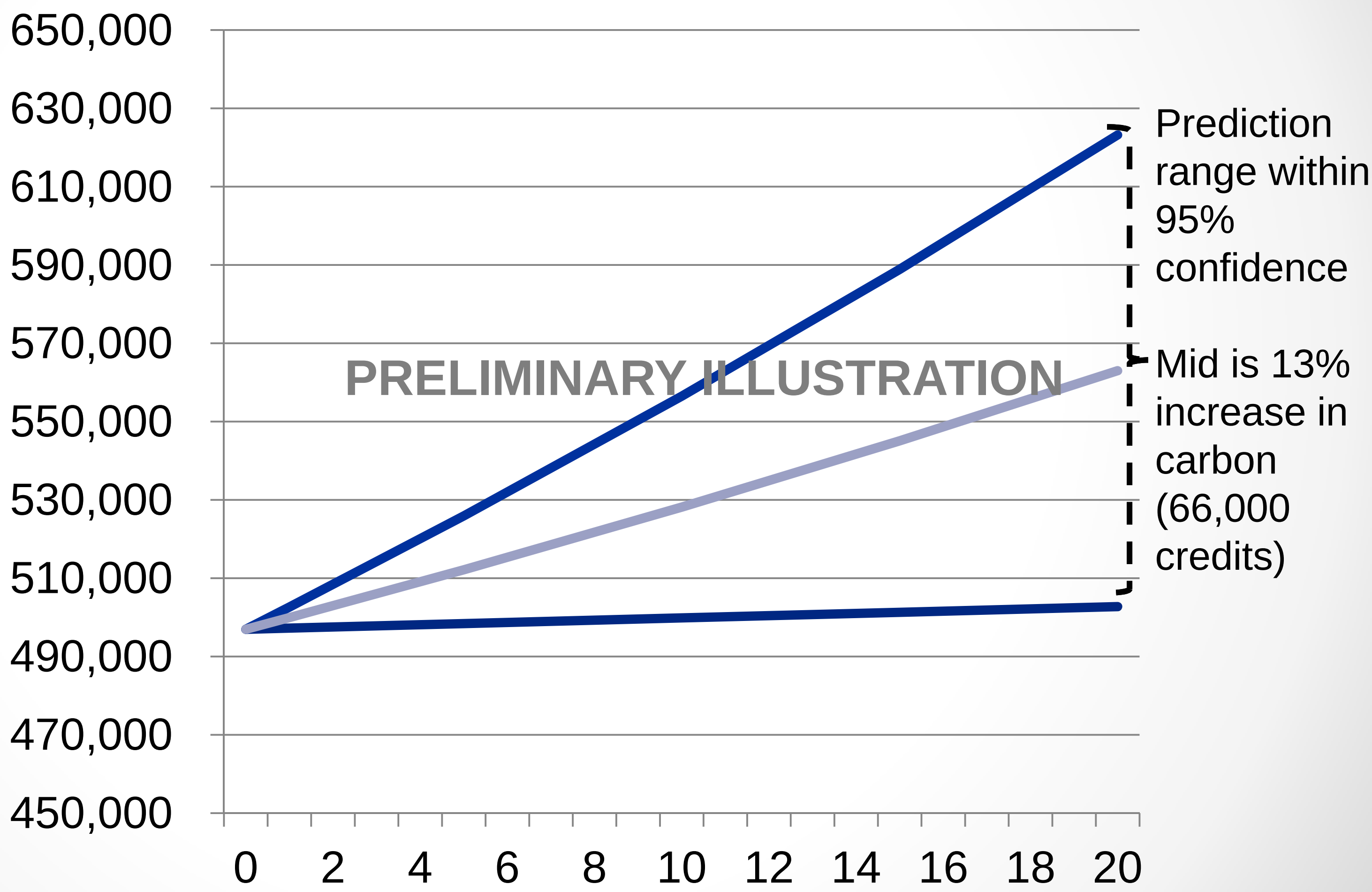
- 34% of the variability of sample results is accounted for by collected data
- Greater amount of carbon in wetter precipitation zones and lower slope positions
- Increased number of years of no-till is associated with more soil organic carbon in upper A horizon, even accounting for precipitation and slope position.
- Many instances of deeply buried carbon in the landscape, and accruals at deep levels

What this can mean for a producer

Basecase average

- 6.1 kg/m^2 of carbon in topsoil
- 27.1 tons of carbon/acre in topsoil
- 99.5 tons CO_2e/acre
- 496,953 tons CO_2e on 5,000 acres

Example from an average 5,000 ac farm, tons CO_2e



1.5-2x more available with Nitrogen management

How the program works

- Producer signs enrollment agreement outlining process and economics
- Carbon is measured and verified through The Earth Partners' Methodology
- Increases in soil carbon are documented and converted into equivalent "verified" carbon credits
- When and if carbon markets develop or buyers emerge, producer already owns these "verified" carbon credits
- The Earth Partners markets the credits, and producer chooses when to sell the credits, and at what price

This project allows producers to begin "banking" their carbon

How to join the program

- Let us know if you are interested in participating (sign the information form)
- We’ll provide you with the Enrollment Agreement to review
- We’ll need an FSA Data Release form for the farms where you are listed with FSA as the producer (not necessarily the owner)
- We’ll follow up to learn about the practices in each field
- We’ll then engage you about the enrollment process and next steps

EQIP funding opportunity

- USDA-NRCS has EQIP funds allocated specifically to support the Greenhouse Gas (GHG) Conservation Innovation Grant (CIG) projects, of which our project is one of six
- Producers practicing no-till and participating in this program are eligible for these EQIP dollars
- EQIP Practices must be core soil carbon practices, including:
  - Residue Management, Seasonal (344)
  - Residue and Tillage Management, Mulch Till (345)
  - Mulching (484)
  - Cover Crop (340)
  - Conservation Crop Rotation (328)
- Application deadlines will be coming quickly in mid- to late-February, so contact your local NRCS office now

For more information

- Chas Taylor (chas.taylor@teplp.com)
- Ry Thompson (ry.thompson@appliedeco.com)

Informing Ecological Design, LLC • Madison, WI 53711

Soil Carbon Final Report

Kevin Little, Ph.D. and Lynda Finn, M.S.

Contents

Table of Figures

Executive Summary

This report summarizes our statistical analysis of soil carbon, the final stage in our work on *Subcontract: Agricultural Soil Carbon in the Palouse Region: Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region, Agreement Number 69-3A75-11-131.*

We derived a linear model that provides an estimate of soil carbon as a function of years of no-till management. The point estimate is 0.135 kg/m^2/year over the range of 0 to 20 years, with an approximate 95% confidence interval: (0.044, 0.225). This model applies to areas within the Palouse roughly above median 30-year precipitation levels and above the first quartile of a slope position parameter. We also analyzed an extensive set of duplicate cores that yields an estimate of core to core variation that may be used for TEP method planning (Appendix 1).

Introduction

Kevin Little, Ph.D. and Lynda Finn, M.S. provided statistical services through an agreement with Applied Ecological Services (*Subcontract: Agricultural Soil Carbon in the Palouse Region: Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region, Agreement Number 69-3A75-11-131.)*

AES scientists wished to develop a landscape scale model for soil carbon based on physical characteristics and years of no-till management. The expectation was that increasing years of no-till management would be associated with increased amounts of soil carbon.

We worked with AES scientists October 2011-March 2012 to design a sampling approach that would achieve the AES aims. The study looked across 100,000 acres in the Palouse Region, with sample cores extracted in the spring and summer of 2012.

Ultimately, we want to show evidence that increasing the number of no-till years will cause an increase in soil carbon accrual. Our design and analysis are focused on a related but different problem: is an increase in no-till years associated with an increase in soil carbon, when we look at a set of cores sampled in one year? In other words, we are conducting a cross-sectional study (with respect to years of no-till farming) to give us insight into a longitudinal problem, the effect of increasing no-till years on given locations.

Description of Data

We supported AES staff in designing a sampling plan to investigate the impact of several factors on carbon accrual in soil in the Palouse. From preliminary study in fall 2011, we identified precipitation, slope position, slope aspect (e.g. northeast or southwest facing direction), and direct seed history as primary factors.

In spring and summer of 2012, two AES field crews obtained 710 cores, as shown in Figure 1.

			Direct Seed History															
			2011 or None Conventional H1		2007-2010 1-5 Yrs H2		2000-2006 6-12 Yrs H3		1992-1999 13-20 Yrs H4		1990 or earlier 21 + Yrs H5		CRP Any H6		MISC (Irrigated) H7	REFERENCE H9		
Precip Zone	Slope Position	Aspect	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Sampled	Sampled		
P2	UP	SW		4			5	5	1	1			5	6		**1**		
P2	UP	NE					5	5	1	1			5	**5**		**3**		
P2	LO	SW		2			5	5	1	1			5	6		**7**		
P2	LO	NE		2			5	5	1	1			5	5		**11**		
P3	UP	SW	1	3	5	**5**	5	5	5	5	1	1	5	**3**		**3**		
P3	UP	NE	1	5	5	5	5	5	5	5	1	1	5	5		**2**		
P3	LO	SW	1	8	5	5	5	5	5	5	5	5	5	**4**		**9**		
P3	LO	NE	1	5	5	5	5	5	5	5	5	5	5	**5**		**8**		
P4	UP	SW	2	2	5	4	5	5	5	5	5	5	5	**4**	**1**	4		
P4	UP	NE	2	4	5	2	5	5	5	5	5	5	5	6	1	**8**		
P4	LO	SW	2	5	5	3	5	5	5	5	5	5	5	6	**5**	**5**		
P4	LO	NE	2	3	5	4	5	5	5	5	5	5	5	5	**1**	**4**		
P5	UP	SW		**3**	5	5	5	5	5	5	5	5	5	5		**6**		
P5	UP	NE		7	5	5	5	5	5	5	5	5	5	7		**4**		
P5	LO	SW		**2**	5	5	5	5	5	6	5	5	5	4		**6**		
P5	LO	NE		4	5	5	5	5	5	5	5	5	5	4		**7**		
P6	UP	SW		4	5	5	5	5	5	**5**			5	5		**5**		
P6	UP	NE		6	5	5	5	5	5	5			5	5		**5**	Total	Total
P6	LO	SW		7	5	**5**	5	5	5	**4**			5	6		**7**	Allocated	Sampled
P6	LO	NE		5	5	5	5	5	5	**5**			5	5		**4**	Locations	Locations
Pre-Allocated or Sampled Plots			**12**	**81**	**80**	**73**	**100**	**100**	**84**	**84**	**52**	**52**	100	101	8	109	428	608
		Target # of Plots	100		100		100		100		100		100			100		
																	Total Duplicates	102
			RED BOLD = Combinations that do NOT have at least one duplicate sample in the same location, many have more than one															
																	Total Samples	710

Figure 1 2012 Core Sample Table

The sampling design attempted to balance core samples across the predictors; certain factor combinations were not available (e.g. in particular, AES could not find suitable sampling locations that uniformly covered low and high precipitation zones.). We'll look at the implication of this imbalance in our discussion of analysis, below.

As noted in Figure 1, there were 102 cores identified as duplicates. This means that each of those cores had a core taken adjacent to the original core. The duplicate samples covered the range of the factor combinations. An analysis of the set of duplicate cores is contained in Appendix 1.

AES provided additional information to characterize each core's location:

- 30 year annual average precipitation (1981-2010)
- Average annual temperature
- Elevation
- Topographic descriptions
    - Topographic Wetness Index (TWI)
    - Slope percent
    - Aspect (coded and in degrees)
    - Curvature
    - Slope position (coded and scaled)

Cores were shipped to the University of Missouri Soils Lab, where laboratory staff extracted the cores from the sample casing. Staff characterized each core by horizon, recorded notes of unusual structure or evidence of erosion and took a digital photo, sample shown in Figure 2.

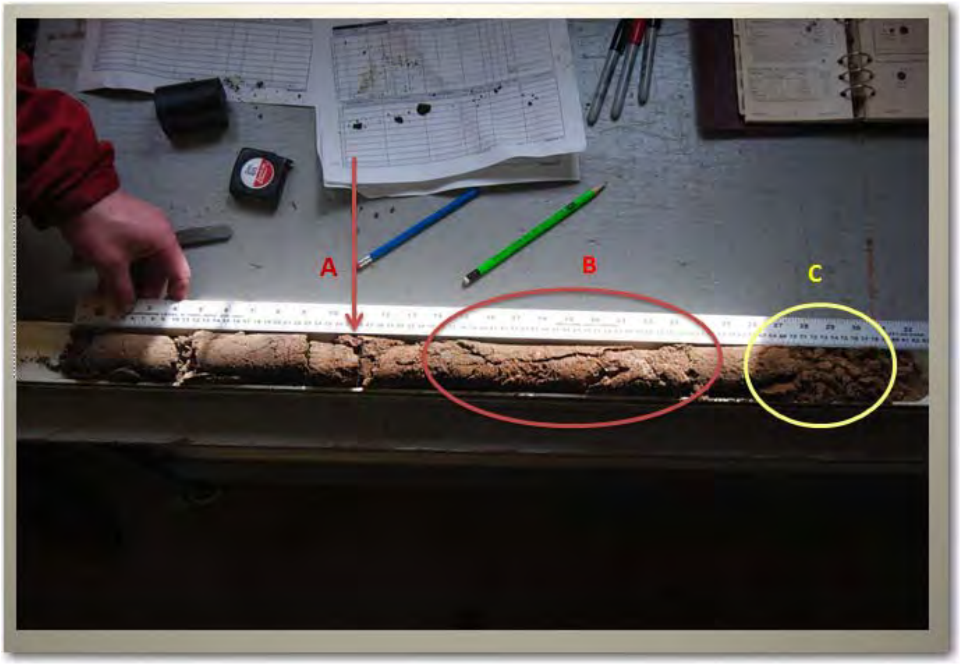


Figure 2 Core sample from preliminary 2011 sampling, showing three horizons

For each horizon, bulk density and percent carbon were calculated as shown in Figure 3.

Calculation of Carbon mass for each horizon (defined by positions Core Bottom and Core Top)

1. Bulk Density:
('Oven Dry Wt. (g)'-'Small Coarse Fragments (g)')/(3.1416*2.1^2*('Core Bottom (cm)'-'Core Top (cm)')).
The units of bulk density are **g/cm^3.**
2. Carbon calculation (organic carbon):
'% Organic C'*'Bulk Density (**g/cm3**)'*('Core Bottom (**cm**)'-'Core Top (**cm**)')*.1
gives % Organic C (dimensionless) x **g/cm^2** x .1
The conversion factor 0.1 is used to express **g/cm^2** as **kg/m**^{2} since **kg/m^2** = 10^3g/10^4cm^2 = 0.1 **g/cm^2**
3. Carbon calculation (total carbon): same calculation as for organic carbon, but using % total carbon.

Figure 3 Calculation of Soil Carbon

The soil carbon for a core is the sum of the soil carbon estimated for each horizon.

Standard calculations of soil carbon include an adjustment for large coarse fragments (e.g. USDA Soil Survey Laboratory Information Manual (2011), p. 251, reference [1]). Tom Hunt confirmed that for this study, we will treat the percent of large coarse fragments as zero (email 1 March 2013).

The primary identification of each core is a four digit number ranging between 1000 and 2362. Sixteen cores had ambiguous identity; we were able to resolve 14 of the cores (see Appendix 2).

Analysis

We made plots and data summaries to characterize the data set. We concentrated our work on cores characterized by the direct seed history code H1 (conventional tillage) through H5 (21+ years).

Coded Factors Complemented by Quantitative variables

The original sampling plan shown in Figure 1 used coded levels of precipitation, aspect, slope position and no-till years. After a round of preliminary regression analyses using coded factors, we augmented the description of each core with numerical values for each of the factors. Our model development incorporated this quantitative information, yielding models that, as expected, could account for more of the observed variability compared to models that relied only on coded levels of variables.

What is the appropriate value of soil carbon for each core?

AES field teams aimed to retrieve 100 cm of core for each sample. This was not possible for a variety of reasons, including shallow soils or wet cores such that the full core length could not be retained. The laboratory provided information that enabled us to calculate both organic carbon and total carbon for each core. We focused our analysis on organic carbon. In the discussion that follows, references to soil carbon should be interpreted as soil organic carbon.

For a given core location, the calculation of core soil carbon implies that greater core depth results in larger estimate of soil carbon. Variation in depth of cores contributes variability to the response and makes it more difficult for regression models to detect relationships with the predictors.

Figure 4 shows the distribution of core lengths for the H1-H5 subset. 5% of cores were less than 67 cm and 10% of the cores were less than or equal to 80 cm. 50% of the cores were 95 cm or longer.

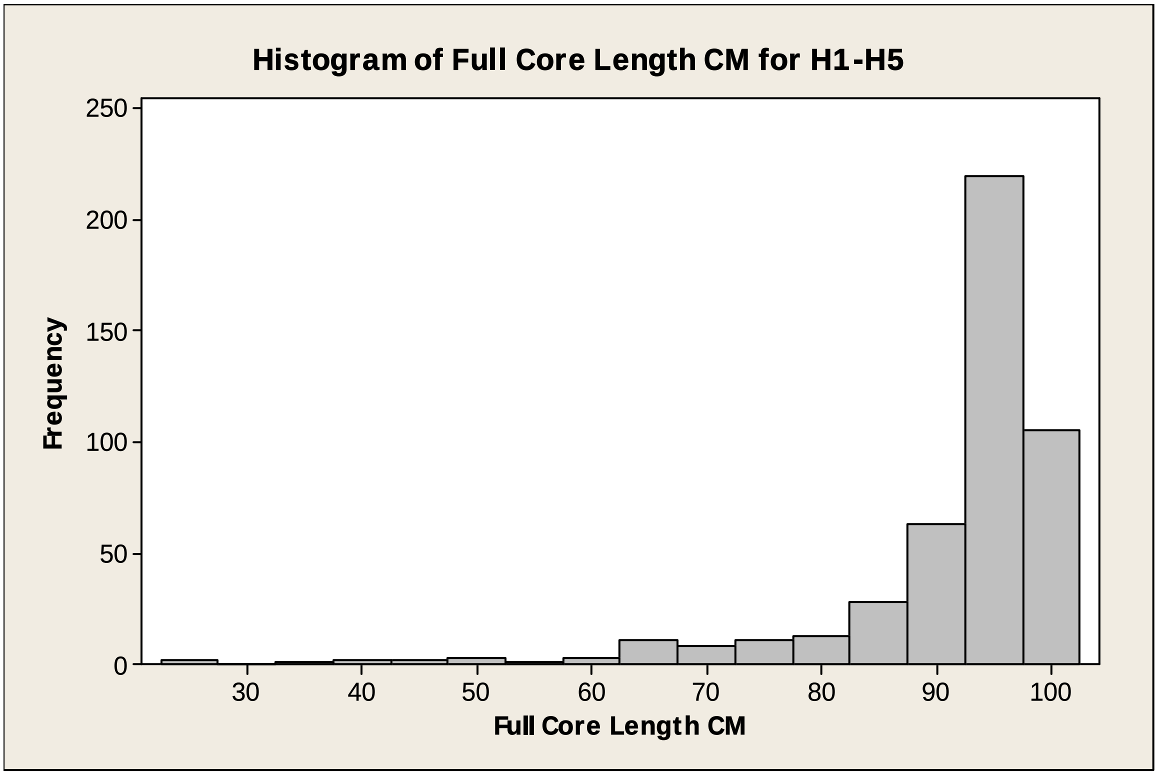


Figure 4 Distribution of Core Lengths for H1-H5 subset. 90% of the samples are at least 80 cm in length.

We looked at the impact of setting aside short cores on a set of regression models; we set aside cores shorter than 70 cm (approximately 6.25% of the cores); cores shorter than 80 cm (10% of the cores); and cores shorter than 88 cm (20% of the cores.). The analysis suggested that setting aside cores shorter than 80 cm was a reasonable compromise that retained most of the cores for analysis while increasing the sensitivity of models with respect to an effect on soil carbon from no-till years. Figure 5 summarizes the impact of short cores on model sensitivity to no-till years.

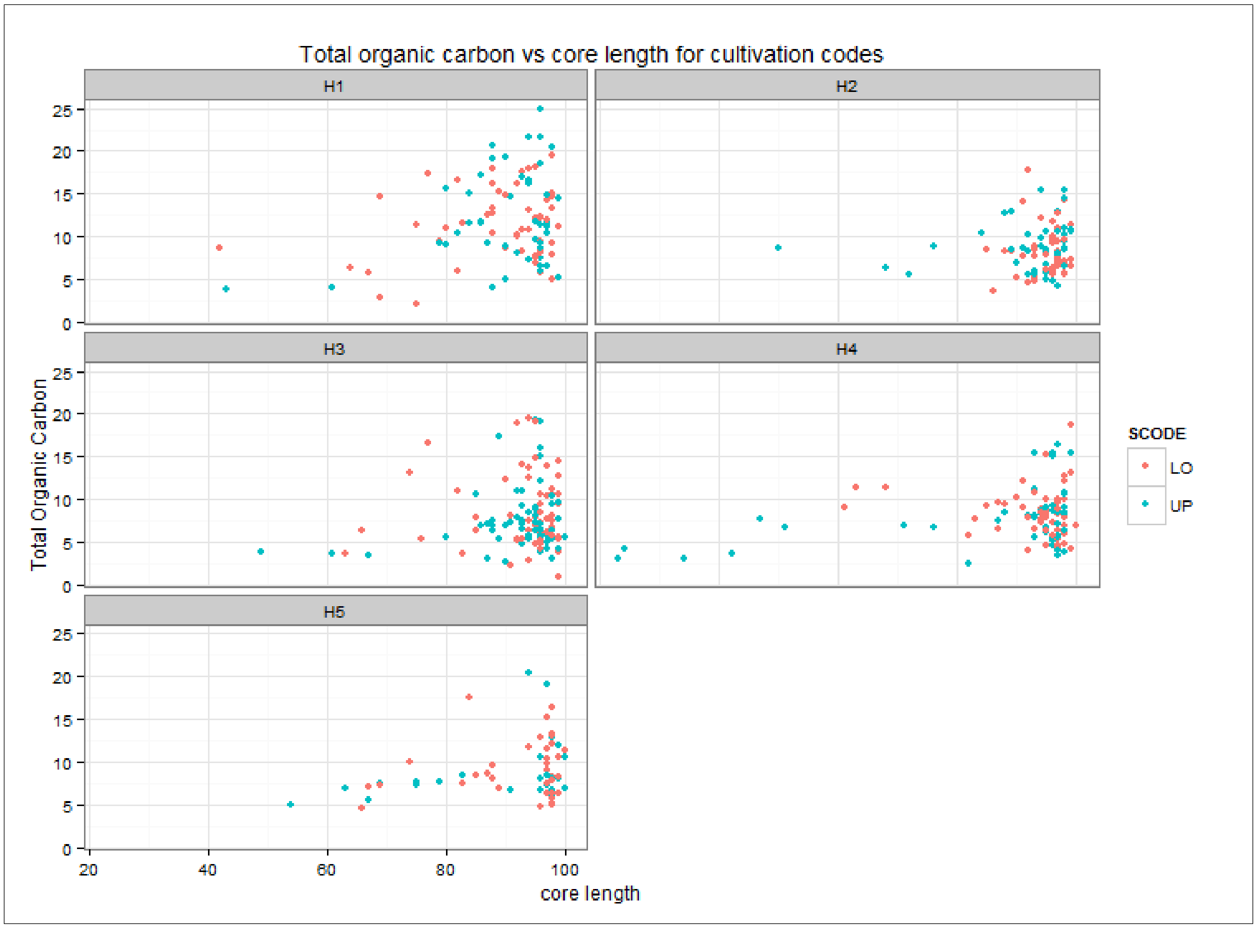


Figure 5 The trend between total organic carbon and core length for the different cultivation classes. The short cores in classes H4 and H5 have relatively low carbon, which makes it more difficult for the regression model to detect an effect of no-till years.

Working with the cores that were at least 80 cm long, we took one more step.

We adjusted the length of these cores to be a nominal 80 cm depth. We identified the horizon that spanned the 80 cm depth and defined a new bottom horizon that terminated at 80 cm. Finally, we used the bulk density and percent carbon from the spanning horizon to calculate soil carbon for an adjusted bottom horizon that terminated at 80 cm.

In general, greater soil depth is associated with greater density but lower percent carbon. The response of interest, soil carbon, is a product of density and percent carbon. Using nominal 80 cm cores reduces variability in the response not clearly associated with the predictors we used. As a result, the length adjustment reduces the overall residual variation, increasing the statistical significance of regression coefficients.

AES staff next reviewed the 10% of the cores shorter than 80 cm and identified 15 cores that were candidates for adjustment, based on field notes and whether or not a duplicate core achieved or exceeded the 80 cm boundary.

For these cores, the bottom horizon was extended to reach 80 cm. The bulk density and percent carbon of the observed bottom horizon was assumed to apply to the extended depth.

Subsequent analysis used the "80 cm adjusted depth" soil carbon values as the response.

Additional Investigation: Adjusting cores to have equal mass

We considered a further adjustment to the cores, to equalize mass of each core, following the method described in [4]. Starting from nominal 80 cm cores, the mass adjustment method calls for lengthening the core length to obtain sufficient mass equivalent to a reference core with maximum mass. This adjustment increased the variability of the soil carbon response in ways not accounted for by the predictors in our regression models. We did not pursue this adjustment further.

Precipitation

After obtaining the average annual precipitation associated with each core, preliminary plots showed a striking pattern. We observed that there were very few cores in the mid-range of average annual precipitation as shown in the histogram in Figure 6.

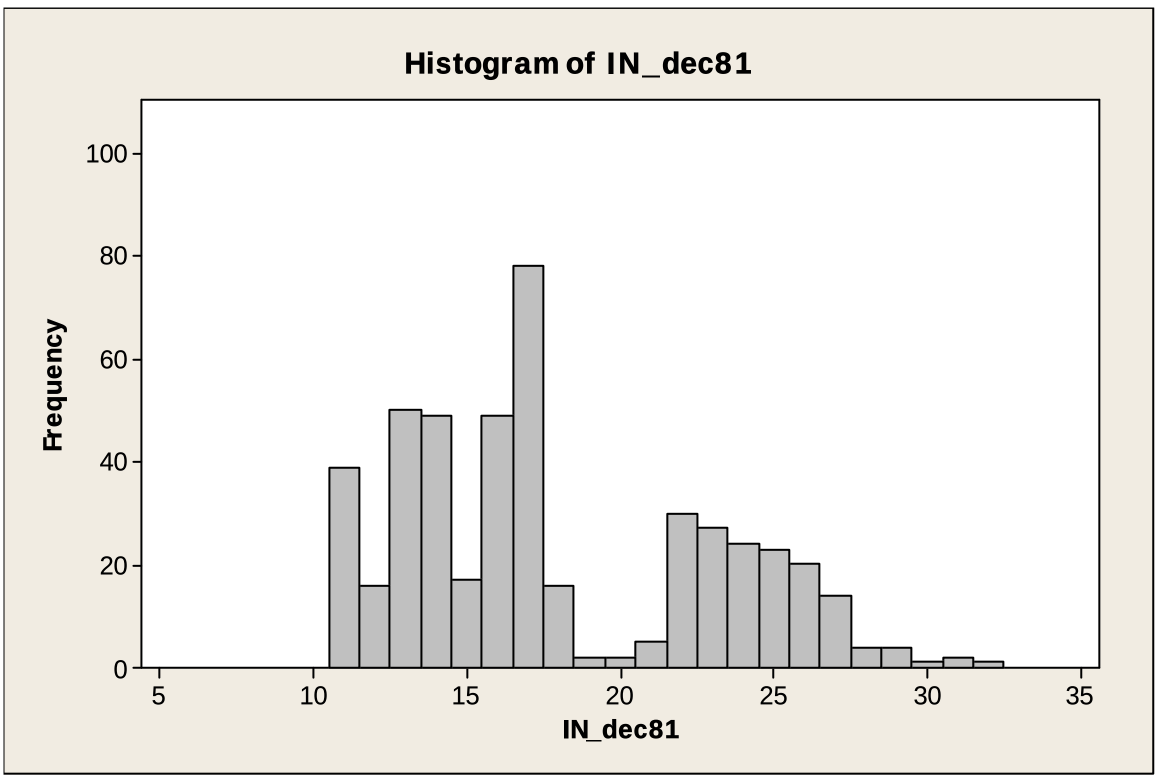


Figure 6 Bimodal distribution of 30-year Average Annual Precipitation

AES staff confirmed that this bimodal pattern reflected the actual cores samples and was not an error in data reporting. As precipitation is an important factor in our models, future sampling should include more values in the mid-range of precipitation to enable AES to confirm or adjust the form of the models.

Curvature in Precipitation

Our initial regression models attempted to fit a simple linear combination of predictors to the response. Parameters descriptive of the physical landscape—precipitation, curvature, and coded slope position (up vs low)—along with no-till years were statistically significant. A typical regression fit is shown in Figure 7 from this stage of the analysis.

```
The regression equation is
80 CM with 15 short cores Org C = 0.845 + 0.364 IN_dec81 - 0.0172 Curvature +
0.0588 NoTillYrs + 1.48 SCODE_LO


441 cases used, 32 cases contain missing values


Predictor         Coef    SE Coef      T      P    VIF
Constant        0.8447     0.5780   1.46  0.145
IN_dec81       0.36351    0.02696  13.48  0.000  1.024
Curvature    -0.017244   0.003551  -4.86  0.000  1.375
NoTillYrs      0.05883    0.01514   3.89  0.000  1.019
SCODE_LO        1.4767     0.3176   4.65  0.000  1.369


S = 2.84935   R-Sq = 40.0%   R-Sq(adj) = 39.4%

PRESS = 3632.34   R-Sq(pred) = 38.43%

Lack of fit test
Possible curvature in variable IN_dec81  (P-Value = 0.000 )

Possible lack of fit at outer X-values (P-Value = 0.001)
Overall lack of fit test is significant at P = 0.000
```

Figure 7 Example Regression Model using simple additive structure of predictors. Curvature in Precipitation is flagged by MINITAB.

Residual analysis confirmed curvature in the precipitation predictor, as shown in figure 8.

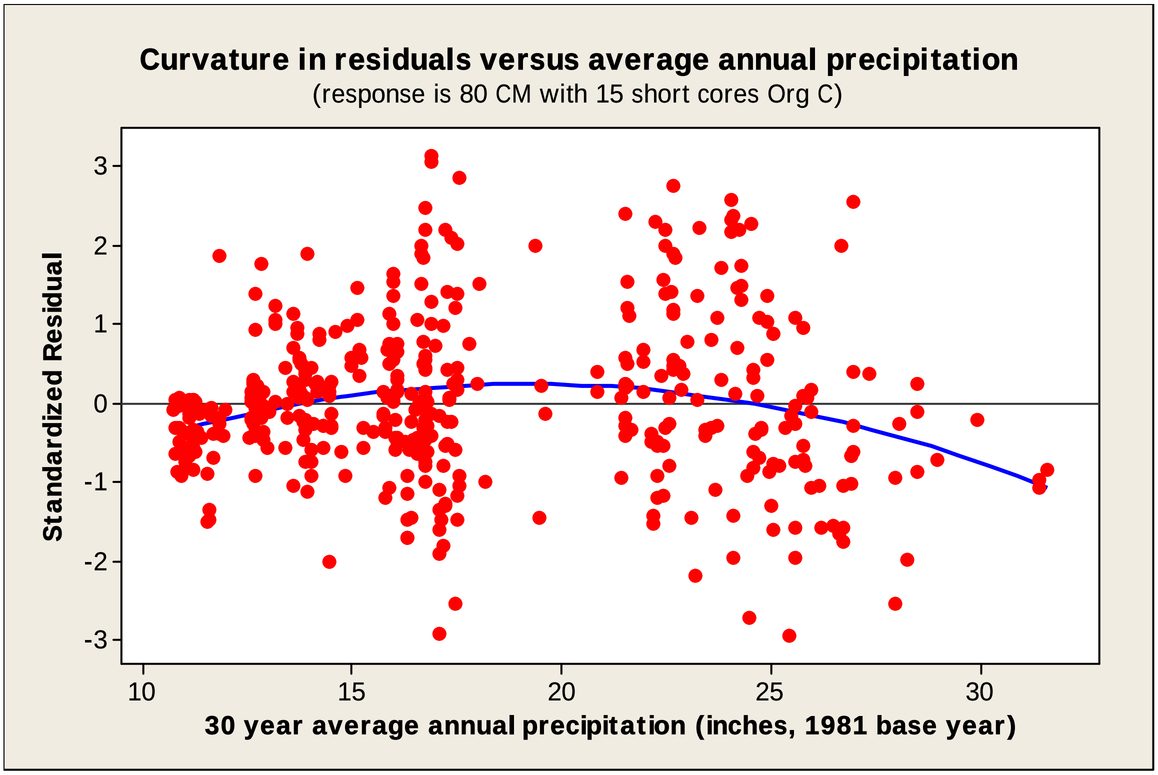


Figure 8 Standardized residuals from the regression fit illustrated in Figure 7. Both low and high values of annual precipitation are associated with relatively negative residuals. The blue curve is a quadratic fit using the residuals as response and 30 year average annual precipitation as the predictor.

AES staff could not provide us with a reason to restrict the precipitation range, which would lessen the observed curvature in the restricted range. We normalized the 30-year precipitation average values by subtracting off a common value (17.8541 inches, the mean of 473 cores in categories H1-H5) and scaling by a measure of variability (5.05187, the standard deviation of the same 473 cores used to derive the mean adjustment): Z(In_Dec81) = (In_Dec81 -17.8541)/5.05187. We added a new predictor, the square of Z(In_Dec81). The normalization centers the precipitation factors at zero and reduces issues with fitting both linear and quadratic terms in the same variable. (See Minitab Project RESID ANALYSIS FINAL MODEL, January 2013).

Restricting the range of no-till years to <= 20 years no-till

The first round of regression modeling confirmed that precipitation is a major predictor of soil carbon. As we worked to understand the interplay of the various factors available for modeling, we found that the cores from land with the greatest number of no-till years were clustered (most at 29 years) and were associated mostly with precipitation levels between the 25^{th} and 75^{th} percentiles. In particular, there were no observations of cores with no-till years greater than the 75^{th} percentile of precipitation. Discussion with AES staff suggested that areas reporting no-till management greater than or equal to 29 years may have had a different management history aside from years on no-till compared to areas with a shorter no-till history. We also were concerned about relying on regression models to extrapolate into a region of precipitation with no observations. Thus, we restricted attention to management history less than or equal to 20 years no-till. See Figure 9.

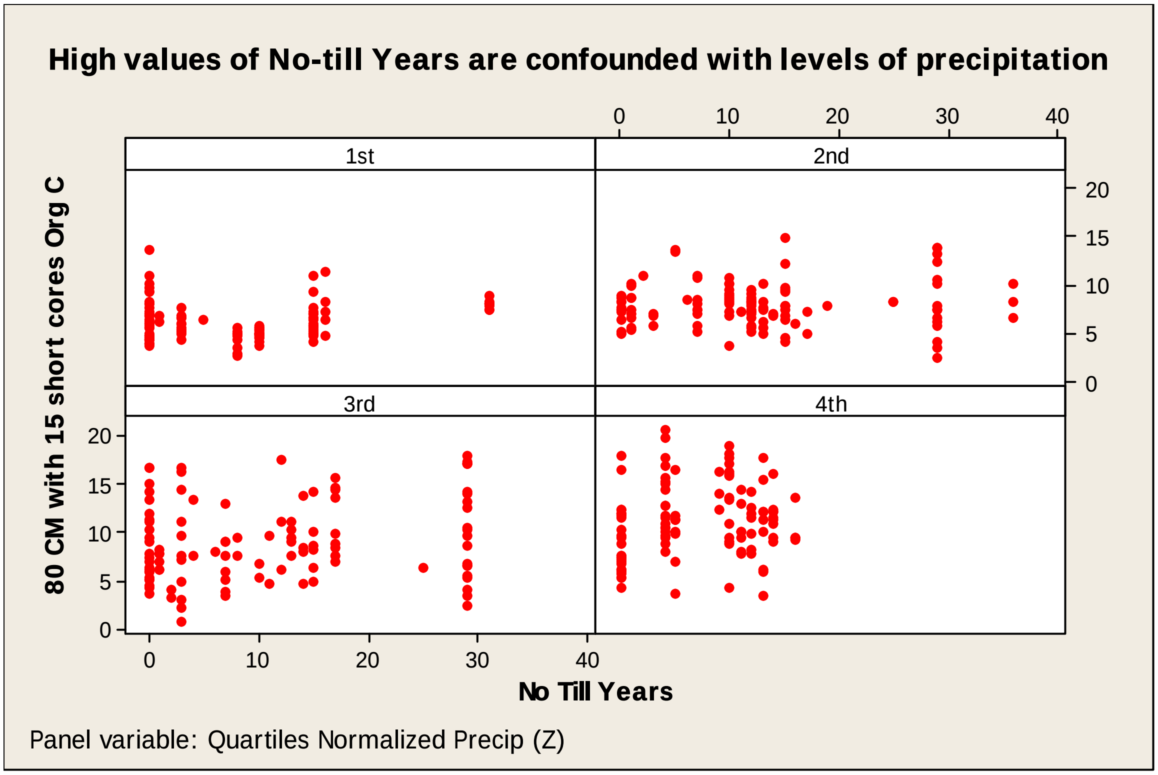


Figure 9 Panel display by four quartiles of Precipitation. No cores with no-till years > 20 occur with the 4th quartile of precipitation and only nine cores occur in the 1st quartile of precipitation.

Break-up of the predictor space: The Red Box analysis

AES provided us with a variable named DEM10m_TPI in April 2013. This parameter measures slope position and completed our augmentation of coded factors with corresponding continuous variables. We also redefined the binary variable used before as a code for two positions of slope (called SCODE). Using the zero value of DEM10m_TPI, we split slope position values into non-overlapping groups of ‘’low” and “up” positions.

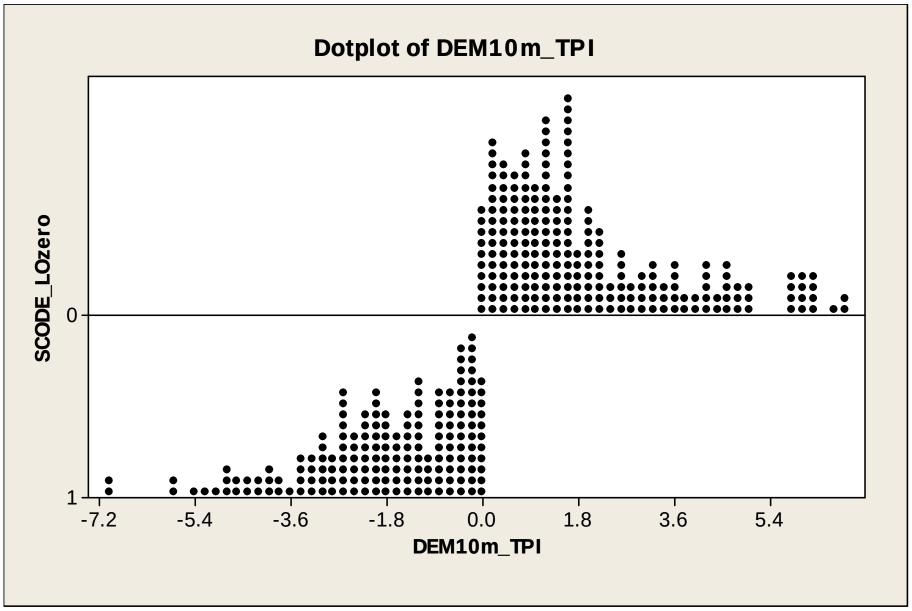


Figure 10 Slope position variable DEM10m_TPI showing split at zero into two classes.

We included DEM10m_TPI in our regression models.

We then refined the modeling to characterize the effect of no-till years. We observed that years of no-till management are associated with an increase soil organic carbon when the core is higher on the slope and when there is more average annual precipitation.

We found a quantitative way to define a subset of the data where there is an effect of no-till years. The subset is defined by precipitation and slope position. Cut-off points for the optimal subset are: DEM10m_TPI>=-1.25525 (24th percentile of the slope position) and INdec_81 (30 year average annual precipitation) >= 16.816878 inches (52nd percentile of precipitation).

In words, we can detect an effect of no-till years for areas roughly above median precipitation and above the bottom quartile of slope position.

We called the portion of the factor space where no-till years has an effect the "Red Box."

Figure 11 is the key plot that shows effect of no-till years present inside the Red Box but no effect outside the Red Box. We broke up the precipitation into quartiles (color coding). The display summarizes evidence that slope position affects the no-till relationship: the blue lines in each panel are a linear regression of organic carbon on years of no-till. The slopes of the regression in the left two panels are essentially zero. The slopes in the right two panels (the Red Box) are positive.

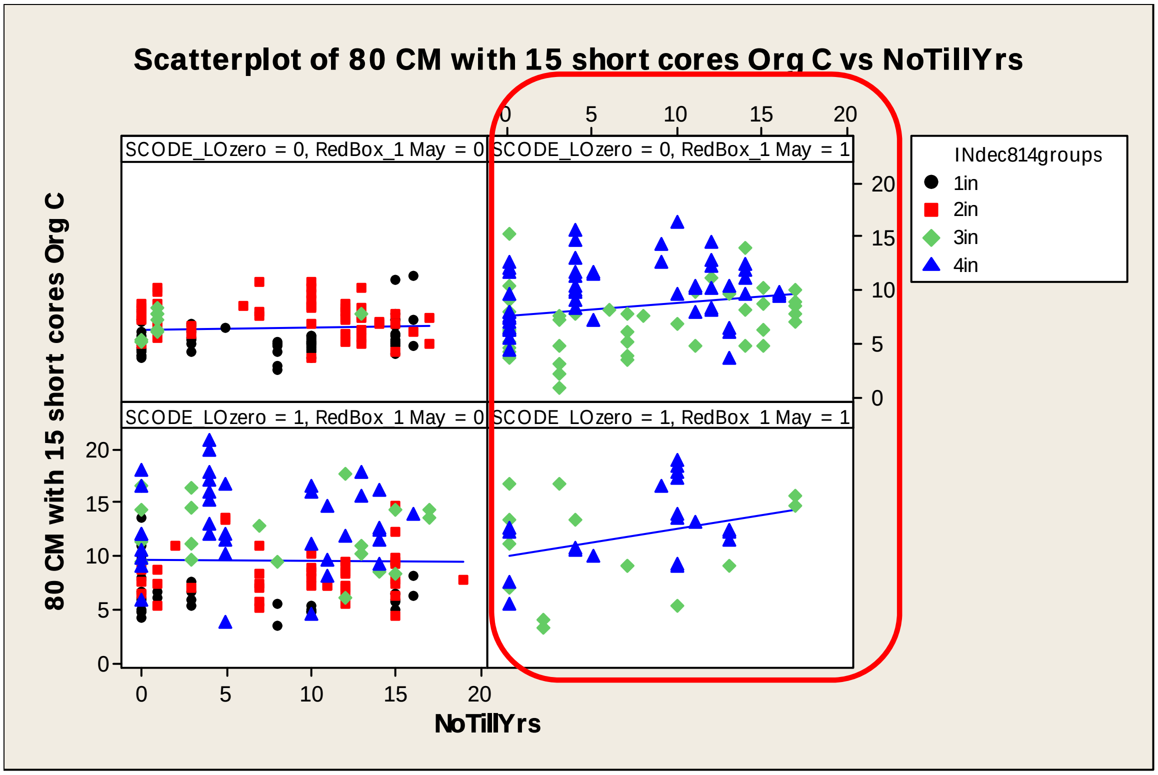


Figure 11 Interaction between effects of no-till years, precipitation and slope position.

Recall from Figure 1 that there were no samples at the lowest precipitation level P2 and 1-5 years of no-till management. The lack of samples restricts our ability to model the impact of no-till years at the lowest levels of precipitation.

We investigated regression models for data inside the Red Box and outside. We used best subsets and stepwise regression to identify candidate models; we looked for models with high values of adjusted R^2 and no indication of over-fitting.

Inside the Red Box (133 cores) our best candidate single model predicts organic soil carbon as a quadratic function of precipitation, a linear function of no-till years and a linear function of slope position. The term for SCODE_LOzero indicates that there is a different and higher intercept for slope positions less than zero on the scale defined by the DEM10m_TPI variable.

```
The regression equation is
80 CM with 15 short cores Org C = 6.03 + 4.79 ZI(Indec81) - 1.64 Z(Indec81)**2 + 0.135
NoTillYrs + 2.43 SCODE_LOzero- 0.323 DEM10m_TPI
```

Predictor	Coef	SE Coef	T	P	VIF
Constant	6.0277	0.8238	7.32	0.000	
ZI(Indec81)	4.790	1.023	4.68	0.000	5.809
Z(Indec81)**2	-1.6395	0.5557	-2.95	0.004	5.842
NoTillYrs	0.13455	0.04532	2.97	0.004	1.067
SCODE_LOzero	2.4292	0.7845	3.10	0.002	1.870
DEM10m_TPI	-0.3229	0.1609	-2.01	0.047	1.896

```
S = 2.93958   R-Sq = 39.1%   R-Sq(adj) = 36.7%

PRESS = 1200.57   R-Sq(pred) = 33.39%

Lack of fit test
Possible interaction in variable Z(Indec8  (P-Value = 0.007 )

Overall lack of fit test is significant at P = 0.007
```

(Source: Minitab worksheet *(<=20 yrs notill) 80 cm-15 short adjusted(UseHCODE = 1)(check grid 3 = 1)* in project DEM10M_TPI ADDED MAY 9.MPJ)

There are no large residuals (defined as standardized residuals greater in absolute value than 3). Overall plots of residuals show no obvious patterns that suggest problems in the fit, see Figure 12.

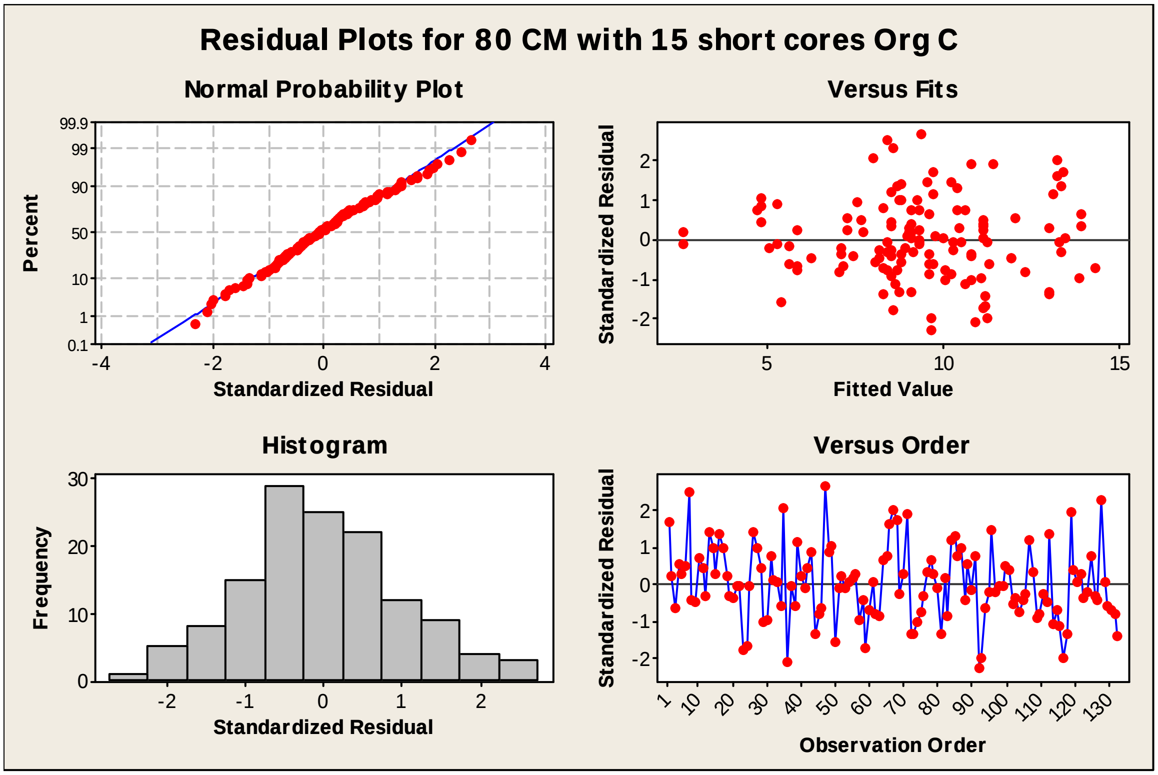


Figure 12 Residuals from model fitted to Red Box data.   No evidence of gross problems in fit.

There are three high leverage points that affect this regression, all related to precipitation (see Figure 13).

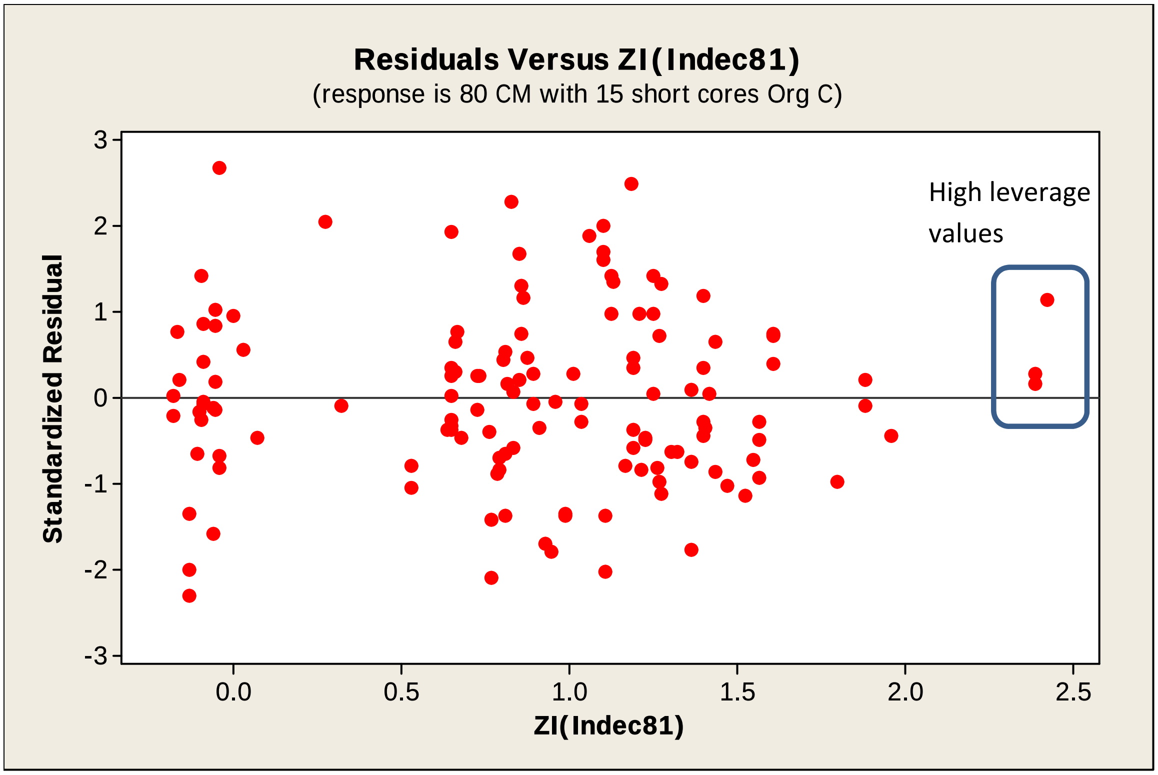


Figure 13 Standardized residuals from model fitted to Red Box data. Three high leverage values identified by Minitab are high precipitation values.

When we remove these, the effect in no-till years is reduced by about 8%. Here's the revised model with the three high leverage points removed:

```
The regression equation is
80 CM with 15 short cores Org C = 6.18 + 5.87 ZI(Indec81) - 2.54 Z(Indec81)**2 + 0.123
NoTillYrs + 2.32 SCODE_LOzero- 0.361 DEM10m_TPI


Predictor          Coef  SE Coef      T      P    VIF
Constant         6.1753   0.8510   7.26  0.000
ZI(Indec81)       5.865    1.227   4.78  0.000  7.081
Z(Indec81)**2   -2.5395   0.7958  -3.19  0.002  7.100
NoTillYrs       0.12323  0.04623   2.67  0.009  1.052
SCODE_LOzero     2.3182   0.8054   2.88  0.005  1.948
DEM10m_TPI      -0.3614   0.1706  -2.12  0.036  1.999


S = 2.94420   R-Sq = 40.1%   R-Sq(adj) = 37.6%

PRESS = 1178.49   R-Sq(pred) = 34.29%


Lack of fit test
Possible interaction in variable Z(Indec8  (P-Value = 0.087 )

Overall lack of fit test is significant at P = 0.087
```

We note that the lack of fit test p value increases when we set aside the three high leverage values, which is consistent with the lack of fit test detecting possible interaction with precipitation.

The three high leverage points, while influential, do not appear aberrant in terms of the entire sample of cores. We decided to work with the Red Box data set and model with these three values included.

Accounting for the effect of duplicate cores

The detailed regression analysis provided by Minitab flags additional information related to the duplicate cores. We expect the duplicate cores to have relatively small variation, dominated by sampling issues related to extracting intact cores and laboratory analysis issues related to horizon identification and analytic procedures.

Appendix 1 reviews the duplicate cores in detail, providing an estimate of core-to-core variation useful for TEP-type applications.

Appendix 2 describes the impact of duplicate cores on the regression analysis. We address the assumption of statistical independence that drives the estimates of regression standard errors and investigate a simple alternative that allows for a common correlation within duplicates.

We conclude there is a modest effect on regression estimates and statistical significance depending on how we assess duplicate cores in the overall analysis. A simple, conservative method to handle duplicates is to replace the duplicate cores with a single observation based on the average values and analyze this reduced data set. We carry out this analysis for the Red Box model in Appendix 2. This model yields an estimated effect of no-till years at 0.122 kg/m^2 per year, with approximate 95% confidence interval (0.019, 0.226).

Outside the Red Box: no effect of no-till years

We used best subsets and stepwise regression to identify candidate models, again looking for models with high values of adjusted R^2 and no indication of over-fitting. The proposed candidate model for 258 cores outside the Red Box shows no effect of no-till years. The Curvature predictor could be eliminated to produce a simpler model.

This model has evidence of interactions or curvature not captured completely by the additive structure as well as an indication that the variance is not constant across the range of fitted values. See Figure 15. We did not investigate the lack of fit for this set of data nor did we carry out detailed residual analysis.

```
The regression equation is
80 CM with 15 short cores Org C = 6.46 + 2.28 ZI(Indec81) - 0.926 Z(Indec81)**2 -
0.00942 Curvature + 0.00422 Elevation
                                  - 0.310 DEM10m_TPI


Predictor            Coef   SE Coef      T      P    VIF
Constant            6.460     1.165   5.54  0.000
ZI(Indec81)        2.2774    0.2460   9.26  0.000  1.992
Z(Indec81)**2     -0.9260    0.2113  -4.38  0.000  1.171
Curvature       -0.009425  0.004738  -1.99  0.048  2.351
Elevation        0.004222  0.001511   2.79  0.006  1.533
DEM10m_TPI        -0.3103    0.1003  -3.09  0.002  2.669


S = 2.24952   R-Sq = 59.7%   R-Sq(adj) = 58.9%

PRESS = 1351.59   R-Sq(pred) = 57.13%
```

```
Lack of fit test
Possible interaction in variable Curvatur  (P-Value = 0.007 )


Possible interaction in variable DEM10m_T  (P-Value = 0.012 )

Possible lack of fit at outer X-values (P-Value = 0.001)
Overall lack of fit test is significant at P = 0.001
```

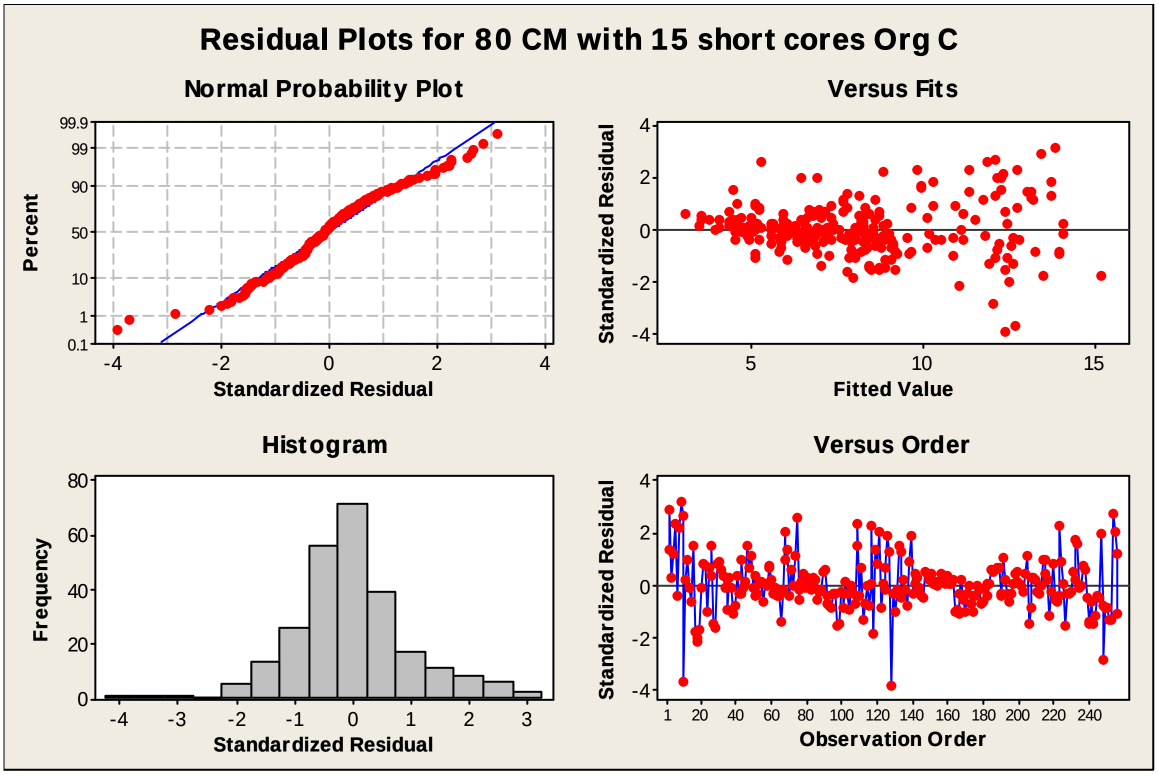


Figure 14 Residual plots for model fitted to "Outsdie the Red Box" data set. Several large residuals and increasing variance with increasing predicted soil carbon.

Red Box Model: Lack of Fit arising from an Interaction with Precipitation?

We investigated the lack of fit flagged by Minitab and shown in the output on p. 16 [4]. The test is detecting a complex interaction with precipitation. We tried modeling the interaction by adding cross product terms of no-till and slope position with precipitation. These terms were not statistically significant though addition of the terms did resolve the lack of fit flagged by Minitab.

We concluded that there is no simple adjustment to the model and so ended our investigation of lack of fit.

Results

Working with cores adjusted to a nominal 80 cm length, we found a relationship between soil organic carbon and no-till years for locations defined by specific ranges of precipitation and slope position: areas with relatively high annual precipitation and above the lowest slope positions. In terms of the predictor variables, the zone has DEM10m_TPI>=-1.25525 (24th percentile of the slope position) and INdec_81 (30 year average annual precipitation) >= 16.816878 inches (52nd percentile of precipitation).

In words, we can detect an effect of no-till years for areas roughly above median precipitation and above the bottom quartile of slope position.

For areas within the defined zone called the Red Box in our discussion, the model predicts that each year of no-till management is associated with an average increase soil carbon of 0.135 kg/m^2 after accounting for effects of precipitation and slope position, with approximate 95% confidence interval (0.044, 0.225). A conservative version of the model (assigning a single average value to replace duplicate cores) yields an average annual increase of 0.122 kg/m^2, with approximate 95% confidence interval (0.019,0.226).

For areas outside the Red Box, we cannot detect an effect of no-till years on soil carbon.

The model inside the Red Box zone captures less of the observed variability than outside the Red Box—it appears easier to characterize soil carbon levels in low slope positions and low annual precipitation.

In Figure 16, we summarize the models assuming independent errors and retaining three cores with high leverage in the precipitation predictor. The response in both is kg/m^2 of organic carbon.

For the predictors in common (precipitation and slope position), the models have similar shape: (1) negative coefficient for slope position, indicating more carbon at lower slope positions and (2) curvature in precipitation represented by a quadratic function. (In original units, the maximum of the quadratic function is at 26.1 inches annual precipitation for inside the Red Box model and 24.8 inches outside the Red Box model.) The common predictors provide some reassurance that our analysis and final models reflect important relationships in the Palouse landscape.

	Inside Red Box			Outside Red Box		
Predictor	Coefficient	Standard Error	p value	Coefficient	Standard Error	p value
Constant	6.0277	0.8238	0.000	6.460	1.165	0.000
Normalized Precip	4.790	1.023	0.000	2.2774	0.246	0.000
Normalized Precip^2	-1.6395	0.5557	0.004	-0.9260	0.2113	0.000
No Till Years	0.13455	0.04532	0.004			
Slope Code	2.4292	0.7845	0.002			
Slope Position	-0.3229	0.1609	0.047	-0.3103	0.1003	0.002
Curvature				-0.009425	0.001511	0.048
Elevation				0.004222	0.1003	0.006
number of obs	133			258		
Residual variation (S)	2.93958			2.24952		
R-Sq (adjusted)	36.7%			58.90%		

Figure 15 Summary Table of Regressions for two zones of the landscape.

Prediction Intervals within the Zone where No-Till Years has an effect

Given levels of precipitation, slope position and years of no-till management, the regression model gives an estimate of organic soil carbon. The model implies that there is linear increase in soil carbon in years of no-till management. The model also provides estimate of uncertainty to guide interpretation of model implications.

To illustrate the arithmetic, let's fix the level of normalized precipitation at a relatively high value (2.38798, which corresponds to 29.9179 inches of average annual precipitation) and the slope position at a relatively low value (-1.31313). Then we can calculate the prediction interval for each year of no-till management as shown in Figure 17.

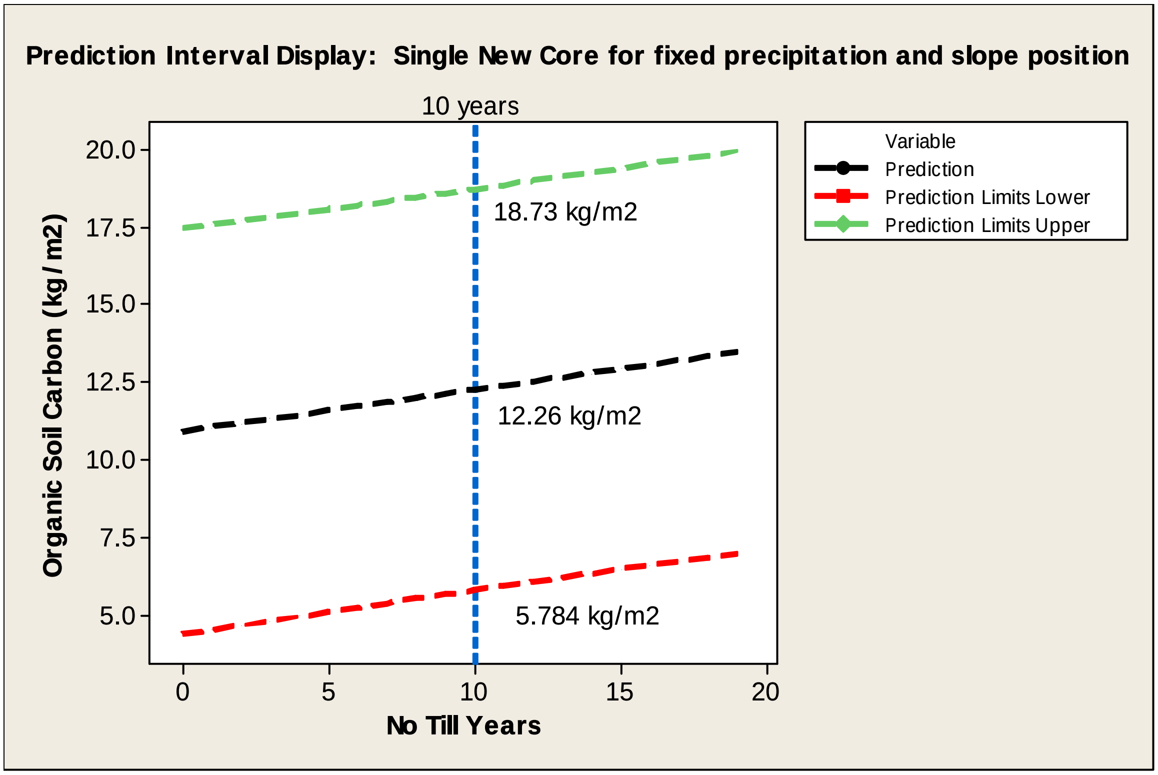


Figure 16 Prediction interval for organic soil carbon at a fixed precipitation, slope position, and no-till years.

At 10 years of no-till, the model predicts a value of 12.25 kg/m^2; the 95% prediction interval range is given by (5.784 kg/m^2, 18.73 kg/m^2). The interpretation of this interval is based on the usual language of confidence intervals: if we suppose that we can sample repeatedly from the same agricultural system at normalized precipitation 2.38798 and slope position -1.31313 and 10 years of no-till management, 95% of the intervals produced from the regression fit will contain the "true" value of soil carbon.

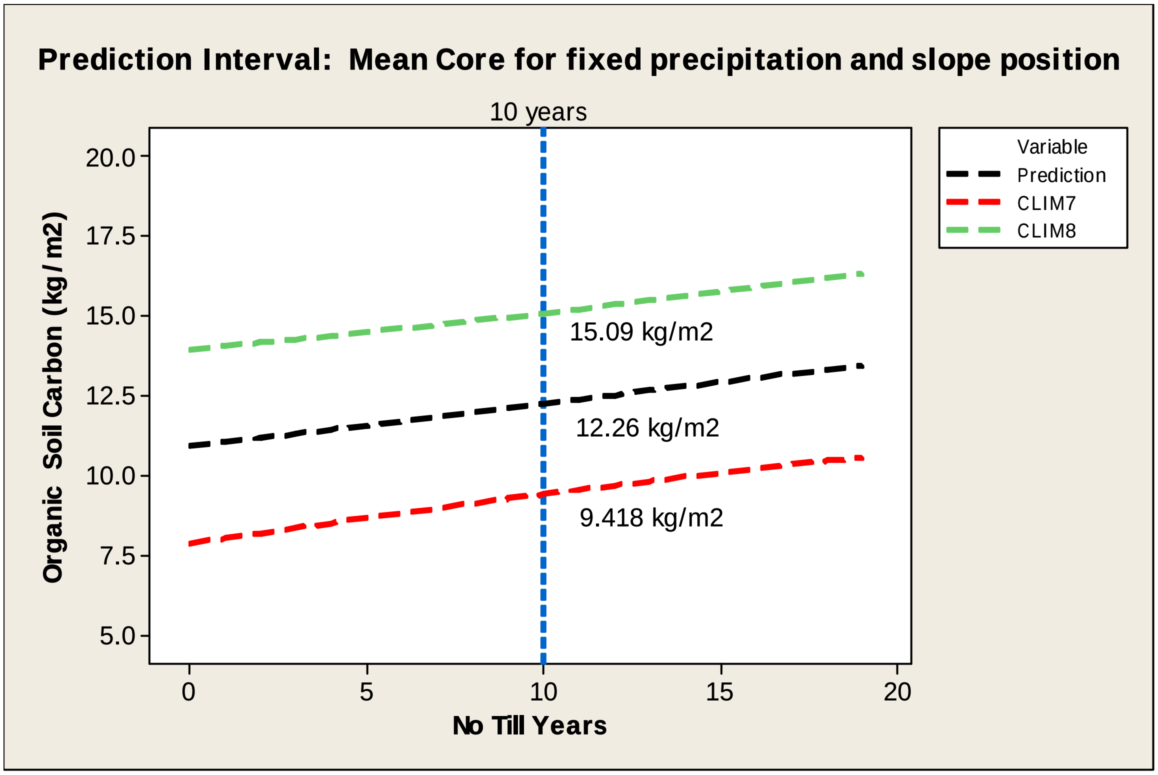


Figure 17 Prediction Interval for mean organic soil carbon at a fixed precipitation, slope position and no-till years.

We often "…act as though the probability that the calculated interval at this point will contain the [predicted value] is 0.95." [5], [6]

We can create a related graph, Figure 18, in terms of the **mean** response expected at a combination of predictors. In this graph, the width of the interval is narrower, as we are predicting the mean response over repeated imaginary samplings rather than the interval associated with a single new value.

Interpretation of the prediction displays

We see that the there is a substantial range of plausible values for organic soil carbon for a given set of predictors.

We can also interpret each display in terms of the regression coefficients: the center of the interval is the predicted soil carbon level when the coefficients for precipitation, slope position and no-till years take the values given by the least squares calculation. The coefficients are shown in the equation on p. 15.

The 95% interval for a single new observation, e.g. (5.784, 18.73) represents a range of prediction values. The range is determined by the variation in the regression coefficients. This variation is defined by the residual mean square error and the relationships among the predictors based on the "hat" matrix that maps the observed values into the predicted values. [7]

We chose seven values of slope position and five values of normalized precipitation and repeated the prediction calculations, using 95% confidence limits for the mean response. Figure 19 shows that these limits are relatively narrow in the center of the Red Box zone and wider near the edges of the Red Box zone. In particular, at high levels of precipitation, where there are relatively few observations in our model, the limits are noticeably wider.

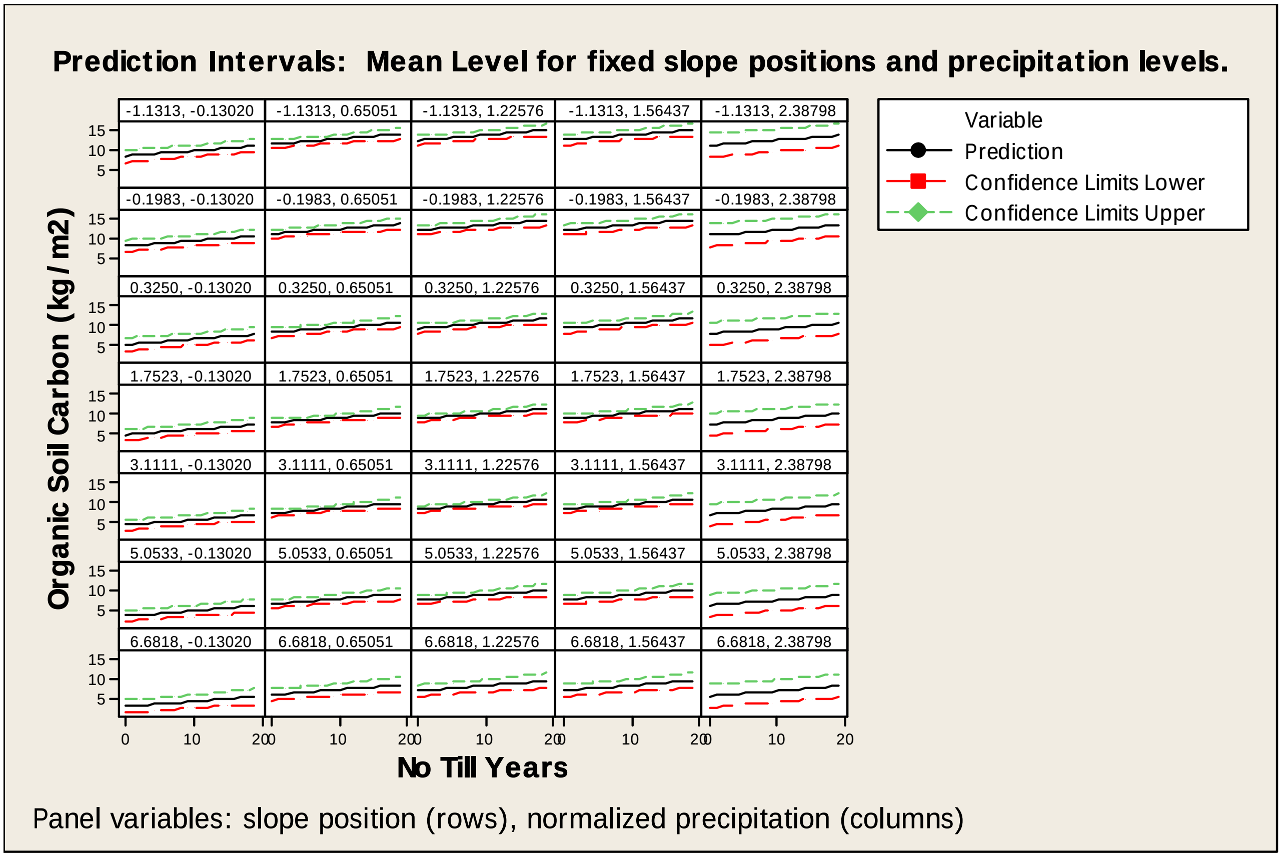


Figure 18. Display of Prediction intervals for fixed slope positions and fixed precipitation levels. The display reminds us that predictions have less variability near the center of the Red Box zone and more variability near the edges.

Method to estimate Carbon Accrual on a Farm

The regression model for the Red Box zone indicates a linear increase of kg/m^2 per year of no-till management, in the range 0 to 20 years. If we assume that the regression model and no-till years coefficient apply over time, it is simple to estimate farm-scale carbon accrual.

For example, to estimate carbon accrual on a farm in the Palouse region now using conventional tilling and the estimate of 0.135 kg/m^2 per year of no-till:

1. Determine the number of square meters of the farm that fall into the Red Box zone, M;
2. State the number of no-till years for which accrual will be estimated, Y, $0 < Y < 20$;
3. Calculate the mass of organic carbon accrual as M x Y x 0.135.

To account for land already under no-till management for N years, the method should be adjusted so that the number of years Y is replaced by $Y^* = \min(Y, 20-N)$, $0 < Y < 20$. If portions of a farm have been in no-till for several years and other portions have not, apply the steps to each portion of the farm separately.

Deriving preliminary estimate of uncertainty in carbon accrual

From the regression model, we can approximate the distribution of the no-till years parameter $b_{no\text{-}till}$ as Normal($\beta_{no\text{-}till}$, $\sigma^2_{no\text{-}till}$). We estimate $\sigma^2_{no\text{-}till}$ using the calculated standard error of the coefficient, $s_{no\text{-}till}$ = 0.04532, and center it at the observed coefficient. See Figure 18.

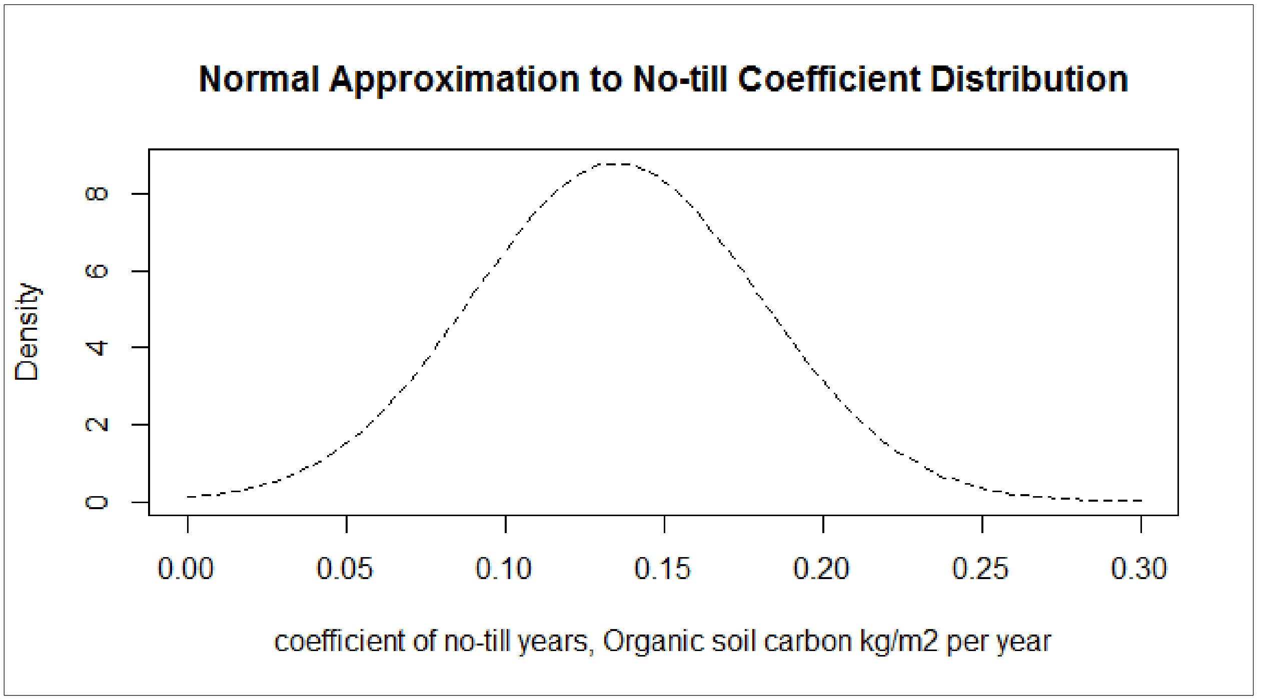


Figure 19 Normal approximation to no-till years coefficient using estimates from regression model.

To estimate the uncertainty in farm-scale accrual, the distribution of total accrual is approximated as

$$\text{Normal}(M \times Y \times 0.135,\ M^2 \times Y^2 \times s^2_{no\text{-}till}).$$

The approximate distribution can be used to build a range of estimates of accrual.

Limitations of the estimate of carbon accrual

This estimate of uncertainty in carbon accrual is likely to be optimistic in the sense that there is more variation that we have not considered:

a. We have ignored any contribution of variability from our estimate of s^2, which is a function of all the parameters and the specific model structure we used;
b. The regression model in the red-zone accounts for only about one third of the observed variation in organic soil carbon, so we know that there are other potential yet unknown factors driving soil carbon accrual.

As such, the estimate of uncertainty in carbon accrual provides a lower limit; that is, we can say we have at least the estimated variation in farm-scale accrual (and likely more variation.) The initial estimate provides a starting point for economic planning.

The estimate of farm-scale carbon accrual depends critically on the extension of our one-year, cross-sectional data analysis to the accrual of carbon over time. See the discussion of Limitations (next section) for additional comments on this critical point.

Conclusions and Limitations; recommendations for future sampling

We have proposed an additive linear model that describes the effect of no-till years on organic soil carbon. The model applies to areas within the Palouse defined by relatively high precipitation and slope positions. The model can be applied to estimate organic soil carbon accrual if AES scientists can justify the translation from a cross-sectional study to a longitudinal setting

Limitations

Inference: Prediction of future carbon accrual

To estimate potential carbon accrual over time, AES scientists must apply subject matter knowledge. The key step is to justify the relevance of the regression model to accrual, which is inherently a multiple year process.

To make the justification, there are at least two critical assumptions:

(1) the effect of no-till years, derived from records of years of no-till on different locations, is the same as the effect of increasing years of no-till on the same location;
(2) the areas of land that experienced different years of no-till management in our data set are essentially like the areas of land that will experience no-till management in the future.

Variation arising from analysis method

For each core, we worked with carbon summed over horizons. As noted in Appendix 1 (discussion of duplicates), the estimate of core carbon depends on the estimate for each horizon, which in turn depends on analysis of horizon boundaries. It is likely that the variance contributed by lab procedures (including estimation of horizon boundaries by lab analysts) is relatively small but we have as yet no way to characterize the variation or its components.

Focus on portion of the entire data set

To estimate impact of no-till years, we set aside analysis of cores from CRC and remnant native areas. Also, we worked with organic soil carbon core by core. Once the calculations of soil carbon were in hand, we ignored the horizon structure. Analysis of entire cores provides one level of insight; the detailed horizon level data awaits analysis.

Independence Assumption: Effect of Duplicates

We developed the Red Box model with regression analysis that assumed statistical independence. As discussed in Appendix 2, there is a modest effect on final parameter estimates and standard errors when we relax that assumption and allow within duplicate core correlation to be greater than zero. A conservative re-analysis could retrace all our steps with a data set that replaces duplicate cores with a single core average for each duplicate pair. We did not re-do the analysis; rather we checked the impact of duplicate cores after developing the Red Box model analysis and reported this in Appendix 2.

Future Sampling

We noted the lack of samples in the center of the precipitation range overall (Figure 6) and the lack of samples for low and high levels of precipitation for 1-5 years of no-till and 21+ years of no-till management (Figure 1). Future samples that fill in these missing regions could provide insight into model issues related to precipitations, especially curvature.

Given the practical challenges of extracting intact cores, we also recommend that if AES scientists aim for a core length of K cm, then the procedure should extract cores of length K + L cm. Our preliminary experience with the Palouse cores suggests a value of L of 20 cm to reduce the need to make post-sampling adjustments to core length.

References

1. USDA NRCS National Soil Survey Center (2011), Soil Survey Laboratory Information Manual: Soil Survey Investigations Report No. 45, Version 2.0.
2. MINITAB® version 16.2.3, www.minitab.com
3. "Measuring and Comparing Soil Carbon Storage" by B.H. Ellert, H.H. Janzen and B.G. McConkey, Chapter 10 in R. Lal, J.M. Kimble, R. Follett and B.A. Stewart (eds.), Assessment Methods for Soil Carbon (2000), Lewis Publishers, Boca Raton, FL.
4. D.X. Wang and M.D. Conerly (2008), "Evaluating the power of Minitab's data subsettting lack of fit test in multiple linear regression," *Journal of Applied Statistics*, **35**, 1, 115-124.
5. N.R. Draper and H. Smith (1998), Applied Regression Analysis, 3rd edition, John Wiley & Sons: New York, p. 81.
6. Minitab Methods and Formulas, version 16.2.3

Confidence interval

The range in which the estimated mean response for a given set of predictor values is expected to fall. The formula is:

$$\hat{y}_o \pm t_{(1-\alpha/2,\, n-p)} * s(\hat{y}_o)$$

$$s(\hat{y}_o) = \sqrt{s^2(\mathbf{x}'_o(\mathbf{X}'\mathbf{X})^{-1}\mathbf{x}_o)} = \sqrt{\mathbf{x}'_o s^2(b)\mathbf{x}_o}$$

Notation

$\hat{y}_o$ = fitted response value for a given set of predictor value

α = level of significance

n = number of observations

p = number of terms in the model

$s^2(b)$ = variance-covariance matrix of coefficient

s^2 = mean square error

$\mathbf{x}$ = predictor matrix

$\mathbf{x}_o$ = matrix of given predictor values

Prediction interval

The range in which the predicted response for a new observation is expected to fall. The formula is:

$$\hat{y}_o \pm t_{(1-\alpha/2,\, n-p)} * s(\text{Pred})$$

$$s(\text{Pred}) = \sqrt{s^2 (1 + \mathbf{x}'_o (\mathbf{x}'\mathbf{x})^{-1} \mathbf{x}_o)}$$

Notation

$\hat{y}_o$ = fitted response value for a given set of predictor value

α = level of significance

n = number of observations

p = number of terms in the model

s^2 = mean square error

$\mathbf{x}$ = predictor matrix

$\mathbf{x}_o$ = matrix of given predictor values

7. D. C. Hoaglin and R. E. Welsch (1978), “The Hat Matrix in Regression and ANOVA,” *The American Statistician*, **32**, No. 1, pp. 17-22.

8. Draper and Smith *op cit*., p. 221-223.

9. Notes on Generalized Linear Model in R by Ingo Ruczinski , Johns Hopkins School of Public Health, http://www.biostat.jhsph.edu/~iruczins/teaching/jf/ch5.pdf accessed 1 July 2013.

Appendix 1: Duplicate Data Analysis final memo 29 April 2013, revised 28 June 2013

Introduction

The AES team gathered 102 pairs of cores to provide insight into variation in field conditions, sampling methods and lab analysis. This represented a significant fraction of the 710 cores extracted from the field in 2012.We recommend that the AES team review the unusual core pairs flagged by the control chart analysis with the soils lab to enable the lab to comment about variation in horizon analysis.

We also recommend that AES team review the table of duplicates cores (horizon levels) in order to gain intuition about general ability of a soils lab to characterize cores that are physically adjacent. This is relevant to TEP programs that seek to develop and maintain carbon markets.

In this appendix, we summarize the duplicate data, identify issues with a small number of pairs, and derive summary estimates of organic carbon variability based on 80 cm cores.

Data Description

AES obtained 102 pairs of duplicate cores. Of those 102 pairs, 83 pairs are in the H1-H5 subset that was the focus of analysis. We ultimately analyzed 75 pairs in terms of the "adjusted to 80 cm data" set that was used in final model work.

Variable	Duplicates?	N	N*	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Full Core OC	NO	504	2	8.430	4.205	0.320	5.514	7.743	10.712	24.904
	YES	204	0	8.628	4.077	1.761	5.625	7.854	10.746	21.684
Full Core Length CM	NO	504	2	83.837	19.843	13.000	80.000	93.000	97.000	100.000
	YES	204	0	88.912	13.740	23.000	87.000	95.000	97.000	100.000
80 CM with 15 short core	NO	386	120	8.607	3.778	0.858	5.779	7.875	10.596	20.794
(H1-H5) OC	YES	177	27	8.563	3.729	1.669	6.024	7.717	11.087	19.009

For the full data set, we see that the duplicates have less variability as measured by the standard deviation (StDev) for both the full core organic carbon and full core length. The difference between the duplicates and the remainder of the data is appropriately reduced in the 80 cm adjusted data set for the H1-H5 management codes. We have no evidence that the cores that are part of duplicate pairs differ in important ways from the cores that are not part of duplicate pairs.

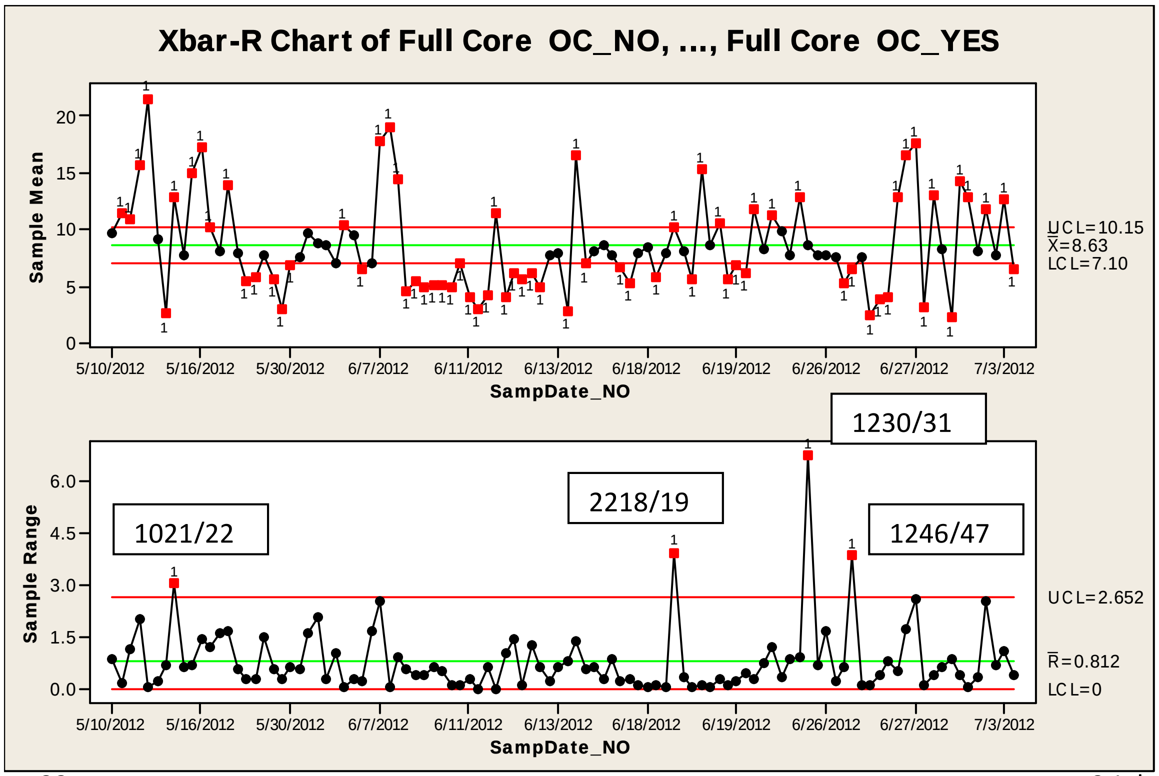
Analysis

In this section, we use control charts to identify duplicate pairs that show unusually large within pair variation for both organic carbon and length. Study of the unusual pairs is a first step to understanding variation in field conditions, sampling methods and lab analysis.

102 pairs of duplicates, Organic Carbon and length

We focus attention on the lower chart, which plots the within pair range. This control chart shows that four of the duplicate pairs have unusually large differences in organic carbon. Note that the upper chart, which shows the average value for each pair, shows much more variation between pairs than within pairs, which is what we expect to see.

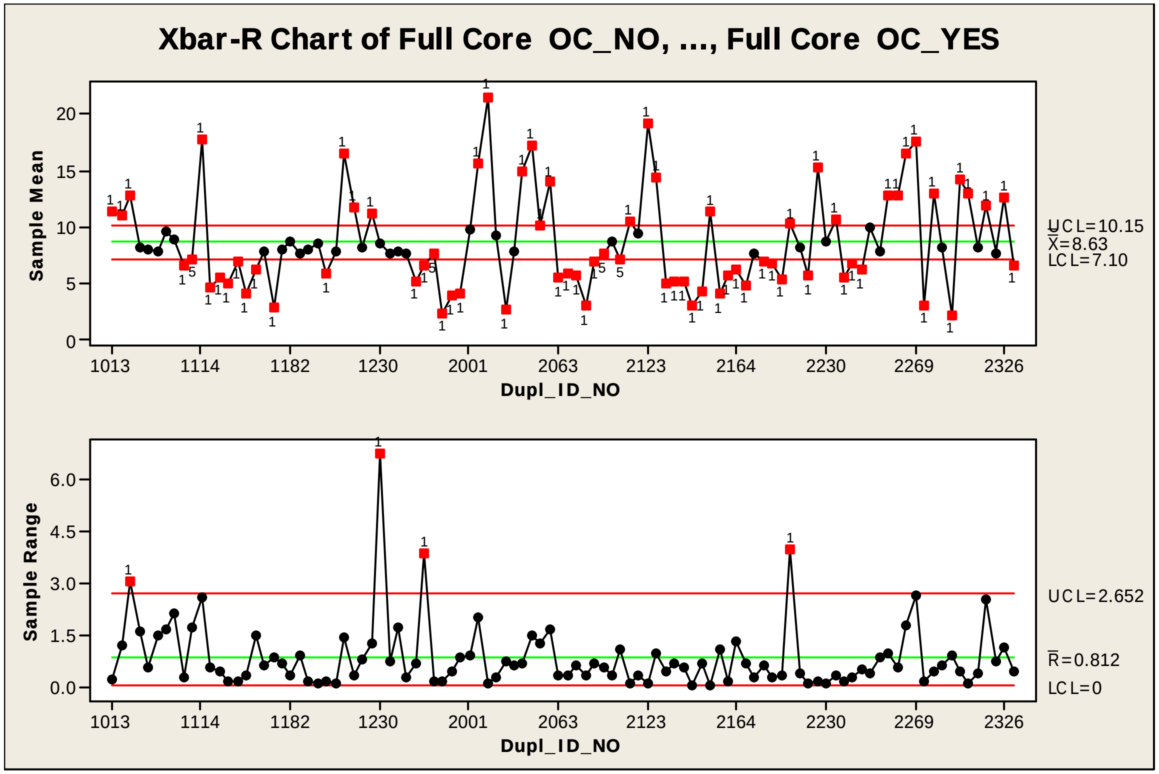
Out of control points relate to pedon IDs 1021, 1230, 1246, and 2218.



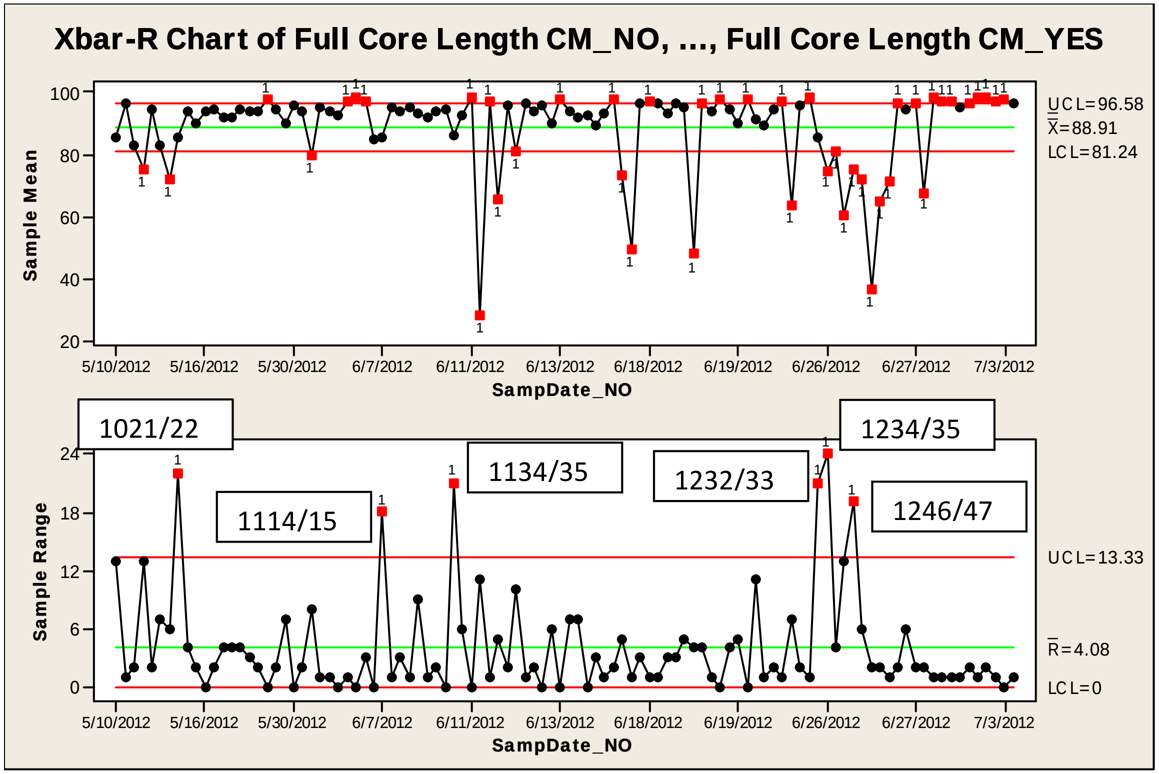
Descriptions of out of control pairs, organic carbon

(1) P6-UP-SW-H2 1021 and 1022 pair: bottom horizon different (Transition vs subsoil) and hence carbon values different and 1021 is 22 cm longer than 1022.
(2) P4-UP-SW-H4 2218 and 2219 pair, the last layer of 2219 carbon should be coded as MISSING, it is entered in the data table as ZERO, hence underestimating the total carbon.
(3) P3-LO-NE-H4 1230 and 1231 pair: very different carbon estimates in topsoil layers (Ap) and different assessment of horizons.
(4) P3-LO-SW-H5 1246 and 1247 pair, the last layer of 1247 was discarded, 1247 much shorter than 1246.

The control charts at right puts the values in pedon order for reference.



Length of core as control chart variable



Descriptions of out of control pairs, length

(1) P6-UP-SW-H2 1021 and 1022 pair: bottom horizon different (Transition vs subsoil) and hence carbon values different and 1021 is 22 cm longer than 1022. This pair is out of control on the OC chart.

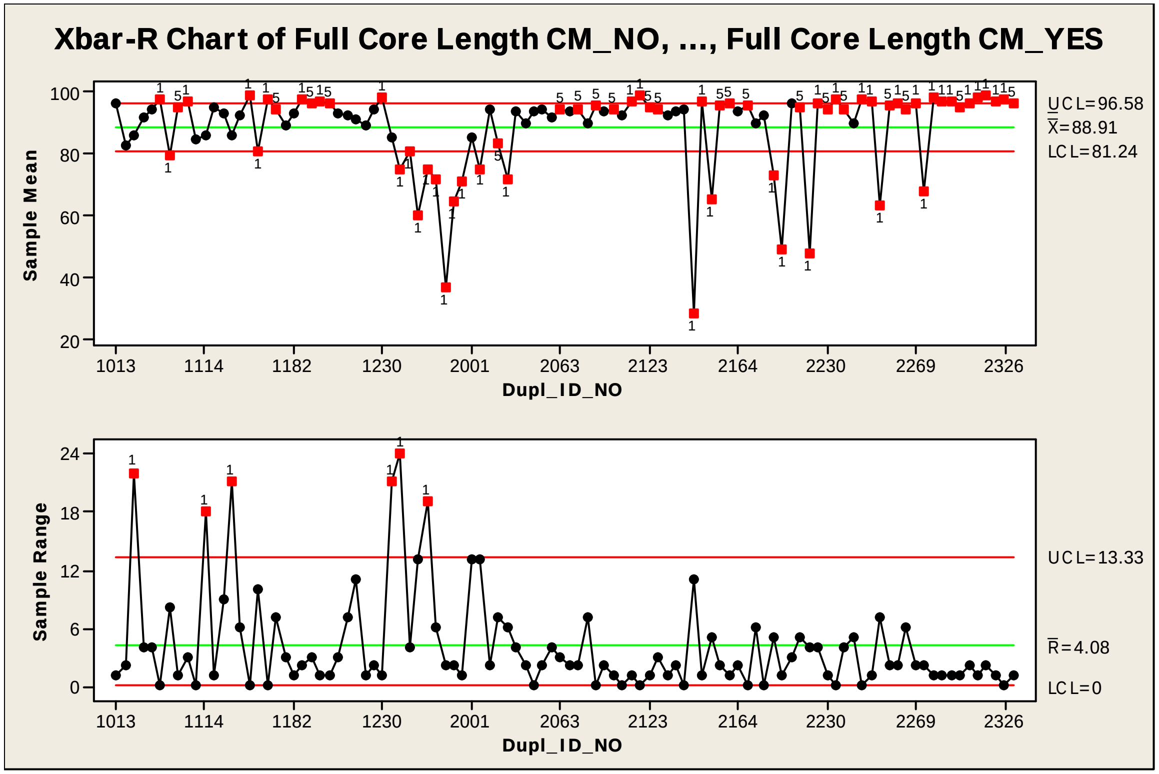
(2) 1114 and 1115 pair: lost bottom of 1114? Only two horizons observed. 18 cm difference.

(3) 1134 and 1135 pair: 23 cm difference, lost bottom of 1134? CRP Samples, these cores do not affect H1-H5 analysis (see below).

(4) 1232 and 1233, lost bottom of 1233? 21 cm difference. AES field notes say bedrock resistance at 70 to 80 cm.

(5) 1234 and 1235, soil fell out of bottom of 1235? 24 cm difference.

(6) 1246 and 1247, lost bottom of 1247 only 2 horizons observed and lost bottom horizon sample. See lab note. 19 cm difference. AES says "Known shallow soils" but like 1232/1233, 1246 gets to 85 cm while 1247 gets only to 66 cm. This pair is out of control on the OC chart.



Control chart with points in pedon order, for reference.

H1-H5 subset

83 duplicate pairs (166 cores) are in the H1-H5 subset used for modeling (conventional plus no-till management areas)

Of 19 duplicate pairs—38 cores—in the complementary subset, 17 of 19 are duplicates from CRP Cropland.

Display at right shows Field sampling order OC control charts.

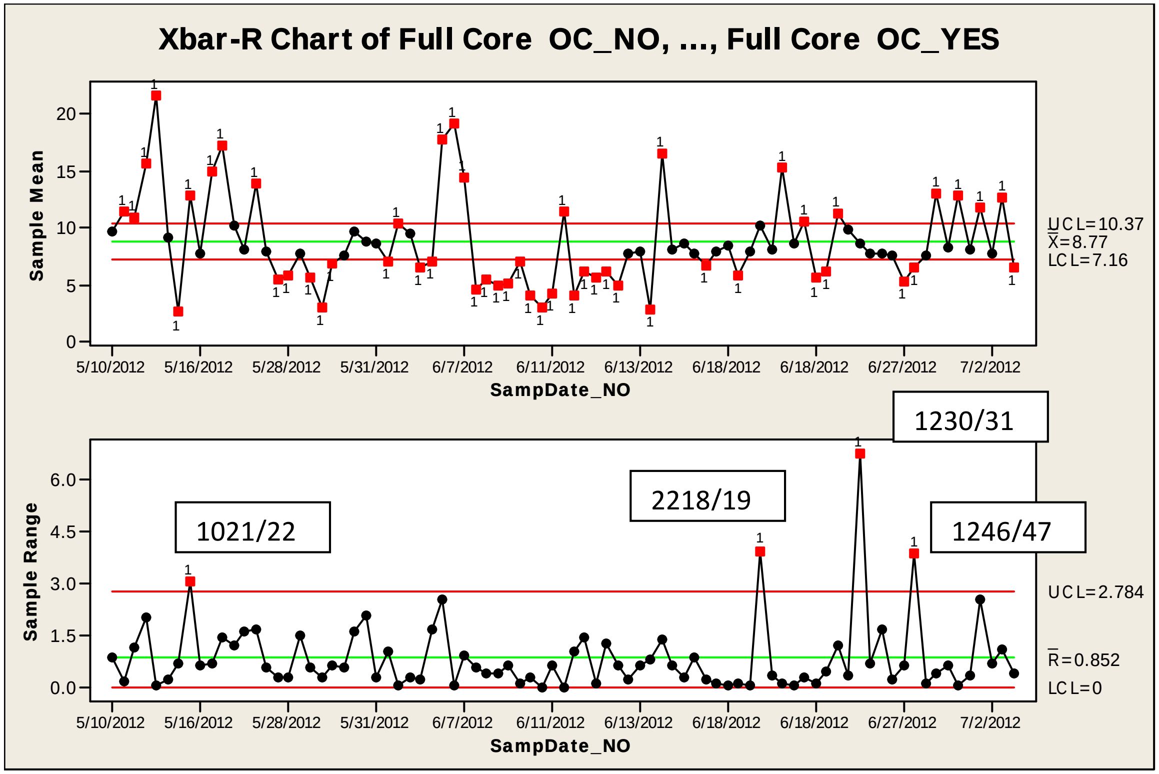
Pairs flagged as out of control in the H1-H5 subset are same as those flagged in full data set:

1021/22

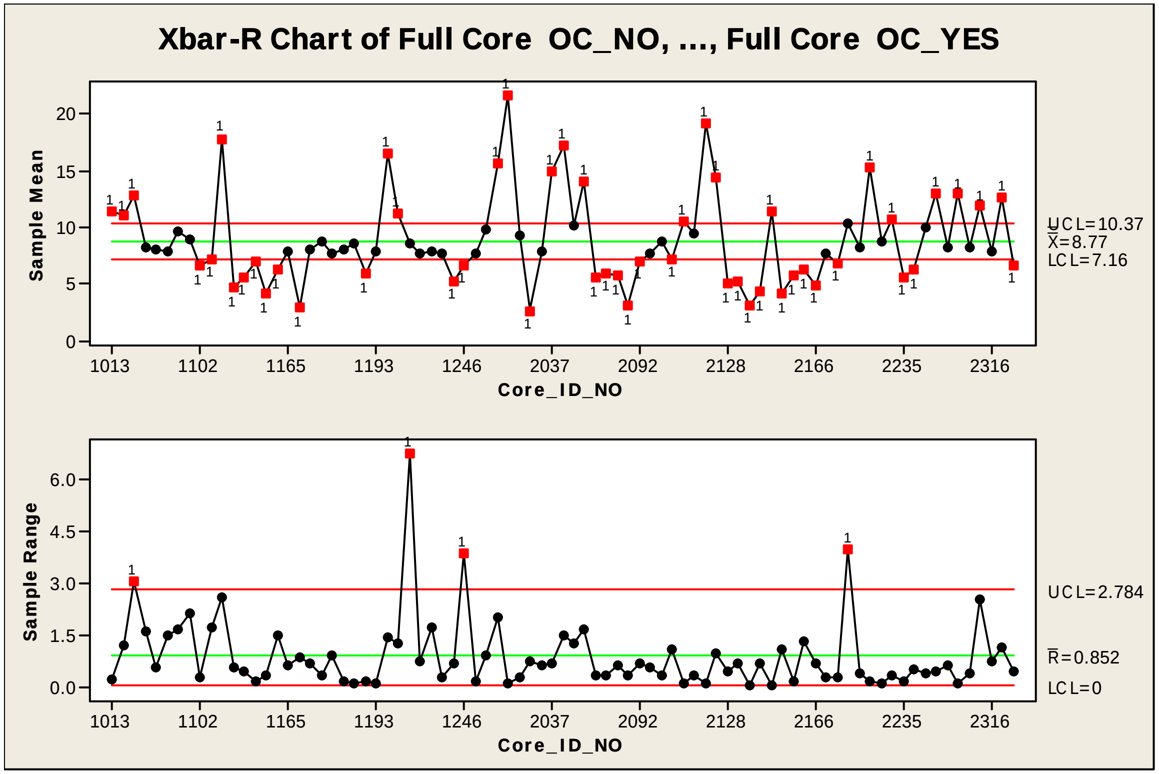
1230/31

1246/47

2218/19

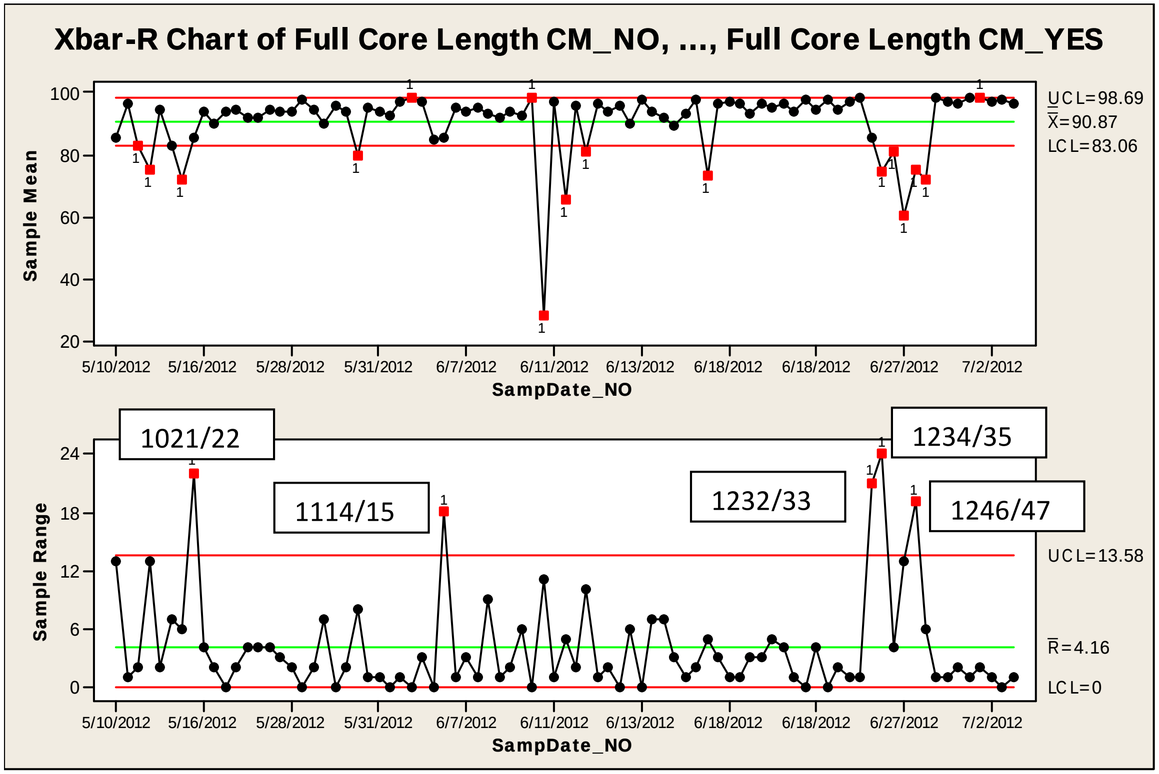


Pedon ID order to make it easier to find cores.

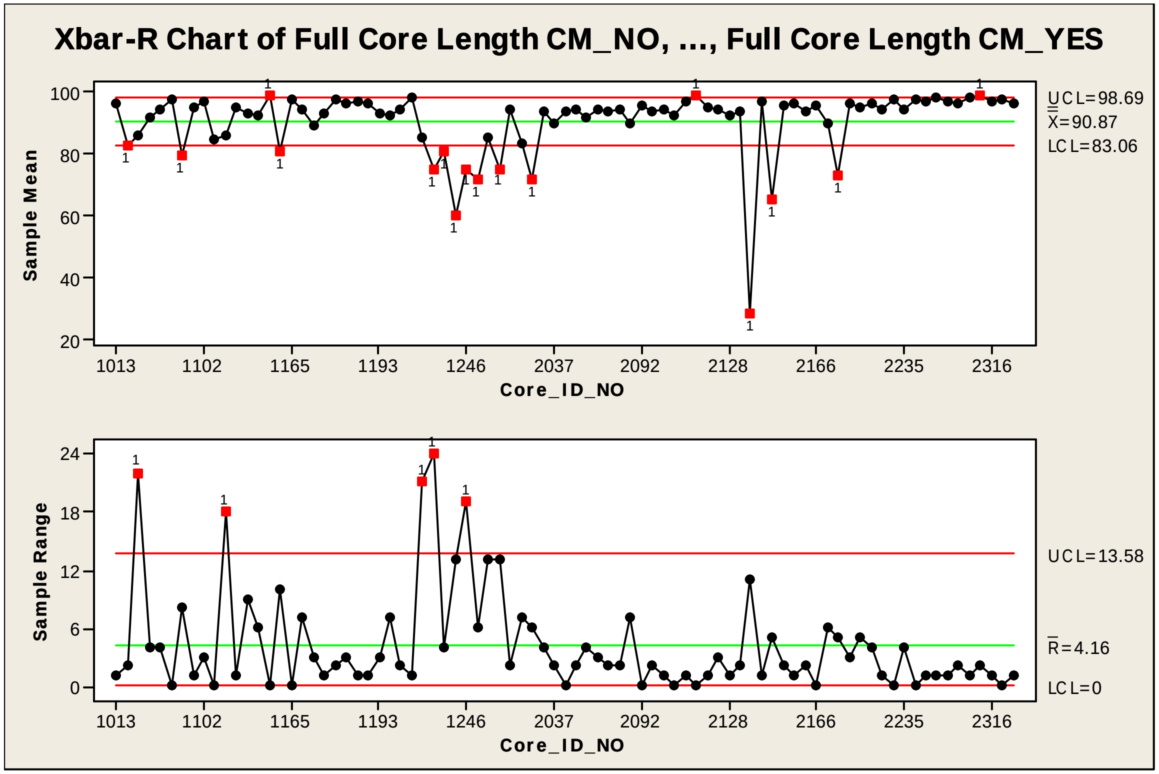


Length of core as control chart variable

In field sampling order, the same pairs are flagged as in the full set: 1021/22, 1114/5, 1232/3, 1234/5, 1246/7 (1134/5 is CRP, set aside from H1-H5 subset.)



Pedon order chart at right



Comparison Full and H1-H5 subset	R bar	R UCL
Organic carbon		
All duplicates	0.812	2.652
Duplicates in H1-H5	0.852	2.874
length		
All duplicates	4.08	13.33
Duplicates in H1-H5	4.16	13.58

The variability in the duplicate pairs increases from the full set to the H1-H5 subset on the order of 5% for carbon and 2% for length.

In other words, there is bit less variability in the duplicates set aside when we form the H1-H5 subset; recall the set aside cores are mostly from CRP cropland.

Adjusted data set: both cores of duplicate pair are >=80 cm and we use 80 cm adjusted OC value

The final data set used for modeling organic carbon consisted of cores that were at least 80 cm in length. These cores then had organic carbon values adjusted so that each core represented a nominal 80 cm long core. In addition, AES identified 15 cores that were shorter than 80 cm that we estimated carbon equivalent to an 80 cm length. Three of these cores, 1022, 1114, 1235, involved duplicate pairs flagged as out of control in control charts for length, full data set.

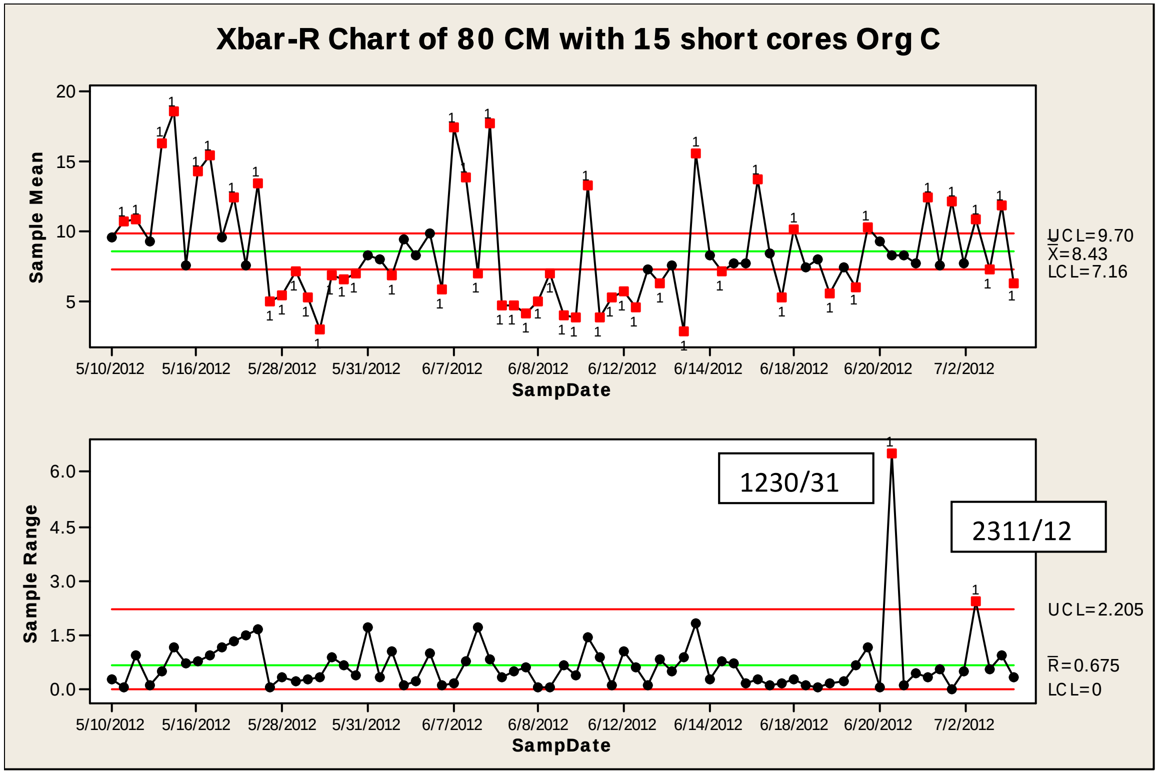
Note for pairs 1246 /47 (31 years no-till) and 2218/19 (13 years no-till), there are measurement anomalies. 1247 and 2219 both have bottom horizon samples labeled as missing or discarded in the lab notes, thus providing censored values for the organic carbon. Both of these pairs are excluded in the 80 cm adjusted data set for the duplicate analysis in this section.

Pair 1232 and 1233 indicated as resistance at 70 to 80 cm, 1233 is short. This pair is also excluded in the 80 cm adjusted data set for duplicate analysis (in workbook *80 cm Short Adjusted (UseHCODE = 1) LF 15 April combo source.MTW(DupSubset = 1),* project *duplicate analysis 9 April 2013.MPJ*.)

After these operations, we have 150 cores in 75 pairs for analysis.

(Reference to AES notes from file *AES proposal H1-H5short cores 5 April 2013.xls* in

C:\Users\Kevin\Documents\Applied Ecological Services\2012 Soil Project work\September 2012 update\April 2013 analysis\Short Core Analysis.)



Pairs out of control on the 80 cm truncated plot are 1230/1231 and 2311/2312

(1) P3-LO-NE-H4 1230 and 1231 pair; very different carbon estimates in topsoil layers (Ap) and different assessment of horizons.
(2) P6-UP-SW-H1 2311 and 2312 pair Lab notes on hillslope sediment affecting top horizon of these cores—difficult to interpret?

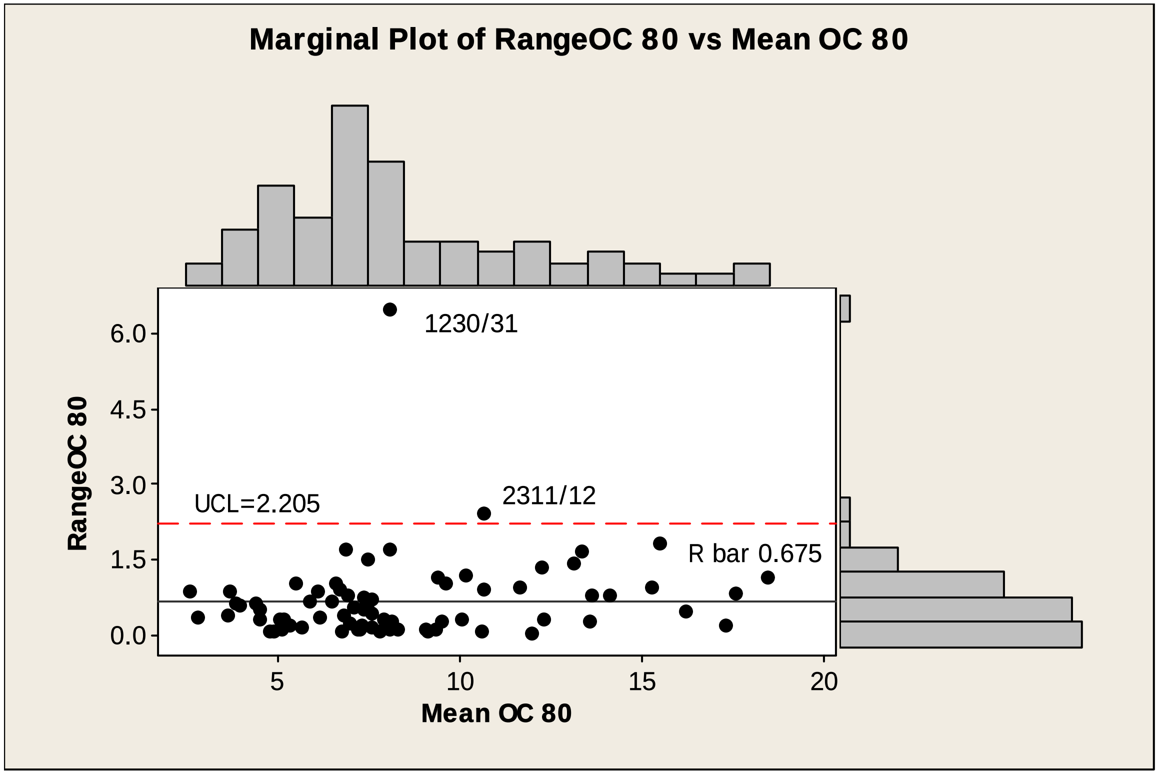
This extract from lab data sheet illustrates the difference in horizon structure of the cores in the 2311/2312 pair:

Data Date	Pedon_id	SCL Lab	Core Top (cm)	Core Bottom (cm)	Horizon	
12/7/2012	2312	PAL2312-1	0	31	Ap	Ap horizon is hillslope sediment
12/7/2012	2312	PAL2312-2	31	51	A	
12/7/2012	2312	PAL2312-3	51	100	B	
12/7/2012	2311	PAL2311-1	0	19	Ap	Surface is hillslope sediment from upslope B material
12/7/2012	2311	PAL2311-2	19	69	2BA	
12/7/2012	2311	PAL2311-3	69	98	3BA	

Note the difference in horizon depths and type; review of duplicates at the horizon level can yield insights into core structure and lab analysis.

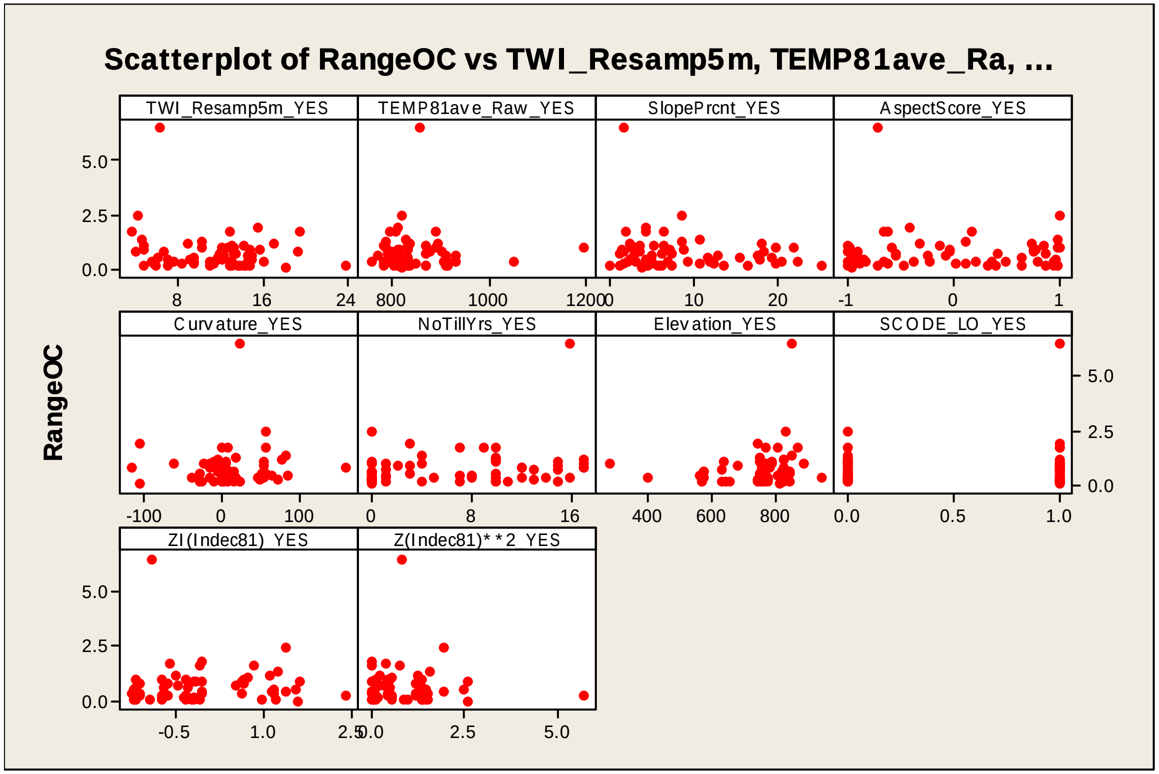
Can we use a single estimate of variability across the entire range of organic carbon values?

The variability increases somewhat as the mean of the pair increases but we can use the overall estimate of R-bar to estimate duplicate variability.



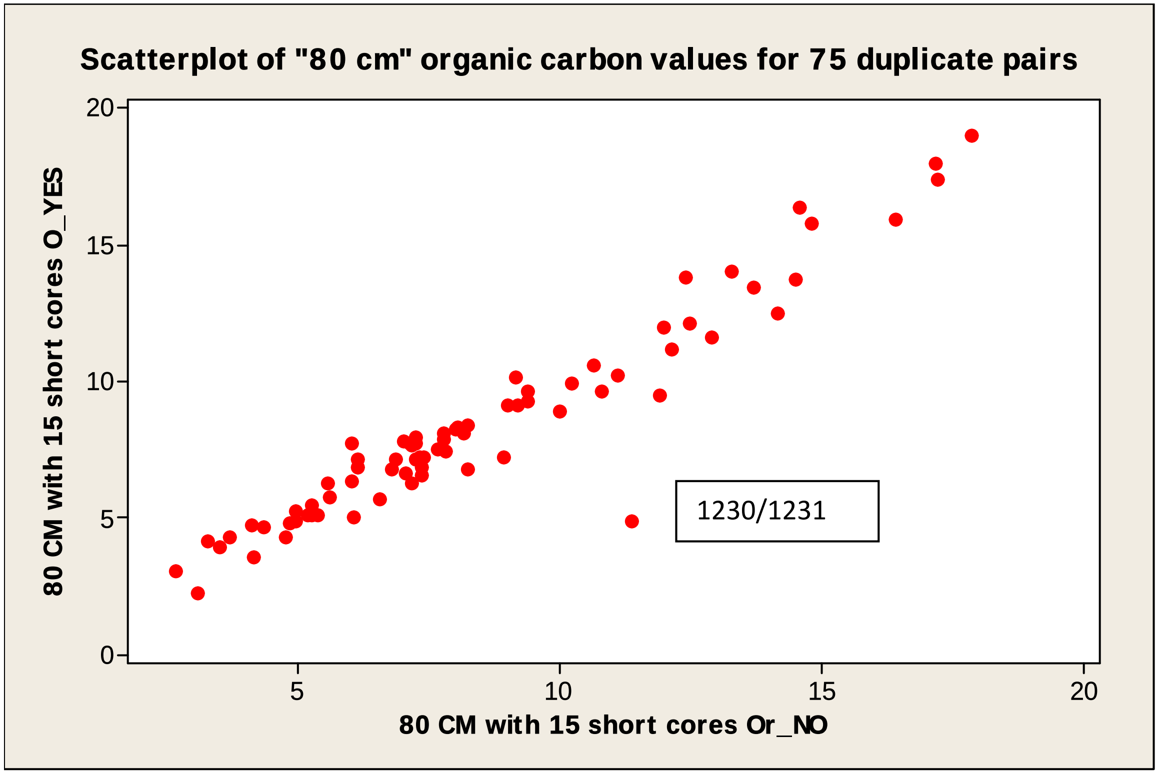
To match our modeling work (which focused on no till years < 20), we next looked at the 66 pairs of duplicates in that range of no-till years.

We see no dependence of range on the predictors in scatterplots on the next page.


Scatterplot of RangeOC vs TWI_Resamp5m, TEMP81ave_Ra, ...
TWI_Resamp5m_YES
TEMP81ave_Raw_YES
SlopePrcnt_YES
AspectScore_YES
Curvature_YES
NoTillYrs_YES
Elevation_YES
SCODE_LO_YES
ZI(Indec81)_YES
Z(Indec81)**2_YES
RangeOC

Another view of duplicate pairs

Let's return to the 75 pairs of duplicates in the H1-H5 80 cm adjusted data set, without restricting the number of no-till years. Here is the scatter plot of carbon values (each point gives the carbon values for a specific duplicate pair.) The duplicate pairs cover most of the range of observed carbon in the corresponding H1-H5 data set and show the expected result—pairs should plot on a straight line with slope close to 1. This plot provides another view to identify pairs of values that appear unusual.



(worksheet *80 cm Short AdjHCode=1 DupSubset LF date sort 1232-33 2218-19 1246-47 deleted* in project *duplicate analysis 9 April 2013.MPJ*)

If we omit the 1230/1231 pair, the correlation coefficient is 0.977. (Note that this pair is outside the Red Box used in the analysis of the final models.)

Regression Analysis: 80 CM with 15 short cores value 1 versus 80 CM with 15 short cores value 2

```
Weighted analysis using weights in Wt 1230/1 (set this pair aside)


The regression equation is
80 CM with 15 short cores value1 = 0.067 + 0.988 80 CM with 15 short cores value2


74 cases used, 1 cases contain missing values
                          or had zero weight


Predictor                            Coef  SE Coef      T      P
Constant                           0.0666   0.2330   0.29  0.776
80 CM with 15 short cores value2  0.98776  0.02534  38.98  0.000


S = 0.790722   R-Sq = 95.5%   R-Sq(adj) = 95.4%  (correlation 0.957)


Analysis of Variance

Source          DF      SS      MS        F      P
Regression       1  950.14  950.14  1519.63  0.000
Residual Error  72   45.02    0.63
Total           73  995.15


Unusual Observations

      80 CM with   80 CM with
        15 short     15 short
Obs  cores Or_NO  cores O_YES      Fit  SE Fit  Residual  St Resid
  6         17.9      19.0087  17.7072  0.2555    1.3015      1.74 X
 22          8.9       7.2292   8.8885  0.0927   -1.6593     -2.11R
 29         17.2      17.3986  17.0714  0.2404    0.3271      0.43 X
 31          6.0       7.7209   6.0275  0.1104    1.6934      2.16R
 32         17.2      17.9766  17.0339  0.2395    0.9427      1.25 X
 49         14.6      16.4060  14.4770  0.1807    1.9291      2.51R
 72         11.9       9.4742  11.8266  0.1270   -2.3523     -3.01R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
```

The initial regression suggests the intercept could be zero. Forcing the intercept to be zero yields a regression that has essentially unit slope as we should expect.

Regression Analysis: 80 CM with 15 short cores value 1 versus 80 CM with 15 short cores value 2 (intercept 0)

```
Weighted analysis using weights in Wt 1230/1 (set this pair aside)



The regression equation is
80 CM with 15 short cores value1 = 0.994 80 CM with 15 short cores value2


74 cases used, 1 cases contain missing values
                          or had zero weight


Predictor                           Coef   SE Coef       T      P
Noconstant
80 CM with 15 short cores Or_NO  0.994409  0.009933  100.11  0.000


S = 0.785733


Analysis of Variance

Source          DF      SS      MS         F      P
Regression       1  6187.3  6187.3  10021.91  0.000
Residual Error  73    45.1     0.6
Total           74  6232.4


Unusual Observations

      80 CM with   80 CM with
        15 short     15 short
Obs  cores Or_NO  cores O_YES      Fit  SE Fit  Residual  St Resid
  5         16.4      15.9520  16.3381  0.1632   -0.3862     -0.50 X
  6         17.9      19.0087  17.7595  0.1774    1.2492      1.63 X
 13         14.2      12.5245  14.0816  0.1407   -1.5571     -2.01R
 22          8.9       7.2292   8.8813  0.0887   -1.6521     -2.12R
 29         17.2      17.3986  17.1194  0.1710    0.2792      0.36 X
 31          6.0       7.7209   6.0011  0.0599    1.7198      2.20R
```

```
 32          17.2       17.9766  17.0816  0.1706    0.8950
 49          14.6       16.4060  14.5074  0.1449    1.8986      2.46R
 72          11.9        9.4742  11.8392  0.1183   -2.3650     -3.04R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
```

Results

Let's represent the organic carbon content of the i-th set of adjacent 80 cm cores with j=1, 2 as normal random variables

$$X_{ij} \sim N(\mu_i, \sigma^2)$$

Our notation says that the mean level of organic carbon can vary among duplicate pairs but the variation in carbon doesn't depend on the mean level of carbon.   This isn't exactly right but is close enough for a first approximation.

We also can suppose that the carbon content of cores within a pair may be positively correlated:

$$Corr(X_{i1}, X_{i2}) = \rho > 0$$

In our approximation, let's state that the correlation doesn't depend on the mean level of carbon.

Now relate these calculations to the control chart analysis in the previous section.

If $D_i = X_{i1} - X_{i2}$ represents the i-th difference, then we can calculate the variance of D_i from the formula for the variance of the sum or difference of two random variables:

$$\sigma_D^2 = Var(D_i) = 2\sigma^2(1 - \rho) \qquad (1)$$

We have the distribution of D_i

$$D_i \sim N(0, \sigma_D^2)$$

We can use the control chart results and theory (e.g. Wheeler and Chambers (1992) *Understanding Statistical Process Control, 2nd edition*, SPC Press.)

In the control chart analysis, we calculated the ranges, which are the absolute values of the adjacent pair core differences, $R_i = |D_i|$.

The distribution of R_i is called the folded normal distribution (http://www.math.uah.edu/stat/special/FoldedNormal.html, accessed 28 April 2013). Given the mean and variance of D_i, the expected value of R_i is determined:

$$E(R_i) = \sigma_D \sqrt{2/\pi} \qquad (2)$$

We estimate the expected value of R_i by the average of the ranges ("R-bar") = 0.596 (after we set aside the range from the pair 1230/31):

$\widehat{\sigma_D}$ = 0.7470 kg C/m^2.

This estimate $\widehat{\sigma_D}$ combines short-distance ("adjacency") field variability, variability in sampling technique and variability in lab analysis. This estimate of variation is essentially "pure error", used in regression analysis to check lack of fit. (Note that Minitab will attempt to compute a pure error test, using records that have the same predictors, which is the case for our duplicate cores. For the model fitted to the Red Box cores on p. 17 of the main report, Minitab reports a similar pure error estimate of 0.64 based on duplicates just in the Red Box zone).

We expect the carbon content of two adjacent cores to be equal on average; thus, an absolute difference in carbon greater than $2\widehat{\sigma_D} = 1.4940$ kg C/m^2would be declared unusual; this calculation corresponds to an approximate 95% confidence interval.

The TEP method requires users to estimate carbon content of cores to a given level of precision. Given the structure of the TEP sampling plan, the $\widehat{\sigma_D}$ estimate should be used for "near neighbor" sampling used to estimate carbon accrual over time.

Can we isolate components of variability?

Given the nature of the soil cores and the method of analysis, the soils lab indicated that that they could not create a true split sample to evaluate lab analytic variability. In our discussion with the lab, we believe that estimates of density are very precise; estimates of carbon percent may be somewhat less precise. However, the lab analysis is not a simple chemical or physical analysis; remember that the cores are divided into sections based on evaluation of horizon boundaries. Then sections are evaluated for density and percent carbon and we apply a uniformity assumption: that density and carbon content are uniform within horizon sections. It seems that the assessment of core horizon and application of the uniformity assumption may contribute more variation to final estimates than the procedures to assess density and carbon content, once a soil sample is in hand.

If cores will be evaluated in the future as they were in this study, we do not see a simple way to decompose the overall estimate of variability $\widehat{\sigma_D}$ into components.

Conclusion

We can use the estimate of σ derived from the duplicates to characterize the combination of near-location field variability, variability in sampling technique and variability in lab analysis. This estimate appears to be free of influence by model predictors and is consistent with the pure error estimate derived in Minitab regression calculations.

If the derived value of variability is too large for commercial use (e.g. in the TEP method), then multiple samples must be taken at each sampling event to reduce the variability in estimating mean levels of organic soil carbon.

Appendix 2: Check on Duplicates and the Red Box model expression

Here's a schematic of the regression model:

$$\mathbf{y} = \mathbf{f}(x_1, x_2, \ldots, x_n) + \mathbf{g}(x_{n+1}, x_{n+2}, \ldots, x_m, \ldots) + \text{variation in physical sampling and lab analysis}$$

In our proposed model for the Red Box zone, **y** is the organic soil carbon from the adjusted cores; we have five x's to predict soil carbon and the function **f** is the equation shown on p. 15:

```
The regression equation is
80 CM with 15 short cores Org C = 6.03 + 4.79 ZI(Indec81) - 1.64 Z(Indec81)**2 + 0.135
NoTillYrs + 2.43 SCODE_LOzero- 0.323 DEM10m_TPI
```

Function **g** represents all the other possible factors that account for variation in soil carbon in the Palouse landscape.

The variation in sampling and lab analysis summarizes the variation in getting intact cores out of the ground and then analyzing horizons, measuring density, and measuring carbon levels in the lab.

The total residual variation in our regression model is driven by the unknown function **g** and the variation in physical sampling and data analysis.

As discussed in Appendix 1, duplicated cores have variation in soil carbon due to variation in sampling and lab analysis, as well as variation in soil structure for near adjacent samples.

The Minitab excerpt on the next page shows how Minitab handles the arithmetic in the analysis of variance table.

Regression Analysis: 80 CM with 1 versus ZI(Indec81), Z(Indec81), ...**

```
The regression equation is
80 CM with 15 short cores Org C = 6.03 + 4.79 ZI(Indec81) - 1.64 Z(Indec81)**2 + 0.135 NoTillYrs + 2.43 SCODE_LOzero
                                  - 0.323 DEM10m_TPI


Predictor         Coef  SE Coef      T      P    VIF
Constant        6.0277   0.8238   7.32  0.000
ZI(Indec81)      4.790    1.023   4.68  0.000  5.809
Z(Indec81)**2  -1.6395   0.5557  -2.95  0.004  5.842
NoTillYrs      0.13455  0.04532   2.97  0.004  1.067
SCODE_LOzero    2.4292   0.7845   3.10  0.002  1.870
DEM10m_TPI     -0.3229   0.1609  -2.01  0.047  1.896


S = 2.93958   R-Sq = 39.1%   R-Sq(adj) = 36.7%

PRESS = 1200.57   R-Sq(pred) = 33.39%

Analysis of Variance

Source           DF       SS      MS      F      P
Regression        5   704.94  140.99  16.32  0.000
Residual Error  127  1097.42    8.64
  Lack of Fit   106  1088.75   10.27  24.88  0.000
  Pure Error     21     8.67    0.41
Total           132  1802.37

 91 rows with no replicates
```

Regression output, expanded, for the Red Box Model

Minitab detects 21 pairs of duplicates in the Red Box zone—pairs of observations with exactly the same predictor values. There are actually 23 pairs of duplicates in the Red Box zone but two pairs have small differences in the slope measure DEM10m_TPI in the second decimal place (pairs 1021/22 and 1109/10 have the discrepancies.) Minitab indeed requires exact match of predictors.

Minitab decomposes the total residual error--used for estimating the precision of the regression coefficients and to give a summary measure of error variation--into two pieces. The “Pure Error” piece represents the variation from the duplicated cores: the variation in physical sampling and lab analysis, along with near adjacency variation. The “Lack of Fit” piece represents the remaining variation in the residual error, which is mostly function **g** in our schematic equation—the unknown set of other factors and relationships that contribute to variation in organic soil carbon.

The residual mean square, 8.64, which is the square of the s value 2.93958, gives an appropriate estimate of variation for observations that are statistically independent.

If we believe the duplicated cores are highly correlated within pairs rather than independent and identically distributed, then a regression model that uses the independence assumption can yield estimates of variability that are too small.

To check the impact, we re-ran the model in the Red Box, replacing the 23 duplicated pairs with the average of each duplicate. We expect to see the residual variance increase and the stated significance levels of the parameters, a function of residual variance, become less significant.

Regression Analysis: 80 CM with 1 versus ZI(Indec81), Z(Indec81)**, ...

```
The regression equation is
80 CM with 15 short cores Org C = 6.43 + 4.45 ZI(Indec81) - 1.56 Z(Indec81)**2 + 0.123
NoTillYrs + 2.36 SCODE_LOzero
                                  - 0.380 DEM10m_TPI


Predictor          Coef  SE Coef      T      P
Constant         6.4260   0.9334   6.88  0.000
ZI(Indec81)       4.450    1.178   3.78  0.000
Z(Indec81)**2   -1.5557   0.6475  -2.40  0.018
NoTillYrs       0.12255  0.05185   2.36  0.020
SCODE_LOzero     2.3590   0.8896   2.65  0.009
DEM10m_TPI      -0.3800   0.1829  -2.08  0.040


S = 3.02036   R-Sq = 36.1%   R-Sq(adj) = 33.1%


Analysis of Variance

Source           DF       SS      MS      F      P
Regression        5   536.55  107.31  11.76  0.000
Residual Error  104   948.75    9.12
Total           109  1485.30
```

Here's a comparison between the model shown in the main text p. 15 and model with the duplicate values averaged. As expected, the residual variation increases, which reduces R^2 and increases the p values of the coefficients:

	Red Box all observations			**Red Box duplicates averaged**		
Predictor	Coefficient	Standard Error	p value	Coefficient	Standard Error	p value
Constant	6.0277	0.8238	0.000	6.426	0.9334	0.000
Normalized Precip	4.790	1.023	0.000	4.45	1.178	0.000
Normalized Precip^2	-1.6395	0.5557	0.004	-1.5557	0.6475	0.018
No Till Years	0.13455	0.04532	0.004	0.12255	0.05185	0.02
Slope Code	2.4292	0.7845	0.002	2.3590	0.8896	0.009
Slope Position	-0.3229	0.1609	0.047	-0.3800	0.1829	0.04
number of obs	133			110		
Residual variation (S)	2.93958			3.02036		
R-Sq (adjusted)	36.7%			33.10%		

The model fitted with each duplicate pair replaced by a single average core provides a quick, conservative summary of the regression relationship.

Alternatively, we can model the linear model's error structure directly to allow positive correlation between duplicates, which is an instance of generalized least squares [8]. The direct modeling approach should yield regression results essentially bounded by the "all observations" case (assumes within pair correlation is 0) and the "duplicates averaged" case (assumes within pair correlation is 1).

We confirmed that the estimates of coefficients and residual variation could be produced directly using the matrix formulas described in [8] using the R statistical language, e.g. [9]. As we vary the correlation in duplicated pairs from 0.9 to 0.1, the coefficients and their standard errors smoothly move between the two boundary cases. A course grid search over correlation values shows that the minimum residual variation comes from a correlation value of about 0.65. The R code is included on the next page.

```
# code to check impact of correlation among duplicate pairs in the soil
# carbon data Instance of generalized least squares, e.g. Draper and smith
# (1998) pp. 221-223 Kevin Little, Ph.D.  2 July 2013

# read in the Red Box data 133 records, with the 23 duplicate pairs at top
# of the data table
d1 <- read.csv("Redbox2.csv", colClasses = "character", sep = ",")

d2 <- d1[1:133, ]
names(d2)
##   [1] "Core_ID"                            "PCODE"
##   [3] "SCODE"                              "ACODE"
##   [5] "HCODE"                              "STATUS"
##   [7] "SampDate"                           "Duplicate"
##   [9] "Dupl_ID"                            "Dupl_Group"
##  [11] "StrataGrp"                          "SeqNum"
##  [13] "pedon_key"                          "Range_IN71"
##  [15] "IN_dec71"                           "IN_dec81"
##  [17] "TWI_raw"                            "TWI_Resamp5m"
##  [19] "TWI_3x3mean"                        "TEMP71max_Raw"
##  [21] "TEMP71min_Raw"                      "TEMP71ave_Raw"
##  [23] "TEMP71ave_Cel"                      "TEMPave_Fahr"
##  [25] "TEMP81_MAX"                         "TEMP81_MIN"
##  [27] "TEMP81ave_Raw"                      "TEMP81ave_Cel"
##  [29] "SlopePrcnt"                         "AspectDeg"
##  [31] "AspectScore"                        "Curvature"
##  [33] "NoTillYrs"                          "DEM_Quality"
##  [35] "Elevation"                          "Full.Core..OC"
##  [37] "Full.Core.TC"                       "Full.Core.Sample.Count"
##  [39] "Full.Core.top.CM"                   "Full.Core.bottom.CM"
##  [41] "Full.Core.Length.CM"                "Top..OC"
##  [43] "Top.TC"                             "Top.Sample.Count"
##  [45] "Top.top.CM"                         "Top.bottom.CM"
##  [47] "Top.Length.CM"                      "Bottom..OC"
##  [49] "Bottom.TC"                          "Bottom.Sample.Count"
##  [51] "Bottom..top.CM"                     "Bottom.bottom.CM"
##  [53] "Bottom.Length.CM"
"X80.cm.Total.Organic..C..kg.m2.l"
##  [55] "Sum.of.80.cm.Total..C..Kg.m2.la"  "Sum.of.Mass.Adjusted.Total.Orga"
##  [57] "Sum.of.Mass.Adjusted.Total..C.k"
"X80.CM.with.15.short.cores.Org.C"
##  [59] "X80.CM.with.15.short.cores.Tot.C" "UseHCODE"
##  [61] "SCODE_LO"                           "SCODE_UP"
##  [63] "ACODE_NE"                           "ACODE_SW"
##  [65] "DEM_Quality_Normal"                 "EM_Quality_Repetitive.Anomalies"
##  [67] "ZI.Indec81."                        "Z.Indec81...2"
##  [69] "DEM10m_TPI"                         "INdec814groups"
##  [71] "Elevation4groups"                   "DEM10mTPI4groups"
##  [73] "NoTillgroups"                       "SRES1"
##  [75] "notillyesorno"                      "SRES2"
##  [77] "X"                                  "order.DEM10.check"
##  [79] "DEM10mTPI4GRPSNew"                  "DEM10m_TPIsplit"
##  [81] "DEM10m_TPIsplitQ1"                  "DEM10m_TPIsplitP35"
##  [83] "HiPrecipUpSlope"                    "SCODE_LOzero"
##  [85] "RedBox_1.May"                       "X.1"
##  [87] "ZPred"                              "ZsquarePred"
##  [89] "NoTillYrsPred"                      "SCode0Pred"
##  [91] "DEM10m_TPIPred"                     "ZPrecipBySlopePos"
##  [93] "ZPrecipBySCODE_LoZero"              "ZPrecipNoTillSlopePos"
##  [95] "X.2"                                "X.3"
##  [97] "X.4"                                "X.5"
##  [99] "X.6"                                "X.7"
## [101] "check.grid.1"                       "check.grid.2"
## [103] "check.grid.alt.min"                 "check.grid.3"
```

```
# change character to numeric for the regression modeling
for (i in c(33, 58, 67:69, 84)) {
    d2[, i] <- as.numeric(d2[, i])
}
# k is number of observations in the data set
k <- 133


# sigmaRho is the function that will make the sigma matrix for duplicate
# pairs correlated but all other entries off the diagonal == 0.

sigmaRho <- function(rho, ndup = 23, k = 133) {
    # fill in lower triangle of matrix for the ndup number of pairs of
    # duplicates
    x <- matrix(data = 0, nrow = k, ncol = k)
    for (i in 1:ndup) {
        x[2 * i, 2 * i - 1] <- rho
    }
    IdM <- diag(1, k, k)
    x1 <- x + IdM
    # now fill in rest of matrix by symmetry
    for (i in 1:(k - 1)) {
        for (j in (i + 1):k) {
            x1[i, j] <- x1[j, i]
        }
    }
    return(x1)
}
# fit linear model assuming independence, no correlation within duplicate
# pairs
lm1 <- lm(d2[, 58] ~ d2[, 67] + d2[, 68] + d2[, 33] + d2[, 84] + d2[, 69])
summary(lm1)
##
## Call:
## lm(formula = d2[, 58] ~ d2[, 67] + d2[, 68] + d2[, 33] + d2[,
##     84] + d2[, 69])
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -6.477 -1.936 -0.174  1.466  8.143
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   6.0277     0.8238    7.32  2.5e-11 ***
## d2[, 67]      4.7896     1.0228    4.68  7.2e-06 ***
## d2[, 68]     -1.6395     0.5557   -2.95   0.0038 **
## d2[, 33]      0.1346     0.0453    2.97   0.0036 **
## d2[, 84]      2.4292     0.7845    3.10   0.0024 **
## d2[, 69]     -0.3229     0.1609   -2.01   0.0469 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.94 on 127 degrees of freedom
## Multiple R-squared: 0.391,   Adjusted R-squared: 0.367
## F-statistic: 16.3 on 5 and 127 DF,  p-value: 2.07e-12
anova(lm1)
## Analysis of Variance Table
##
## Response: d2[, 58]
##            Df Sum Sq Mean Sq F value  Pr(>F)
## d2[, 67]    1    173   173.0   20.02 1.7e-05 ***
## d2[, 68]    1     78    78.5    9.08 0.00311 **
## d2[, 33]    1    104   103.7   12.01 0.00072 ***
## d2[, 84]    1    315   314.9   36.44 1.6e-08 ***
```

```
## d2[, 69]    1     35    34.8    4.03 0.04688 *
## Residuals 127   1097     8.6
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
# work with the sigma matrix with pairwise correlation of duplicate pairs
# transform the y and x values to undo the correlation. we get the
# Cholesky decomp which provides a triangular matrix such that SS-prime =
# Sigma

# follow logic outlined in
# http://www.biostat.jhsph.edu/~iruczins/teaching/jf/ch5.pdf pp 60-61

# choose value of rho and then run the following commands to get revised
# linear model result we have put the commands inside a loop, to cover a
# range of correlation values.
R2correct <- rep(NA, 11)
R2correctAdj <- rep(NA, 11)
s_check <- rep(NA, 11)

for (j in 1:11) {

    rho <- 0.4 + 0.05 * j
    # Calculate Sigma matrix given the correlation structure
    sm0 <- sigmaRho(rho)
    # compute the Cholesky decomposition to implement the generalized least
    # squares calculations see Notes on Generalized Linear Model in R by Ingo
    # Ruczinski , Johns Hopkins School of Public Health,
    # http://www.biostat.jhsph.edu/~iruczins/teaching/jf/ch5.pdf accessed 1
    # July 2013
    sm <- chol(sm0)
    sm1 <- solve(t(sm))
    # extract the X matrix from the original linear model fit
    xmatrix <- model.matrix(lm1)
    # transform the original X matrix and response by the inverse of
    sx <- sm1 %*% xmatrix
    sy <- sm1 %*% d2[, 58]
    # now we have to take off the constant in the next linear model fit as we
    # have already accounted for intercept in the model matrix xmatrix
    lm2 <- lm(sy ~ sx - 1)
    # examine the fit to the transformed data and X matrix
    summary(lm2)
    anova(lm2)

    # calculate the residual sum of squares directly and compare to lm output
    check5 <- lm2$residuals
    s_check[j] <- sqrt(sum(check5^2)/lm2$df)
    s_check


    # now check R-squared--ignore the R2 statement from summary lm fitted to
    # the transformed model that is incorrectly calculated, we need to adjust
    # the regression SS for the first term in the regression corresponding to
    # the adjustment made in ordinary least squares for the intercept term
Now
    # we compute appropriate sums of squares to calculate R-squared. For
    # general discussion see Draper and Smith (1998) pp. 149-151 and in
    # particular formulas from Penn State Statistics Course 442 notes by
    # Professor Laura Simon (2002)
    # http://sites.stat.psu.edu/~lsimon/stat462/fa02/handouts/seqssq.ppt
    anovaAll <- anova(lm2)

    # now fit without the first beta term to enable calc of sum of squares
    # attributable to the first term
    lm3 <- lm(sy ~ sx[, 2] + sx[, 3] + sx[, 4] + sx[, 5] + sx[, 6])
```

```
    anovaAllbutB1 <- anova(lm3)
    # calculate the regression for just the first term in the transformed
    # model
    lm4 <- lm(sy ~ sx[, 1])
    anovaB1 <- anova(lm4)

    # calculate total SS for the transformed variables: Y' x Sigma-Inverse x
Y
    tss <- t(d2[, 58]) %*% solve(sm0) %*% d2[, 58]

    # calculate the adjusted sums of squares to enter the R2 ratio first get
    # the regression sum of squares for all predictors given the first
    # predictor
    SSR_AllgX1 <- anovaB1[["Sum Sq"]][2] - anovaAll[["Sum Sq"]][2]
    # now get the regression sum of squares due to just the first predictor
in
    # the set of predictors
    SSR_X1 <- anovaAll[["Sum Sq"]][1] - SSR_AllgX1
    # correct calculation of R2 becomes
    R2correct[j] <- (SSR_AllgX1)/(tss - SSR_X1)
    # R2correct
    R2correctAdj[j] <- 1 - (1 - R2correct[j]) * ((k - 1)/lm2$df.residual)
    # R2correctAdj
}
# Look at summary statistics from grid search
R2correct
##  [1] 0.3699 0.3680 0.3660 0.3640 0.3618 0.3595 0.3568 0.3534 0.3486 0.3403
## [11] 0.3196
R2correctAdj
##  [1] 0.3451 0.3431 0.3410 0.3389 0.3367 0.3343 0.3315 0.3279 0.3229 0.3144
## [11] 0.2928
s_check
##  [1] 2.836 2.829 2.824 2.821 2.819 2.819 2.822 2.830 2.849 2.892 3.027
```

Appendix 3: Detective Work on resolution of mis-labeled cores--3 April 2013 note

Kevin Little, Ph.D.

The error appears to have started in the email from Russ Dresbach on 23 January. Note that the list of cores occurs in pairs. The first id is our duplicate number and the 2nd id is Russ's guess. In each pair, there should be a match of duplicate core number to an existing core number. This pattern holds EXCEPT for 2245, which almost surely represents a TYPO, as we should have a match to the existing core **2243**. I didn't flag this discrepancy in January, I took the values as given. And I compounded the error by swapping 2243 for 2343 in my table that displayed the new and old labels.

From: Dresbach, Russell I. [mailto:DresbachR@missouri.edu]
Sent: Wednesday, January 23, 2013 1:41 PM
To: 'Ry L. Thompson'; 'Kevin Little'
Cc: 'LyndaFinn'; David W. Aslesen
Subject: RE: check on core samples missing UPDATE

I think we can assume that the cores had some shrinkage while bouncing around during shipping, so that means:

1045 (99 cm) is 1045

1045 (84 cm) is 2045

1080 (98 cm) can't be determined from length [subsequently matched to 1088]

1080 (95 cm) can't be determined from length [subsequently matched to 1080]

1123 (98 cm) is 1123

1123 (86 cm) is 1223

1244 (74 cm) is 1244

1244 (84 cm) is 1224

1278 (36 cm) is 1278

1278 (31 cm) is 1276

1295 (15 cm) can't be determined from length (only the upper 15 cm was intact – the rest of the core was jumbled and not sampled)

1295 (81 cm) can't be determined from length

2079 (97 cm) is 2079

2079 (96 cm) is 2076

2243 (93 cm) is 2245

2243 (97 cm) is 2343

this 2245 is almost surely a typo and should be 2243.

Russ

I examined the file *Palouse Data by horizon.xls*, which I prepared for AES on 31 January 2013, after our detective work.

I made a copy and saved it as *Palouse Data by horizon_KL 2 April 2013.xlsx* saved in

C:\Users\Kevin\Documents\Applied Ecological Services\2012 Soil Project work\Septenber 2012 update\Jan 2013 analysis\27 January 2013 update\Call 30 Jan 2013 follup

I searched for pedon IDs 2243, 2245 and 2343, the pedons in the Red Box above.

Here is what I see:

1	Data Data	pedon_	duplicate renumbered	SCL Lab	Core Top (cm)	Core Bottom (cm)	Horizon	Soil Movement	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm3)	Small Coarse Fragments (g)
921	10/29/2012	2245	1	PAL2243-1	0	39	A	D	746.68	619.73	1.04	55.10
922	10/29/2012	2245	1	PAL2243-2	39	60	BA	D	432.92	370.63	1.18	27.67
923	10/29/2012	2245	1	PAL2243-3	60	93	Bt	D	785.85	687.12	1.26	108.79
1536	11/16/2012	2245		PAL2245-1	0	24	Ap	E	415.49	368.45	1.11	0.00
1537	11/16/2012	2245		PAL2245-2	24	42	BA	E	308.20	280.5	1.12	0.00
1538	11/16/2012	2245		PAL2245-3	42	96	Bt	E	1114.47	991.55	1.33	0.15
1712	12/7/2012	2243		PAL2243-1	0	16	Ap	E	305.54	266.58	1.20	0.00
1713	12/7/2012	2243		PAL2243-2	16	35	A	E	442.34	375.91	1.43	0.00
1714	12/7/2012	2243		PAL2243-3	35	97	Bt	E	1452.95	1211.48	1.41	0.00

First, there is no pedon 2343 in this master list!

Now, here is the spreadsheet we used in labeling the pedons, used in January discussion with Russ and Ry:

dupe cores 24 Jan 2013 KL 2 April 2013.xlsx

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	2 April 2013 recapitulation	emails 23 Russ pedon_id fix	Data Data--Lab	pedon_id	SCL Lab	Core Top (cm)	Core Bottom (cm)	Horizon	Soil Movement	Wet Wt. (g)	Oven Dry Wt. (g)	Bulk Density (g/cm3)	Small Coarse Fragments (g)
46	2243?	2245	10/29/2012	2243	PAL2243-1	0	39	A	D	746.68	619.73	1.04	55.1
47		2245	10/29/2012	2243	PAL2243-2	39	60	BA	D	432.92	370.63	1.18	27.67
48		2245	10/29/2012	2243	PAL2243-3	60	93	Bt	D	785.85	687.12	1.26	108.79
49	2343?	2243	12/7/2012	2243	PAL2243-1	0	16	Ap	E	305.54	266.58	1.2	0
50		2243	12/7/2012	2243	PAL2243-2	16	35	A	E	442.34	375.91	1.43	0
51		2243	12/7/2012	2243	PAL2243-3	35	97	Bt	E	1452.95	1211.48	1.41	0

We can unravel things by using the SCL Lab labels.

PROPOSED CHANGES:

The 97 cm core { PAL2243-1,PAL2243-2,PAL2243-3} should be core **2343** (per Russ's table in email)

The 93 cm core {PAL2243-1,PAL2243-2,PAL2243-3} should be core **2243** (if we believe the typo theory)

The 96 cm core {PAL2245-1, PAL2245-2, PAL2245-3} should be core **2245** (unchanged from before our messing with the core numbers)

This change leads to unique cores 2243, 2245, and 2343.

I made those changes in

Palouse Data by horizon_KL 2 April 2013.xlsx and saved this file in this location:

C:\Users\Kevin\Documents\Applied Ecological Services\2012 Soil Project work\September 2012 update\Jan 2013 analysis\27 January 2013 update\Call 30 Jan 2013 follup

In that file, columns W through AC summarize the cores over horizons.

I copied over the changes into the file *PalouseDatabyhorizon 28 June 2013.xlsx,* sent to AES with this final report document.

W	X	Y	Z	AA	AB	AC
Pedon	Total Organic "C" Kg/m2-layer_1	Total "C" Kg/m2-layer_1	Count	Top	Bottom	length
2243	6.84269	6.84269	3	0	97	97
2245	15.06192	15.06192	6	0	96	96

So this part of the spreadsheet needs to be corrected as well.

Lynda produced this either in MTB or Excel.

Here are the calculations that should be present for cores 2243, 2245 and 2343:

PedonID	Total Organic "C" Kg/m2-layer_1	Total "C" Kg/m2-layer_1	Count	Top	Bottom	length
2243	6.68166	6.68166	3	0	93	93
2245	8.38026	8.38026	3	0	96	96
2343	6.84269	6.84269	3	0	97	97

I show these calculations in a new tab (worksheet) in the file *Palouse Data by horizon_KL 2 April 2013.xlsx* called ***Summary 2243 2245 2343*** (This worksheet also has calculations for the tops and bottoms of the cores referenced in the next section.)

I amended columns W through AC with these values.

Repair of data table used for analysis

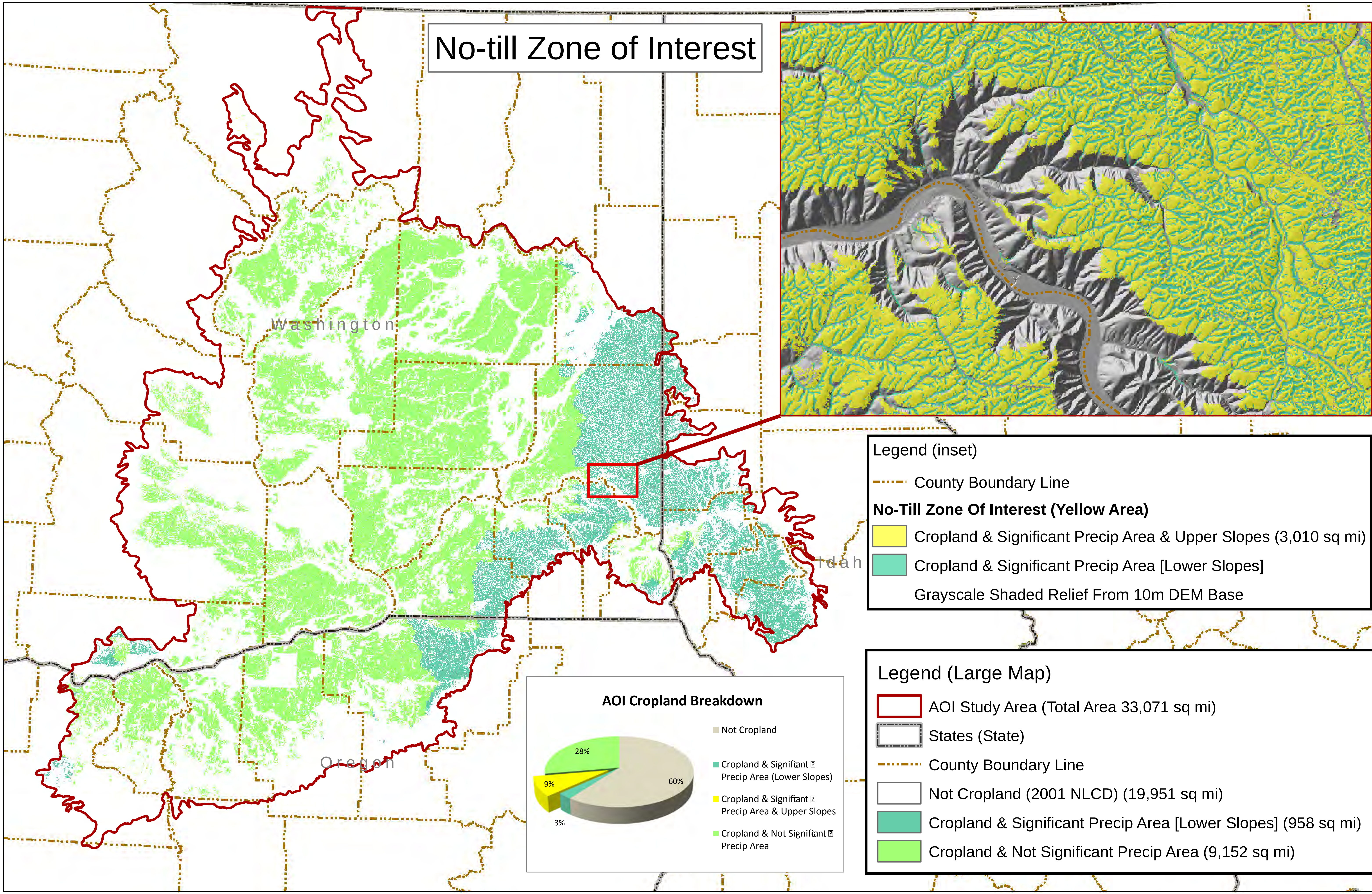
Also in January, from Lynda's working MTB file, I produced a data table for AES that shows the predictors and the responses *merged final data 25 Jan 2013 rev1.xlsx* in

C:\Users\Kevin\Documents\Applied Ecological Services\2012 Soil Project work\September 2012 update\Jan 2013 analysis\27 January 2013 update\Call 30 Jan 2013 follup

I copied this file to *merged final data 25 Jan 2013 rev 2 April 2013.xlsx* in the same directory to insert changes to the three cores 2243, 2245, 2343.

The ***export_output*** worksheet uses look up tables to produce the core summaries (summing horizons).

1. I corrected the Total Core worksheet with the total core values on the previous page, resorting the table in PedonID order. Confirmed that vlookup is correct in columns AJ-AO of export_output worksheet.
2. I corrected the Tops and Bottoms worksheets in the same way and verified vlookup is correct in columns AP-AU and AV-BA.



No-till Zone of Interest
Washington
Oregon
Idaho
Legend (inset)
County Boundary Line
No-Till Zone Of Interest (Yellow Area)
Cropland & Significant Precip Area & Upper Slopes (3,010 sq mi)
Cropland & Significant Precip Area [Lower Slopes]
Grayscale Shaded Relief From 10m DEM Base
AOI Cropland Breakdown
Not Cropland
Cropland & Significant Precip Area (Lower Slopes)
Cropland & Significant Precip Area & Upper Slopes
Cropland & Not Significant Precip Area
60%
28%
9%
3%
Legend (Large Map)
AOI Study Area (Total Area 33,071 sq mi)
States (State)
County Boundary Line
Not Cropland (2001 NLCD) (19,951 sq mi)
Cropland & Significant Precip Area [Lower Slopes] (958 sq mi)
Cropland & Not Significant Precip Area (9,152 sq mi)

Lessons Learned from Soil Carbon Studies of the Palouse Region

David Tepper, Steven I. Apfelbaum,
Ry Thompson, Tom Hunt, Frederik Vroom,
Robert Seaton and Chas Taylor
The Earth Partners, LP
Applied Ecological Services, Inc.
17921 Smith Road, PO Box 256
Brodhead, WI 53520
608-897-8641

Contents

Executive Summary

Applied Ecological Services and The Earth Partners have undertaken the development of a large-scale project, entitled the Palouse Soil Carbon Project, based on a hypothesis that soil carbon increases at a faster rate under no-till agriculture than under traditional agricultural plowing practices. The project is an ecosystem-scale demonstration of methods of measuring carbon stocks in soil and vegetation and of providing market-based incentives for farmers to undertake activities that improve soil carbon and reduce greenhouse gas (GHG) emissions from agriculture. The partners worked closely with Shepherd's Grain, a wheat producing co-operative that focuses on setting standards for sustainable practices and grain quality for farmers in order to access higher-value markets for their wheat products. Assisted by a US Department of Agriculture / Natural Resources Conservation Service (NRCS) Conservation Innovation Grant (CIG)[1], the partners have:

- Validated a modular methodology for soil-related carbon credit projects, developed by The Earth Partners through the Verified Carbon Standard (VCS), a leading voluntary carbon standards organization.[2]
- Collected and analyzed 750 one-meter-deep soil samples from across a seven-million acre area of the Palouse region, centered in the state of Washington in the Northwestern U.S.
- Aggregated farmers under contract managing over 100,000 acres of land, predominantly in dryland (non-irrigated) wheat production

Based on this work, the partners have identified key technical lessons for the development of soil carbon improvement projects:

- In general, the use of models to forecast soil carbon levels and accumulation rates is likely to result in significant levels of uncertainty, due typically to the existence of insufficient data for calibration of the models in a specific area, especially for deeper soil layers. While good general models exist, they must be tuned with a significant amount of site-specific data on the amount and timing of soil changes associated with changes in farming methods to reduce the uncertainty of the model results. For many areas and farming methods, these data do not currently exist.
- Sampling may be a successful and cost-effective method for quantifying soil carbon, but in many cases it will only be viable for large-scale projects due to the fixed costs associated with implementing a methodology, aggregating producers, and verifying and validating the carbon. Based on the variability found in the Palouse region, the minimum effective project size likely ranges from 100,000 to 180,000 acres. However, minimum project size is critically dependent on soil variability, carbon accrual rates, and carbon prices.
- Agricultural carbon projects must be able to allow for farmer flexibility in practices and land ownership as well as for ecological variability. This requirement for flexibility has implications for methods used to determine project activities, identify project boundaries, assess additionality, and ensure permanence.

---

[1] http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/

[2] VM0021 VCS Soil Carbon Quantification Methodology v1.0 (http://v-c-s.org/methodologies/VM0021, last visited 27-03-2013)

Lessons learned related to farmer engagement, aggregation, and contracting for carbon projects include:

- Efficient aggregation of farmers requires agreement structures that define the basic relationship between the farmer and the aggregator while creating a context within which details regarding practices, credit allocations, and other specifics may be determined at a later time and may change over time as needed.
- In aggregations of farmers, not all participants will be undertaking the same practices or having the same carbon sequestration results. Aggregation structures must therefore contain systems for allocating benefits that recognize differentials in results. There is a trade-off between simplicity and precision: systems must be simple and clear enough to create well-defined links between practice and benefit, while being flexible enough to acknowledge differences in starting conditions. The system must also plan for the ongoing fine-tuning of allocation systems as additional data are gained.
- Because farmer flexibility is a requirement, and this flexibility may include temporary or permanent changes in practice—as well as farmers leaving the project—permanence mechanisms, which provide insurance that the global warming reductions are lasting, must be able to address farmer flexibility in a way that does not unduly reduce the payments to farmers, as might occur if too much of the benefit was allocated to an insurance pool. Methods of allocating payments and paying for insurance must also not unduly penalize long-term participants, as compared with temporary participants. The development of appropriate permanence structures that meet these requirements will likely necessitate the development of insurance methods that share risk among farmers, aggregators, and certification bodies.

The Palouse Soil Carbon Project has significantly advanced the understanding of soil conditions and farm practices in the Palouse as well as provided information on a wide range of problems, issues, and opportunities related to the development of agricultural soil carbon projects in general. This has resulted in the creation of the basic structures required to undertake similar projects in other locations, including the Soil Carbon Quantification Methodology, sampling techniques, and approaches to aggregating farmers. It has also provided knowledge related to key variables, such as soil variability, which will be critical to assessing project viability. However, due to variance in agricultural landscapes, soil processes, and farming practices, each project will require a unique combination of carbon measurement and project management approaches to fit it to the specific situation.

Context

Agriculture is the dominant form of human land management, with approximately 49 million square kilometers (33% of the world's land area) managed for annual and perennial crops and for grazing. Every form of agriculture has the potential to impact the world's soil carbon store, currently estimated at 1500Gt of C in the upper 100cm of the world's soils[3]. If one tonne of additional carbon were sequestered per hectare per year in 10% of the world's agricultural soils, 1.8 billion tonnes of CO_2 would be removed from the atmosphere annually. Furthermore, agricultural soils are currently recognized as likely being a net source of greenhouse gases (GHGs), due to current management practices, although the magnitude of that effect is unclear.

Soil carbon (carbon held within the soil, primarily as part of soil organic matter content) is the largest terrestrial pool of carbon on earth and is important as a global carbon sink for GHGs. Yet, despite this potential to both reduce emissions from soils and to store atmospheric carbon in soils, the development of methods to incentivize and measure the effects of enhanced soil management techniques on soil carbon has lagged behind GHG measurement and management in most other sectors of the economy. This is true for a number of reasons, including:

- Soil carbon is dispersed across a variable landscape, unlike point-source combustion engine tailpipe fossil fuel and chemical emissions.
- Measurement of soil carbon requires laboratory testing, unlike forest biomass carbon pools, where measurement can be conducted in the field using well-developed techniques.
- Soil carbon has proven difficult to assess with accuracy using remote sensing, unlike trees or other above-ground ecological elements, where robust algorithms exist to assess biomass carbon pools utilizing high-resolution remote sensing imagery.
- Soil carbon models, while well designed, are handicapped by limited data availability for accurate calibration. This is particularly true with regard to deeper soil strata.
- Our knowledge about soil carbon and soil carbon processes is rapidly evolving. For instance, it has only recently been recognized that soil carbon in deeper soil layers (below 30—60cm) may also be quite dynamic.
- Agriculture is typically undertaken by individual farmers, each with his or own own management methods and history, which impact the amount and trend of soil carbon on

Project Partners

Applied Ecological Services, Inc. (AES) served as the scientific and technical lead, focusing on the landscape-scale stratification, sample allocation and implementation, and statistical analysis of the soils dataset to establish baselines and projected accrual of soil carbon.

The Earth Partners (TEP), a land restoration company overseeing the carbon methodology, carbon markets, landowner engagement and business models for climate-smart land use, served as the business and market lead, focusing on the producer recruitment and aggregation, development of the business model and cultivation of the markets.

Shepherd's Grain is a specialty value-chain business that markets high-end wheat flour grown sustainably by over 40 family farmers in the Columbia Plateau region of eastern Washington, northern Oregon and western Idaho, using sustainable and certified farming methods.

USDA-NRCS: The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) awarded a Conservation Innovation Grant (CIG) to the project partners to support the development of the Palouse Soil Carbon project.

---

[3] Batjes, N.H. (1996), Total carbon and nitrogen in the soils of the world. European Journal of Soil Science, 47: 151–163. doi: 10.1111/j.1365-2389.1996.tb01386.x

their land. In the northern countries, this might mean areas of hundreds or thousands of hectares, but in the developing world, farms can average less than 1 hectare each.

- Soil carbon is highly sensitive to soil-forming and landscape processes, and in some cases, it can vary significantly within a few tens of meters, depending on the landforms, soil processes, and land utilization history.
- Changes in soil management may have multiple effects, some of which may be positive for reducing global warming, while others are negative. For instance, changes may increase soil carbon content but also increase methane emissions.

For these reasons and others, development of agricultural soil carbon methods and improvement projects has been slow. The scale and the variability found over the landscape, as well as ever-changing land uses, have created policy, science, and marketplace confusion over how to evaluate landscape-scale investments in mitigating climate change. However, soil carbon also has some very significant characteristics that make pursuing methods and projects in this area important. These include the following:

- Soil carbon in well-managed landscapes is low-risk. Although erosion can result in the significant movement of soil carbon and potential releases to the atmosphere, soil carbon is not vulnerable to sudden release in the way that biomass carbon is vulnerable to release from fire.
- Soil carbon enhancement is a win-win process. Although in some soil types significant amounts of carbon may be held in inorganic forms, the majority of the soil carbon impacted by agricultural techniques is held in the form of soil organic matter. Increased soil organic matter is generally very beneficial for agriculture, enhancing water and nutrient holding capabilities. It is widely accepted that the carbon content of soil is a major factor in overall soil health.
- Soils may store carbon reliably over very long periods of time.
- Agricultural certification and climate-smart agriculture may be highly complementary, resulting in improvements in long-term agricultural sustainability.
- The history of soil carbon loss in many agricultural soils means that very significant amounts of atmospheric carbon could be sequestered in soils before these soils are ever returned to their base state. (In contrast, in forests, especially in the northern hemisphere, fire control and commercial management has, in many areas, driven biomass carbon content above historic levels, resulting in an increased risk of biomass carbon loss.)

In addition to the ecological and management complexities of soil carbon, significant process and financial barriers exist to incentivizing soil carbon accrual. A review of C-AGG[4] and T-AGG[5] (and other reports[6] on the challenges of bringing soil carbon to carbon markets) identifies perceived problems including the following:

---

4 http://www.c-agg.org/

5 http://nicholasinstitute.duke.edu/initiatives/technical-working-group-agricultural-greenhouse-gases-t-agg

6 Sandra Corsi, Friedrich T, Kassam A., Pisante, M., de Moraes Sa, J., 2012, Soil Organic Carbon Accumulation and Greenhouse Gas Emission Reductions from Conservation Agriculture: A literature review, FAO Integrated Crop Management Vol.16- (http://www.fao.org/fileadmin/user_upload/agp/icm16.pdf, last viewed 27-03-2013)

- Carbon accruals are too expensive to measure, and default models either do not produce robust enough accounting or are too conservative, given variances across the landscape. This results in insufficient carbon payment incentives to drive long-term changes in practices.
- Predicting carbon accruals at the average farm scale is too uncertain, and variances in accruals over time make carbon payments poor incentive mechanisms to create changes in farming practices (particularly if done annually).
- Smaller project boundaries, such as at the average farm-scale, create high transaction costs and discounting to manage the risks inherent in land-based carbon (permanence, eligibility, additionality, leakage).
- Significant progress and investment has been made to develop monitoring, reporting and verification (MRV) tools at the regional scale. This progress has been made in REDD+ to address the issues above, but tools at regional/landscape level to support on-farm carbon accounting (including soil, cover cropping and input management) have not been developed. This leaves a disconnect at the regional scale between the development of REDD+ carbon accounting and climate-smart agriculture.

The Palouse project was designed as a laboratory within which operational-scale solutions could be developed and tested against some of those challenges. The project examines the impact of strategies such as aggregating farms to create economies of scale, employing measurement with modeling, and developing other techniques to address many of the obstacles and challenges that have limited the ability to bring climate-smart agriculture (including non-soil carbon GHG contributors related to nitrogen and methane management) into the marketplace.

The Palouse Soil Carbon Project

The Palouse Soil Carbon Project is an ecosystem-scale demonstration of how to measure carbon stocks in soil and how to engage farmers in activities that improve soil carbon and reduce greenhouse gas emissions from agriculture. Through in-field measurements and modeling projections, the project focused on documenting the soil carbon and GHG emissions benefits of and fertilizer practices. The project is focused on a 7-million acre area of the Palouse region (*see maps in Figures 1 and 2*), where farmers and landowners on over 100,000 acres of wheat production land are contractually participating in a large-scale carbon program. Undertaken with Shepherd's Grain, a farmer-run organization that focuses on producing high-quality sustainable grain through sustainable farming practices, this project has the opportunity to be one of the largest agricultural carbon projects in the world.

Objectives of the project included:

1. Development of technical data on soil carbon measurement and projection, which can inform policy, and supporting further research into soil carbon enhancement as a method of GHG mitigation. The project utilizes Geographic Information System (GIS) landform and geomorphic modeling and mapping to design, evaluate, and implement a regional, on-the-ground baseline analysis of soil carbon levels across the Palouse landscape.
2. Demonstration of an efficient (cost and time) aggregation model for soil carbon. Assembling landowners over large areas at relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. Through our work with landowners, the team has developed, tested, and refined a low-cost aggregation model.
3. Demonstration of an agricultural eco-regional carbon accounting approach through the landscape-level implementation of the VCS-verified Soil Carbon Quantification Methodology developed by The Earth Partners.[7]

Introduction to the Palouse Agro-Ecosystem

The Palouse grassland ecosystem formed in loess soils (wind-blown silt) deposited during glacial melting during the Pleistocene epoch. The relatively recent surface loess deposits are Holocene aged. Loess mantles much of southeast Washington, northwestern Idaho and parts of northeastern Oregon. Loess is the most uniformly sized soil parent material on earth. This uniformity results in relatively predictable patterns of soil development that are controlled by temporal and spatial distributions of water, nutrients, and energy, which, in turn, are influenced by local topographic conditions.

Loess of the same age blankets most of the fertile Midwest as well, extending from central Canada into the upper southern United States and forming deep, fertile deposits adjacent to the Mississippi River as far south as southern Mississippi. Therefore, the results of this project will be applicable to much of North America's most fertile farmland.

Serious soil deterioration and erosion occurs with conventional tillage and the use of conventional fertilizers such as anhydrous ammonium over vast acreages of U.S. farmlands. The same type of deterioration and emissions occurs in the steep Palouse agro-ecosystem landforms that are covered with silt loam soils with low cohesion. Very high rates of soil erosion have been associated with conventional tillage in the Palouse. In combination with high rates of application of conventional fertilizer, these erosion rates have contributed to high levels of nitrogen and other fertilizer constituents in surface and ground water runoff.

Downstream receiving water bodies include habitat for critically endangered salmonid fishes and also receive and collect eroded soils and fertilizers. Under anaerobic conditions in the ground water and pooled surface waters, nitrous oxide and methane emissions contribute to secondary effects of agriculture in such watersheds as the Snake and Columbia rivers in Washington State.

---

[7] VM0021 VCS Soil Carbon Quantification Methodology v1.0 (http://v-c-s.org/methodologies/VM0021, last visited 27-03-2013)

Development of project design approaches and methods with the potential to be relevant for carbon markets like California Air Resources Board (C-ARB) and other emerging compliance markets.

Figure 1: Palouse Region Study Area (Columbia Plateau Ecoregion)

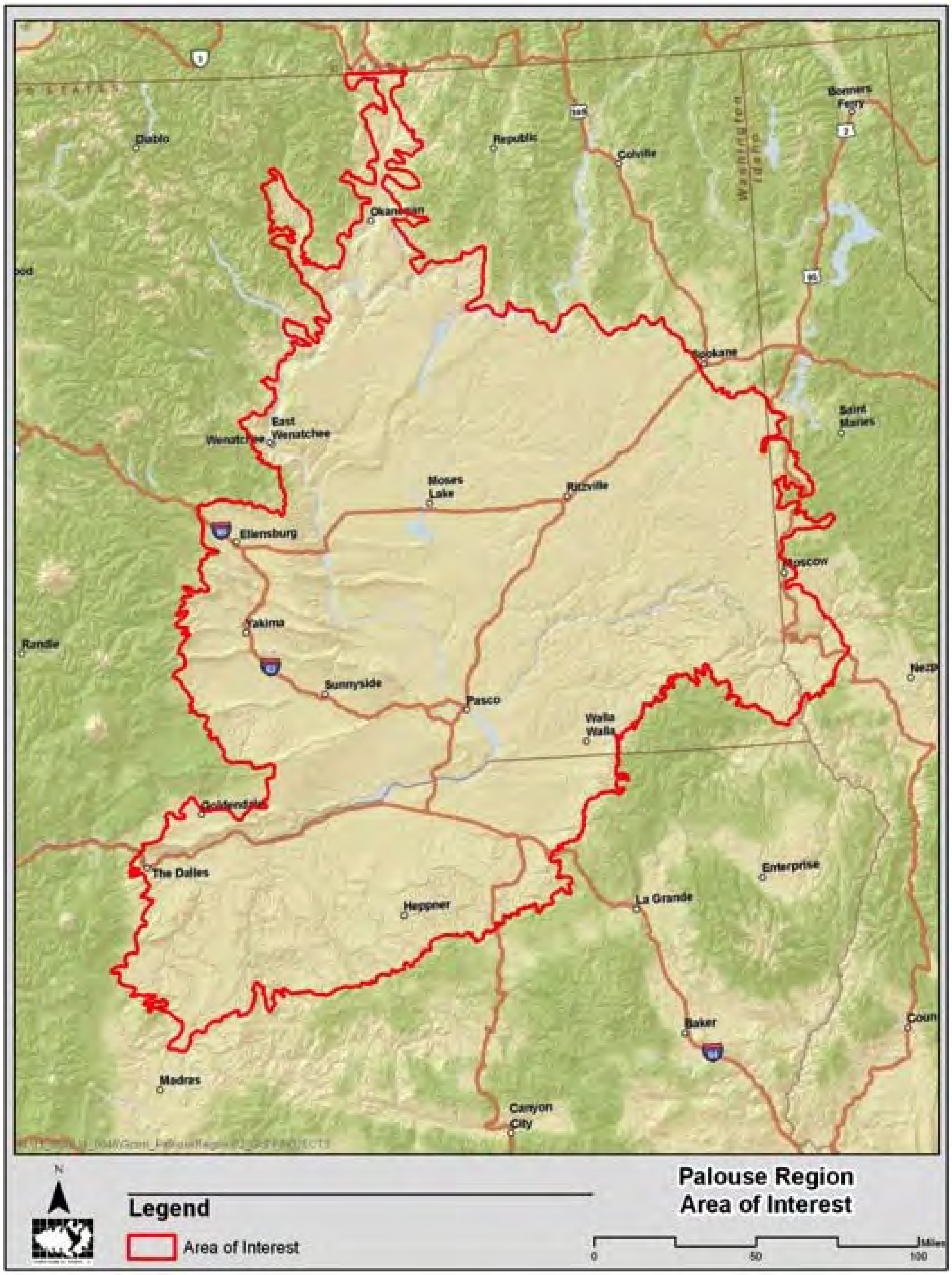
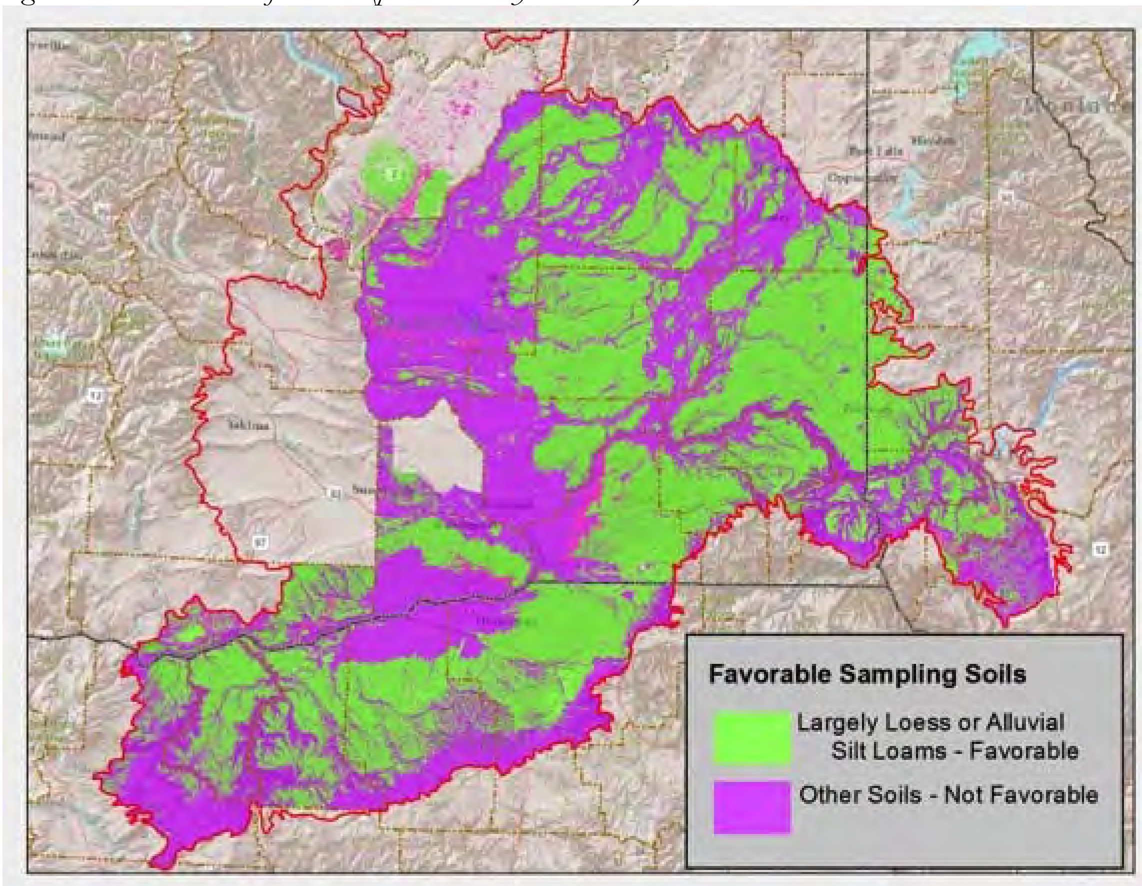


Figure 2: Palouse Area of Interest (predominantly loess soils)



As shown in figure 2, from within the study area, specific regions were chosen for more the project, based on mapped soil types. The goal of this approach was to reduce the sampling variability by reducing the range of soil types examined. Regions noted as "Not Favorable" on Figure 2 would likely also have good potential for agricultural soil carbon accumulation, but were excluded from the project because their soil conditions and dynamics were likely to be substantially different from those found in the core area.

Project Methods

The methods used to assess the soil carbon baseline and develop projections of the potential for future soil carbon accrual are based on the methods used in The Earth Partners' Soil Carbon Methodology. These methods included the following steps:

1. **Pre-sampling:** Pre-sampling of soils was used to determine the statistical variance around key soil chemistry variables (e.g., fractioned soil organic and inorganic carbon and bulk density). It was also used to provide information that assisted with the stratification of the project region. Pre-sampling allows investigators to make initial estimates of the number of samples required during the sampling stage.
2. **Stratification:** Stratification is the process of dividing a land area into relatively homogenous sub-areas based on variations in soil texture, carbon density, and other dynamic factors that govern GHG interactions. Project areas are often heterogeneous in terms of micro-climate, soil condition, vegetation cover, and management history. Stratification allows sampling and

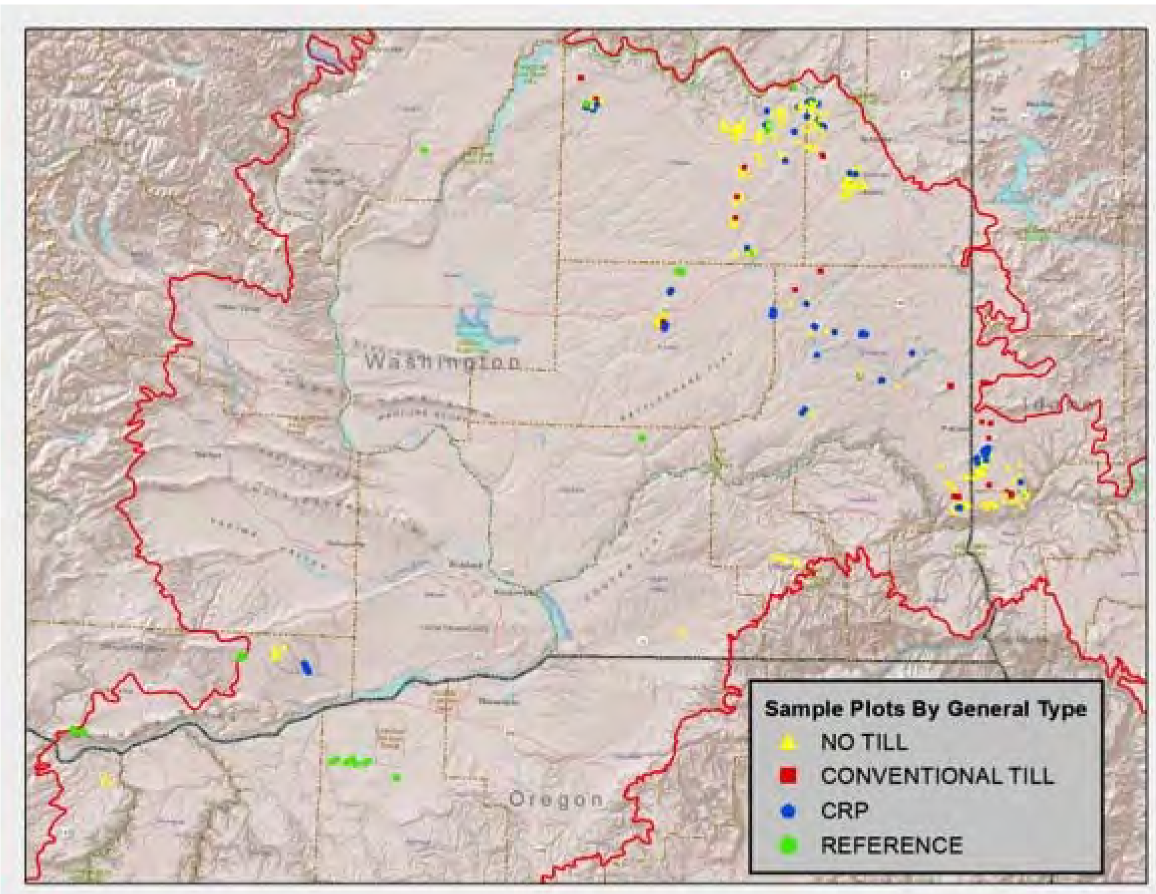
quantification to focus on more homogenous areas. Stratification for the Palouse Soil Carbon Project utilized GIS mapping information, land surveys, climate databases, and other data sources. The initial stratification was then adjusted after sampling and modeling. Stratification reduced the number of permanent samples plots required for each homogeneous subset. It enabled more accurate results with higher confidence intervals because of the lower variance within each homogeneous unit. Accurate stratification provides critical support for effective modeling of future conditions.

3. **Sampling:** Sampling is used to develop statistically rigorous information on the carbon content of carbon pools within the strata. In this project, a stratified random sampling technique was undertaken prior to project commencement to establish initial conditions and assist in developing a baseline for the project. Sampling will also be undertaken periodically thereafter to serve as the basis for the verification of the carbon benefits of the project activities. For the soil carbon pool, sampling should be undertaken to at least a 1-meter depth (where possible) to capture the soil carbon dynamics of the deeper soil layers. The samples taken prior to project commencement can also be used as source material for a cross-sectional study, to enhance the ability of the project developer to predict the effects of the activities which will be undertaken as part of the project.
4. **Modeling:** Results from the field sampling, farmer surveys, aerial imagery, and information on land use, tillage practices, and residue management practices were used to refine the GIS modeling and carbon modeling. The modeling established projections of regional net changes, and field-by-field net changes in soil carbon accrual, based on their duration in no-till agriculture and under conventional tillage, baseline starting conditions, and myriad other variables (soil type, texture, moisture regime, meteorological growing conditions, and season length). Because the sampling in this project covered areas that had been undertaking improved farming practices for 20 or more years, the models could be used to forecast the results of practice changes in fields that were still being managed using conventional techniques.
5. **Baseline development** Based on the information gathered in the previous steps, projection of a soil carbon baseline was conducted. Where the data on soil conditions, tillage practices, and other factors indicated that ongoing loss of soil carbon was occurring, a flat baseline equal to the initial sampling results was conservatively used, which reduced the complexity and uncertainty of forecasting future soil carbon dynamics under the baseline condition. Otherwise, projection of the baseline was used, which took into consideration a wide range of tillage practices, biophysical processes, economic indicators, and other processes.

Soil Carbon Sampling: Lessons Learned

During the sampling phase of the Palouse Soil Carbon Project, more than 750 1-meter soil cores[8] were collected in cultivated and conservation reserve fields and natural areas sites across the 7-million acre area. Sample sites were chosen within each stratum, using a stratified random approach, but they included only private fields and publicly owned sites where access had been secured. To the extent practicable, equal numbers of samples were taken in each stratum. This is one of the single largest 1-meter deep soil core data sets now available in the USA (*see Figure 3*).

Figure 3: Soil Sample Locations



Each soil core was described in the laboratory by a soil pedologist and then divided into 3-4 soil samples based on the horizons (soil layers) observed. Each sample underwent laboratory testing for a range of variables including bulk density and organic and inorganic soil carbon content.

The results of this extensive soil carbon sampling have provided a number of key lessons:

- The 750 samples provided data meeting statistical requirements (standard error of the mean ≤ 10% at 95% confidence) in some but not all of the strata. However, because the goal of the sampling was partly to undertake a cross-sectional study of the impacts of no-till

---

[8] The aim of the study was a depth of 1 meter, though the actual results have several cores less than 1 meter due to various conditions encountered in the field. In the cultivated subset of 442 cores, 90% of the cores were ≥80cm, and 50% were ≥95cm.

practices, a large number of strata were identified; including strata where no-till had already been implemented for 20 or more years. Therefore, the typical number of samples in a stratum was between 20 and 25. For this project, approximately 250 additional samples were required to meet statistical requirement in all strata. Given that in general, the soil carbon variability was quite high for a large, relatively homogenous area (as discussed in the next bullet point), this result is likely reasonably representative of many sites. It would appear that for landscapes of this sort, 30—35 samples per stratum are likely to be sufficient in most cases. On the other hand, one of the partners involved in this study undertook a pre-sampling study in a hyper-variable landscape, typified by active deposition of alluvial soils, and found that as many as 150 samples might be required for a single stratum. This result probably represents the extreme of sampling requirements for soil carbon.

- Standard parametric regression analysis was completed by the project statisticians. This analysis of landscape-scale soil carbon relationships in the Palouse suggested that three key variables (precipitation, slope position, and years in continuous no-till[9]) accounted for 37% of the variance over the landscape. Though this may not seem high, this is a significant accomplishment for a landscape/ecosystem-scale study of this type.

Table 1: Palouse Soil Dataset Summary Statistics (Cultivated Dataset)

	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI			% Error
History Codes 1-5	Total C kg/m²	A+B+C	8.99	3.52	441	0.168	95%	0.05	0.975	440	1.965	0.33	8.66	to	9.32	3.7%
	Organic C kg/m²	A+B+C	8.65	3.66	441	0.174	95%	0.05	0.975	440	1.965	0.34	8.30	to	8.99	4.0%
History Code 1	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI			% Error
	Total C kg/m2	A+B+C	8.18	3.27	99	0.328	95%	0.05	0.975	98	1.984	0.65	7.53	to	8.83	8.0%
	Organic C kg/m2	A+B+C	7.94	3.28	99	0.329	95%	0.05	0.975	98	1.984	0.65	7.29	to	8.60	8.2%
History Code 2	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI			% Error
	Total C kg/m2	A+B+C	9.79	3.90	79	0.439	95%	0.05	0.975	78	1.991	0.87	8.91	to	10.66	8.9%
	Organic C kg/m2	A+B+C	9.35	4.21	79	0.473	95%	0.05	0.975	78	1.991	0.94	8.41	to	10.29	10.1%
History Code 3	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI			% Error
	Total C kg/m2	A+B+C	8.74	3.56	116	0.331	95%	0.05	0.975	115	1.981	0.66	8.08	to	9.39	7.5%
	Organic C kg/m2	A+B+C	8.45	3.72	116	0.345	95%	0.05	0.975	115	1.981	0.68	7.77	to	9.14	8.1%
History Code 4	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI			% Error
	Total C kg/m2	A+B+C	9.21	3.08	95	0.316	95%	0.05	0.98	94	1.986	0.63	8.58	to	9.84	6.8%
	Organic C kg/m2	A+B+C	8.78	3.18	95	0.326	95%	0.05	0.98	94	1.986	0.65	8.13	to	9.43	7.4%
History Code 5	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI			% Error
	Total C kg/m2	A+B+C	9.50	3.79	52	0.526	95%	0.05	0.98	51	2.008	1.06	8.44	to	10.55	11.1%
	Organic C kg/m2	A+B+C	9.11	4.01	52	0.567	95%	0.05	0.98	51	2.008	1.12	7.99	to	10.23	12.3%

- With this analysis, the variance that cannot be accounted for appears to be primarily related to historical land uses and disturbance prior to the commencement of no-till management on individual farm fields. Erosion has been a major factor in soil dynamics since the onset of

[9] Though no time-series data has been collected for this study, we are using a predictor that has the years in no-till as a proxy for the direct influence of years of no-till on soil carbon.

farming and is highly specific to site and conditions. In addition, the implementation of no-till farming in many fields has been inconsistent because of a history of continuously changing market drivers for commodity grain. Variations in fertilizer formulations through time and across fields are also likely to have had an effect on soil carbon trajectories.

- Sampling to a one-meter depth in the Palouse landscape suggests that the primary soil carbon accruals are currently occurring in the upper layers of the soil. It appears that the shallower soil layers are the most severely impacted by erosion, variable management practices, fertilizer formulations, and other management practices, and are now showing recovery, albeit highly variable. The deeper layers appear to be stable and have more uniform soil carbon levels that appear not to be responding significantly to soil carbon accruals in the upper horizons.
- Nearly 100 duplicate soil samples, collected from various strata across the landscape, were analyzed to quantify in-field variability. Statistical analysis indicated a very high correlation between duplicate samples (*See Table 2*). This provides additional confirmation of the modeling approach that combines landscape-scale (cross-sectional) with field-scale (micro) replicated data and repeat sampling over time.

Table 2: Palouse Duplicate Soil Dataset Summary Statistics (Cultivated Dataset)

Variable	Duplicates?	N	N*	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Full Core OC	NO	504	2	8.430	4.205	0.320	5.514	7.743	10.712	24.904
	YES	204	0	8.628	4.077	1.761	5.625	7.854	10.746	21.684
Full Core Length CM	NO	504	2	83.837	19.843	13.000	80.000	93.000	97.000	100.000
	YES	204	0	88.912	13.740	23.000	87.000	95.000	97.000	100.000
80CM cores (H1-H5)	NO	386	120	3.778	3.778	0.858	5.779	7.875	10.596	20.794
	YES	177	27	3.729	3.729	1.669	6.024	7.717	11.087	19.009

For the full data set, we see that the duplicates have less variability as measured by the standard deviation (StDev) for both the full core organic carbon and full core length. The difference between the duplicates and the remainder of the data is appropriately reduced in the 80 cm adjusted data set for the H1-H5 management codes. We have no evidence that the cores that are part of duplicate pairs differ in important ways from the cores that are not part of duplicate pairs.

Agricultural Soil Carbon Projects: Lessons Learned

Defining project activities

To develop a carbon project, there must be a clear activity or set of activities that the project will undertake and which may be demonstrated to be additional, and result in atmospheric GHG reductions. For non-agricultural projects, where the project is usually under the control of a single person or entity, defining the project activities is typically simple and may be contained in a management plan or planting design. However, an agricultural project cannot (nor would it be beneficial to) dictate exact management strategies to farmers enrolled in the project. Farmers may need, for instance, to use a different plowing practice in a specific year, to respond to crop changes, weed problems, weather or other variables. As such, a more sophisticated approach to defining project activities is needed.

Based on the Palouse project, the following appear to be viable strategies, for which specific programmatic changes in specific carbon certification rules may be needed:

- Development and use of tools and procedures for assessing the additionality of a menu of activities, rather than single activities or a set suite of activities.
- Development of positive lists of activities which are defined as being additional, potentially applicable to certain areas and with certain conditions, as discussed in the section below entitled "Positive Lists for Determination of Additionality".

Project Boundaries and Changing Participants

Conventionally, in land-based projects, fixed physical project boundaries can be identified geographically within which the project will occur. As discussed elsewhere in this report, agricultural projects tend to require large-scale aggregation of many users, from tens or hundreds of large producers in the northern hemisphere, to hundreds or thousands in some developing nations. In addition, agricultural projects cannot insist that individual farmers commit to continuing to participate in the project for the entire project timeframe. There is thus a significant likelihood that some areas of land will drop out of the project during its timeframe.

At the same time, if projects are successful, they should offer powerful incentives for new farmers to join the projects, and this would be the optimal outcome, in terms of expanding GHG mitigation benefits. Therefore, carbon certification bodies and compliance programs must develop robust mechanisms to address this issue. Whereas some mechanisms exist in some programs for the addition of new areas of land after the commencement of the project, they generally have limited time horizons or other limitations on bringing additional area into a project. Enhanced mechanisms for dealing with constantly changing project boundaries, while maintaining additionality and permanence, will likely be required.

Aggregating Producers

Assembling producers over large acreages at relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. The Palouse project provided an on-the-ground opportunity to develop, test, and refine a low-cost aggregation model. Aggregation involves several issues discussed below, such as flexibility of practice, the ability of producers to opt in and out, the method for allocating benefits, and other issues. These need to be included in agreements between the farmers and the project developer. These agreements may include a master agreement that sets the standards by which specific issues, such as benefit allocation, are to be determined but which leaves the specifics of these issues to be determined in periodically reviewed sub-agreements. This structure will allow necessary flexibility, recognizing that changes in carbon markets, producer practices, enrollment and other variables will occur over time. It also allows initial enrollment to be streamlined, by reducing the number of issues which need to be addressed at that stage.

The Palouse project team developed standard partnership and contract structures to streamline landowner interactions and engagement. To date, this program has contractually enrolled producers representing more than 100,000 acres. A future enrollment phase will seek to include additional producers. Because the sampling has captured the variance in soil carbon and practices present in a broader region (rather than just on the farms of the currently enrolled farmers), the addition of more farmers can be undertaken without large expenditures for new sampling, thus reducing implementation costs.

Producer aggregation has been aided by clearly identifying the benefits to the individual producers, including:

- Producers receive valuable information about their land (e.g., detailed property maps, soil reports, and analysis of impact of different land use practices over time).
- Producers begin to accrue rights to carbon assets once the baseline has been developed and producers have contractually committed to the project.

In enrolling producers using the standardized contract approach, the variable costs are the time and labor required to connect, meet, discuss, and work with producers. Activities include the following:

- Identifying groups of farmers and co-convening meetings when they are together such as during annual association meetings to introduce the program.
- Working one-on-one with interested farmers to enroll them, which require contract discussions, projections on economic benefits, and discussions about access for on-going soil carbon measurements.

Capturing the Benefits of Scale

A key project design issue to be considered is the relative uniformity of the soils and practices across the project area. While all soil carbon improvement projects are likely to include variability in soil, weather or terrain, projects which cross major soil morphology, weather or farming practice boundaries are likely to require significantly greater sampling. These will probably be unable to achieve the scale benefits of the Palouse project.

For example, a project that includes 75,000 acres of farms on an old glacial lake bottom with predominantly clay soils and 125,000 acres of land in an alluvial area with recently deposited silty loam soils would, from the perspective of sampling, in fact be two projects. Many of the benefits of scale would be lost. The stratification used in this Palouse project has been focused on identifying and only including the most uniform area of the Palouse region to maximize scale benefits.

In addition to site uniformity, the project should probably not cross major farm practice boundaries. In the Palouse region, for example, there are specialty crop farmers in parts of the landscape that are very different than the uniform stratified landscape included within the project boundary. For instance, irrigated wheat production lands occur in this region, typically in locations in sandy alluvial soils along major rivers where irrigation is readily available. The inclusion of these farms would have resulted in needing to account, both from the carbon quantification and the benefit allocation perspective, for a completely different set of practices and issues.

The same issues would likely occur across major crop boundaries, such as corn to wheat. Many relatively uniform agricultural landscapes contain multiple crops in rotation, and these practices can significantly enhance soil productivity and soil carbon accumulation. However, where projects include large areas with completely different agricultural practices and crops, some benefits of scale may be lost, and the project may become unduly complex.

Sampling vs. Modeling

There are two major approaches to quantifying soil carbon: modeling and sampling. An ability to quantify soil carbon benefits from changes in agricultural practice or land management using modeling as a primary tool would clearly be preferable from a cost perspective. However, the existing models suffer from a lack of high-quality soil carbon data showing benefits over time and thus have unacceptably large margins of error.

Most carbon models constructed to date have been created for major agricultural settings and soils, such as the Midwestern U.S. corn belt.[10] Furthermore, cross-sectional studies, which compare areas of land that have undergone different practices, are in many cases not able to produce high accuracy data on soil carbon rates of change associated with practice change, due to unknown differences in starting conditions.

In addition, neither the scientific literature nor the models developed using data from this project are always conclusive. For example, considerable controversy among soil scientists still exists on the value of no-till agriculture compared to conventional tillage. One overarching synthesis, based on a review of hundreds of studies, suggested that under no-till practices, soil carbon accruals occurred in the upper horizons, but soil carbon losses occurred below the upper horizons because root growth (and therefore carbon accrual) did not travel as deep into the soil under no-till.

Therefore, sampling as a quantification method may be the only option where there is significant uncertainty on the actual carbon stocks and likely changes in carbon stocks as a result of a land-use changes or management activities, which will be the case in many areas. In the long term, data derived from repeat sampling of projects—essentially longitudinal studies—will provide the information needed to calibrate soil carbon models such that in the future, modeling will become a more viable approach to quantification.

Economics of Sampling and Laboratory Analysis

The need to use sampling as a quantification method leads to a requirement for larger-scale projects during this early stage of soil carbon project development. In most landscapes, sampling costs are not linearly connected with project size. In many agricultural landscapes, they soon reach a plateau where increased project size results in little increase in sample point numbers or costs. The

[10] Long-term soil carbon measurements and data sets are available from the Palouse region (Columbia Basin Agricultural Research Center near Pendleton, OR and the Agricultural Research Center at Washington State University in Pullman, WA) and other regions that have documented soil carbon changes over one hundred years or more under various continuous cropping and rotation scenarios. These datasets are useful to understand carbon accrual and soil carbon degeneration relationships that have operated over time. Models such as Century, Comet VX, and Comet Farm have used the long-term data sets for model creation and calibration in the Palouse and elsewhere. However, long-term data sets do not account for new farming technologies, including no-till farming. For this reason, literature data sets typically provide only part of the carbon accrual story desirable. The data sets have been augmented in such regions with more recent data sets and time-series relationships developed often over the past 30 years in which technologies such as no-till methods have been tested side by side with conventional tillage. Furthermore, most models are based on soil sampling to a depth of 30 centimeters as a standard practice compared to 1-meter depth in this project.

minimum area that results in acceptable economics for a project will depend not only on sampling costs but also on carbon price and the amount of additional carbon sequestered per unit area per year.

For a carbon project, the quantification of carbon pools will typically be undertaken once every 3 to 5 years. From the experience of The Earth Partners, revenues must be shared between farmers and the project developers. And because there are expected to be significant additional costs for project design, verification, management and farm aggregation, total costs for sampling (at project start-up and at each subsequent verification event) should not exceed 15% of gross revenues.

The work undertaken in this project provides some guidance on the relation between scale and costs. Although the project area was approximately 100,000 acres, the sampling included points from within a 7-million-acre area. Costs are developed at two scales for this report: the 100,000-acre sampled scale with actual costs summarized, and for the entire 7-million-acre area, where total project costs are divided by this larger acreage:

Over the 100,000-acre sampling area, the costs incurred were approximately $1.35 per acre. Combined, the total cost per core for field sampling and laboratory analysis was approximately $213 per acre.

- Collection of 710 soil cores occurred during a two-month period with two crews in the field. The total effort cost $114,915 for 1,915 hours of crew time. This is an average of 2.7 person-hours required per soil core (including all travel and field time), costing $162 for each core.
- Laboratory analysis of the 710 soil cores collected during the baseline soil sampling cost $36,085. After the cores were described, they were split into an average of 3 samples (one for each soil horizon) for sample preparation, and analysis of bulk density and carbon, costing $17.50 per sample or $51 per core.

These are costs only, and normal rates of return for these activities are not expected, so an average cost of about $280 per core would probably represent commercial costs.

During this project, about 750 samples were collected. Based on the most likely stratification, the samples collected did not quite meet the normal statistical requirements for accuracy in all strata. An estimated 250 additional samples would be required to meet this goal. Based on these inputs, the sensitivity shown in *Table 3* gives a range of outcomes, in terms of changes in prices, areas and sequestration rates:

Table 3: Sensitivity analysis for project scale and related variables (variables changed highlighted in yellow)

Project basics	Base Case	Price changes		Carbon sequestration rate changes			Area changes		Downside Case
price/tonne CO2	$5	$3	$7	$5	$5	$5	$5	$5	$3
acres in project	100,000	100,000	100,000	100,000	100,000	100,000	60,000	140,000	180,000
year project life	20	20	20	20	20	20	20	20	20
tC/acre/yr sequestered	0.4	0.4	0.4	0.2	0.3	0.6	0.4	0.4	0.3
buffer deduction	20%	20%	20%	20%	20%	20%	20%	20%	20%
Sampling									
samples taken at each sampling event	1000	1000	1000	1000	1000	1000	1000	1000	1000
Sampling events over 20 years	5	5	5	5	5	5	5	5	5
$/sample	$ 280.00	$ 280.00	$ 280.00	$ 280.00	$ 280.00	$ 280.00	$ 280.00	$ 280.00	$ 280.00
Results									
Revenue	$11,680,000	$7,008,000	$16,352,000	$5,840,000	$8,760,000	$17,520,000	$7,008,000	$16,352,000	$9,460,800
Sampling costs	$1,400,000	$1,400,000	$1,400,000	$1,400,000	$1,400,000	$1,400,000	$1,400,000	$1,400,000	$1,400,000
Percentage of revenue	**12%**	**20%**	**9%**	**24%**	**16%**	**8%**	**20%**	**9%**	**15%**

The base-case scenario shows that a 100,000-acre project meets the goal of having sampling costs at or below 15% of total project revenue. However, several of the sensitivity analyses show sampling costs exceeding the 15% goal. For a commercial carbon project, the goal would probably be to have the sampling costs at or below the goal for a somewhat less favorable case. The last column shows that, using somewhat pessimistic assumptions, the project would have to include approximately 180,000 acres to meet the goal.

Because this baseline sampling was designed to capture the strata found within the entire 7-million acres—and because the baseline study allows for additional farmers to enroll and does not necessarily require sampling of their fields—we also compute cost estimates using the 7-million-acre project boundary as the denominator. This suggests a total averaged cost per acre of $0.17/acre for all activities, including sampling and lab analysis.

While aggregating hundreds of thousands of acres in a single area requires significant effort on the part of aggregators—and commitment on the part of farmers—aggregations of this scale are eminently practical in many large farming areas such as the Palouse region—especially in the event that there is a clear pathway to monetizing carbon assets (i.e., carbon market or subsidy program). In the past, there have been cost objections raised to field sampling to quantify soil carbon. This project demonstrates that although large areas must be involved, sampling can be a viable approach to soil carbon quantification. Furthermore, using sampling approaches in actual projects is likely one of the best paths toward developing the accurate knowledge necessary to support modeled approaches in the future.

Allocating Benefits to Producers

Each farm is likely to have somewhat unique management, based on the farmer's preferences, history, equipment, and methods. While inclusion in a project would clearly involve farmers meeting some basic practice standards, it would not be practical or desirable to require identical practices from each farmer. Individual farmers will respond appropriately to site, weather, crop, market and other variables applicable to their farms. The project must allow them to maintain this flexibility as long as they meet agreed-to operating principles and some standard land use/land management behaviors and/or performance results.

Because initial conditions and management practices among farms will not be perfectly uniform, rates of carbon accumulation will vary from farm to farm and often from field to field. Furthermore, farmers will need the flexibility to undertake practices in a given year which are known to produce less carbon accumulation. As a result of this variability, not all farmers will be accumulating carbon at the same rate on their land. Any system of aggregation must include methods for fairly distributing carbon benefits, based on farmer performance, such that enhanced practices are rewarded.

Sampling to statistically valid levels on each farm is not a practical solution to the problem of allocating carbon accrual benefits at the farm level, as the cost would be prohibitive. Therefore, the allocation of benefits will have to be based on a division of total benefits realized based on a modeled approach that has been regionally calibrated through stratified sampling. Any allocation system should meet the following criteria:

1. **Transparent.** The allocation system should result in a score that the farmer can calculate and understand. Using a sophisticated model such as Century to allocate carbon benefits would not meet these criteria, although the model might be used to develop the allocation system. Use of a transparent system is required to allow farmers to understand and assess the incentives for better practice.

2. **Proportional**. Because the absolute amount of benefit provided by the project over a 3- to 5-year period will not be known ahead of time, the system cannot allocate absolute benefits. Instead, it should determine proportions of the total benefits due to each farmer.
3. **Provides feedback**. Although sampling to high statistical accuracy cannot be undertaken on each farm, the system should provide a basis for using sampling results to identify areas where the allocation system appears not to be reflecting actual results and allow the system to be adjusted. Noting such discrepancies could also identify key areas where research efforts could pay big dividends, in terms of enhancing our understanding of soil carbon processes.
4. **Periodically updated**. Based on results and further research, the system needs to have a regular, transparent method for updating the weights given to each practice. Updating should be careful and conservative, given the limitations of the data availability, but should aim to optimize the effectiveness of the project as an incentive for farmers to undertake practices that provide the greatest GHG benefits.

The Early Adopter Problem

Additionality criteria have always been recognized as critical for ensuring that credit is only given where actions result in real reductions in GHGs over and above those that would have occurred in the absence of the project. However, it is also recognized that additionality criteria can penalize those who have undertaken leading-edge actions that reduce GHGs without programs or markets that provide benefits for these actions, and without reduction of GHGs being the goal of the actions. In the early years of international negotiations, Costa Rica, which was an early adopter in the protection of natural forests, raised this point as a problem with the proposed CDM system.

Since early adopters may have undertaken changes in practices regardless of whether carbon incentives existed, it is clear that their actions are not additional in the conventional sense. On the other hand, it is also clear that they are often critical in the development of new practices—and that without them, these practices might not gain widespread acceptance, even with the existence of GHG mitigation incentives. Essentially, the presence of early adopters is often a key to overcoming a common practice barrier that incentives from carbon sequestration alone might not be able to overcome.

This problem is closely related to the problem of accelerated adoption. Adoption of new agricultural practices is often slow and gradual, but over time, practices which reduce GHGs, and which have other benefits may become standard practice, even in the absence of GHG mitigation incentives. However, the addition of GHG mitigation incentives may substantially speed up the adoption of the practices, yielding real benefits in terms of GHG reduction.

Solutions to the early adoption problem and the problem of gradual adoption of a practice without GHG mitigation incentives require solutions at the structural level. One potential solution is that discussed in the "Positive Lists" section below, where lists include declining percentages of benefits over time for activities on the positive list. However, other solutions may also exist.

Baseline and Additionality Issues

Common practice baselines

To make agricultural practices change a significant tool for addressing GHGs, structures and methods used must be able to function within a compliance market, such as the California market.

California is promoting the development of common practice baselines that simplify the demonstration of additionality and the forecasting of baseline conditions.

California currently only has an agricultural common practice baseline for rice cultivation. Common practice baselines are pre-determined through extensive research and/or modeling examining the following:

- Average types and levels of practice across an industry or sector.
- Average carbon content of carbon emissions or pools based on these practices.

The results of the research undertaken in this project have significant relevance for the development of common practice baselines for agriculture and soil carbon improvements. The extensive sampling undertaken as part of this project revealed that carbon content of soils are highly variable, even within one of the more uniform areas of the Palouse, and are influenced by a wide range of conditions. Such conditions include topographic position, the moisture index of soils related to crop productivity, past management and disturbance history, soil processes, and other factors. However, statistical analysis of these data suggests that despite this variability, it would be possible to develop a meaningful common practice baseline figure for soil carbon content in a region such as the Palouse.

However, the use of a common practice baseline would necessarily imply the use of modeled approaches to estimating the carbon benefits of specific practices for project-level accounting. Using a common practice baseline with a sampled quantification approach for actual carbon benefits would typically result in a high degree of variability, with some farmers showing huge carbon accrual and others showing large carbon losses. These variations would not be indicative of actual changes in the carbon content of soil but would rather be the result of differences in initial conditions, which in many cases would not match the common practice baseline.

In this Palouse project, farming methods used by the enrolled farmers are converging on a suite of similar practices. This convergence is being driven by the need to meet Shepherd's Grain certification requirements for no-till, as well as by improved knowledge of fertilizer relationships required to meet the protein content of the grain, and other environmental and behavioral influences. However, despite this convergence, soil carbon content and accrual rates remain heterogeneous due to differences in initial field conditions.

As discussed in previous sections, the use of a modeled approach to carbon benefits arising from specific practice changes necessarily involves large uncertainties. Much of the existing calibration data was based on studies that sampled superficial soil layers only and missed significant changes at depth.

Notwithstanding these uncertainties, it would be possible to design a system that relies on common practice baselines and modeled benefits. However, if the goal was to ensure that accounted atmospheric carbon benefits had a high probability of being real, the results of the models would have to be interpreted extremely conservatively, likely resulting in the under-accounting of carbon benefits in many cases.

The alternative would be the creation of a system which may be vulnerable to challenge on the basis of failure to be adequately conservative, and the creation of GHG offsets with potentially serious credibility problems that could undermine the credibility of the compliance system.

In general, based on the outcome of the work conducted in this project, the use of strictly modeled approaches appears to carry high risks of systemic problems. However, without modeled approaches, common practice baselines are unlikely to prove useful in an agricultural soil carbon setting.

Positive Lists for Determination of Additionality

Positive lists consist of identified activities that are pre-determined to be additional and eligible under the Carbon Standard, based on extensive research on current practices in the sector. For instance, in a given area (state or sub-state region), research might discover that only 2% of farmers use no-till methods. Based on that research, no-till in that area might be designated as eligible and additional. While this approach does mean that some crediting might occur for actions that would have already occurred (the 2% of farmers using no-till without incentives from carbon benefits), appropriately developed positive lists could minimize this issue while still offering positive incentives to those early adopters who are creating and validating new practices with atmospheric benefits.

Positive lists could also be designed with declining benefits to address issues of gradual adoption and to eliminate the accounting of excess benefits based on early adopter participation. In this case, for a given practice, projections might show that, over time, many or most farmers would have commenced the practice even in the absence of incentives for carbon benefits.

The positive list would then include a declining curve, such that either all farmers received a gradually declining percentage of the total carbon benefits that they generated, or that carbon benefits for a given farmer were pro-rated based on when they started their management changes. This system could ensure that total carbon benefits are not exaggerated and could prorate benefits to incentivize early adopters while eliminating the crediting of carbon which is not additional by reducing the credit given to other producers, proportional to the credit given to early adopters.

The development of positive lists could be a key tool in addressing the "menu of activities" problem discussed in the section above presenting the definition of project activities.

Permanence

Permanence in agricultural projects is complex, addressing farmers who cannot realistically be tied to hundred-year commitments, and undertaking the management of lands whose ownership and usage rights may be subject to change. Not only do farmers need flexibility, both with regard to practice and land ownership, but they frequently may farm on leased land.

However, to meet market requirements, soil carbon benefits associated with improved farming practices must be permanent, usually defined as lasting at least 100 years. Some mechanism is therefore required to ensure permanence of project carbon while allowing the farmers appropriate flexibility. Conventionally, permanence is ensured through the use of buffer pools that withhold a percentage of the carbon from the market to cover unforeseen losses. For agricultural carbon, there are several potential structures that could address loss risks associated with farmer flexibility:

1. **Risks assumed by certification bodies.** Regulatory and verification bodies could appropriately take some of the risks associated with the inherent uncertainties of agricultural projects. These bodies, by reason of the scale and scope of projects with which they are involved, might be better placed to assess and appropriately retain buffer pools covering these risks. Usually, such buffer pools are only intended to address unforeseen circumstances. However, these pools could be extended to cover anticipated losses associated with independent actions by farmers. Depending on the bodies involved and the depth of the buffer pool, such an arrangement might result in some of the same conservative over-insurance issues as those noted below for aggregator risk assumption.

2. **Aggregator risk assumption.** In this approach, the legal contracts contain no permanence requirements regarding length of farmer participation and no penalties for farmer withdrawal. The contracts also do not allocate carbon losses resulting from farmer withdrawal to the farmers. In essence, the aggregator provides an insurance function, in the form of a risk pool, consisting of either retained carbon credits or cash. The aggregator can design a landscape-scale carbon assurance buffering system, reflective of past and present patterns of land use, crop change, and tillage method changes (i.e., land use dynamics). Modeling of the land-use dynamics may be based on the online farmer survey and aerial imagery. The result of the modeling may be used to drive buffer pool requirements. For example, annually 20% of 1-year-old no-till fields, 15% of 3-year-old no-till fields, 8% of 5-year-old no-till fields, and 0% of 10-year-old or older no-till fields may be converted back to conventional tillage. Based on these data, a model of total carbon losses associated with this behavior may be built as a basis for assurance buffering needs. This model can continue to be validated and updated through the tracking of actual farmer conversions and re-conversion behavior.

   While this is probably the simplest structure, it has several potential problems. The system is likely to amount to a subsidy of farmers who temporarily participate and a penalty to the long-term participants, as the aggregator will have to reduce the returns to all farmers to cover their risk. In addition, because the aggregator will carry the risk, and because there is likely to be significant model uncertainty, the tendency will be for the aggregator to insure, with high certainty, that the buffer pool covers the potential risk. The aggregator will thus tend to overcharge for the risk. This could also take the form of a model similar to the first, except that in this case, the farmers as a group agree to bear the risk of farmer withdrawals. This could potentially reduce the cost-per-farmer for such withdrawals, as it may reduce carrying costs and expectations of returns, but it retains the problem of penalizing the most committed farmers.

3. **Aggregator-farmer co-operative risk assumption.** In this model, the liability associated with farmers leaving the project is defined and shared between aggregator and farmers, and individual farmers may bear some liability for leaving the project. This strategy could follow a typical insurance program with individual farmers liable for the equivalent of deductibles and payments of deductibles covered through performance bonds or other sureties. The remaining risk would be covered by a buffer pool approach. In this case, farmer participation could allow structures in which buffer requirements slowly decline as participation stability is established, allowing some of the buffer pool to be sold, to the benefit of the farmers. This approach would partly overcome the problem of the implicate subsidy for short-term participants.

4. **Individual risk assumption.** In this case, carbon benefits paid to farmers are accompanied by contingent liabilities—requirements to repay the benefits if they drop out or remove a specific piece of land from the program. Farmers could gain considerable flexibility from this approach, as it would, for instance, allow them the possibility of not enrolling all of their land and maintaining a portion of it as a buffer against losing a lease or that of choosing a different management strategy for part of their holdings. This structure could also allow for the option of gradual repayment, based on the rate at which carbon is lost from the land where improved practices are no longer occurring. However, there are also some complexities to this approach. Because the liability would probably have to be against the farmer rather than the land, to allow for the situation of leased land, the aggregator could be assuming significant counter-party risk. In addition, if the system were to be completely

unbiased, the repayment would have to be in carbon credits, or their equivalent in cash at the current market price at time of repayment, which would make the size of the potential liability open ended, as carbon prices could fluctuate considerably.

None of these systems achieves a perfect result, and the appropriate system will probably be a hybrid that shares risk among the verification/certification/regulatory bodies, the farmers and the aggregator in a way that maximizes flexibility, minimizes the penalization of committed farmers, and ensures that the aggregator's insurance role does not consume a large proportion of the benefits.

In the case of the Palouse project, risk has been reduced by working with an existing association of farmers, Shepherd's Grain, who were already motivated to work together and share the benefits of their association. Situations such as this have significant potential to reduce the complexity of the required structural issues and associated contractual language regarding withdrawal risks.

Programmatic Synergy

The management activities that result in soil carbon increases may also have other benefits, including the "green labeling" of products, reductions in downstream water quality issues and other environmental benefits, and enhanced crop productivity and resilience. Many of these benefits are already the focus of existing associations, marketing programs, government training programs and certification schemes. In the Palouse, organizations such as Shepherd's Grain and the Pacific Northwest Direct Seeding Association are advocates and resources for no-till farming. In addition, USDA-NRCS is a valuable partner, given its deep, local relationships with producers. Relationships between these associations, organizations, certification groups, and carbon programs can potentially enhance the success of all and reduce total producer costs for achieving multiple goals. For instance, the validation of a carbon project may be undertaken in conjunction with green certification, and quantification of downstream benefits, reducing the costs for all of the programs compared to individual approaches.

TO: **Secretary Tom Vilsack***
U.S. Department of Agriculture (USDA)
FROM: **Debbie Reed, Executive Director**
Coalition on Agricultural Greenhouse Gases (C-AGG)
and
USDA Greenhouse Gas (GHG) Conservation Innovation Grant (CIG) Project Participants
SUBJECT: **USDA GHG CIG Projects: C-AGG Recommendations and Feedback to USDA**
DATE: **August 15, 2013**

We are writing to provide recommendations and feedback about the substantial benefits that have been realized from USDA Natural Resource Conservation Service (NRCS) investments in FY2011 of $7.47M for Conservation Innovation Grant (CIG) projects to reduce greenhouse gas (GHG) emissions and promote carbon sequestration, hereinafter referred to as the USDA GHG CIG projects.

C-AGG also wishes to thank you for USDA's investments in GHG mitigation and adaptation activities as they relate to the agricultural sector, but in particular, investments to prepare the sector to voluntarily contribute to GHG mitigation efforts in a manner that simultaneously benefits agricultural operations. The investments include many reports, tools and calculators developed by USDA that are helping to engage and support the sector in mutually beneficial activities and programs.

In particular, the focus of this memo is on the USDA GHG CIG projects. C-AGG urges USDA to continue to invest in the existing USDA GHG CIG projects, as well as to consider funding additional USDA GHG CIG projects in the future. Among the many successes of the existing projects is that the California (CA) Air Resources Board (ARB) is currently engaged in adoption of an agricultural offset protocol for rice growers that is based on one of the USDA GHG CIG projects. It is essential that agricultural offsets be included in CA's mandatory cap-and-trade program, both to satisfy the need and demand for cost-effective offsets within CA's compliance market and future additional compliance markets, but also to show how to effectively develop the necessary infrastructure and programmatic underpinnings to enable and encourage agricultural producers' participation in carbon markets. The USDA GHG CIG projects have provided a critical path to enabling viable agricultural offset protocols to be adopted in CA as well as within voluntary carbon markets. Additionally, USDA's investments have leveraged private sector and Canadian government investments in agricultural offset protocol and methodology development and related activities that are critical to further progress in this important area.

---

* cc: Krysta Harden
Robert Bonnie
Ann Bartuska
Ann Mills

Background Information on C-AGG

C-AGG is a multi-stakeholder coalition of agricultural producers, scientists, methodology experts and developers, carbon investors, environmental ngo's, and project developers that fosters a fact-based discourse on the development and adoption of policies, programs, methodologies, protocols and tools for GHG emissions reductions and carbon sequestration from the agricultural sector. C-AGG's primary objective is to incentivize voluntary GHG emissions reductions opportunities for agricultural producers that enhance productivity and income generation opportunities while benefiting society.

Given C-AGG's focus, objectives, and activities, we welcomed USDA's investment in GHG CIG projects as a focal area, and have benefited greatly from our collaborative engagement with USDA's GHG CIG projects. To foster this partnership, C-AGG provides financial support to the USDA GHG CIG project participants to participate in C-AGG meetings and workshops, including informal dinners with USDA staff, in order to promote collaboration, shared learning, and productive, focused discussions on the projects. C-AGG devotes specific sessions during meetings and workshops to address USDA GHG CIG and related project updates, successes and challenges. We created a portal on our website to showcase the USDA GHG CIG and related projects (http://www.c-agg.org/cig/), and to allow project participants to communicate and share information in a dedicated online forum; and have utilized our network of participants and stakeholders to share news and information regarding the GHG CIGS and related projects, as well as opportunities and announcements of likely interest and benefit to project developers and other stakeholders.

We would like to take this opportunity to summarize our shared learning based on our partnership with USDA GHG CIG project participants. While most of the USDA GHG CIG projects are in the second year of three-year grant cycles, there is much progress and success to report, and this memo presents just a snapshot of the many benefits. The following lessons and outcomes are categorized into three broad areas: successes, challenges, and future recommendations.

<u>USDA GHG CIG Project Successes</u>

- USDA GHG CIG Projects are Informing the Development of the Mandatory CA Cap-&-Trade Program and Voluntary Carbon Market Registries and Protocol Development
    - The process of developing, planning and implementing the USDA GHG CIG projects has and continues to play a key role in helping to inform ongoing development of agricultural offset protocols and future protocol opportunities in the CA Cap-&-Trade Program as well as in voluntary GHG markets, and market-based registries. The USDA GHG CIG projects have served as project pilots, providing a formative and developmental bridge to carbon offset markets and the potential role of agricultural projects within these markets.
        - This role is particularly valuable given that agricultural offsets represent a new area within offset markets, which has led investors and potential buyers to view them as still high-risk, which will only be overcome once these early projects show success, and build confidence with markets, regulators, and investors (including purchasers of credits).
    - USDA GHG CIG project developers have engaged directly and through C-AGG with CA policymakers to share program requirements and opportunities related to agricultural protocol development, and the CA ARB is currently working to adopt a Rice Protocol based on one of the USDA GHG CIG projects.

  - USDA GHG CIG projects are providing innovative agricultural offset and related, derivative opportunities to the agricultural sector, such as informing sustainable supply chain initiatives and ecosystem market opportunities for the agricultural sector.
  - Significant cross-border (Canada-US) collaboration between scientists on adapting protocols within the USDA GHG CIG projects has led to synergistic progress on pathways to quantifying and reducing greenhouse gas emissions in agricultural operations.

- USDA GHG CIG Project Developers, Collaborators Represent Diverse Backgrounds, Disciplines
  - USDA GHG CIG project developers and collaborators:
    - Include conservation leaders and stakeholders focused on multiple beneficial environmental outcomes from agricultural ecosystems, including but not solely based on GHG mitigation;
      - e.g., the Chesapeake Bay Foundation (CBF), Ducks Unlimited (DU), Environmental Defense Fund (EDF), and Winrock International (WI)
    - Include key agricultural sector stakeholders seeking to enhance member productivity and sustainability in the face of changing market needs;
      - e.g., The Fertilizer Institute (TFI), Dairy Management Institute (DMI), the California Rice Commission, the California Farm Bureau Federation, the New England Farmers Union, and Shepherds Grain
    - Have trusted relationships with the agricultural sector, including an understanding of the realities of agricultural operations, and are typically valued and recognized agents of change within the sector;
    - Play the valuable role of aggregation and program interpretation for individual producers – in other words, they make possible the ability of individual farms/farmers and groups of farms/farmers to participate in GHG mitigation programs and carbon offset markets, regardless of farm size;
    - Are building the necessary infrastructure to enable successful and cost-effective aggregation, as well as leveraging financing and added value for projects. This includes the development of educational materials, protocol development, recruitment, training, data collection, web-based interface development, purchasing credits, etc.
    - Are developing web-based interfaces that are user ("farmer") friendly, to simplify and minimize producer data collection requirements and burdens, which can be significant. Some of the USDA GHG CIG projects have developed unique, open access interfaces for their projects and others.

- USDA GHG CIG Projects Encouraged Collaborative Engagement with Other Programs
  - The collaborative opportunities provided by the USDA GHG CIG projects have led to significant cross-pollination of agricultural and land-based offset and ecosystem service experiences, including with water quality programs and sustainable agricultural certification programs.
    - Project development encouraged new program outreach and collaborations between NRCS, other USDA agencies, and private sector partners.
  - The Alberta Offset Program experience with Agricultural Offset Protocols and project verification has been a topic of dialogue within C-AGG, and is a valuable source of learning and direction for GHG market and protocol developers, registries, and USDA GHG CIG projects, and continues to help inform program and protocol development.

- The shared findings of the Office of the Auditor General of Alberta (independent auditors of all Government of Alberta Ministries) through audit reports, as well as presentations by C-AGG Alberta participants reporting on program developments and changes have been particularly instrumental in contributing key learnings, such as describing the characteristics of data management systems needed by project developers and aggregators to bring quality offset ton to markets.

- USDA Conservation Programs Offer Key Benefits to USDA GHG CIG Projects
  - Conservation programs in particular are familiar to producers, providing a point of entry for agricultural offset-type programs, and a potential source of funds to help get projects started, and help with producer engagement by "starting the conversation" with trusted sources.

- Agricultural GHG Mitigation Activities Offer Significant Co-benefits
  - The value of agricultural GHG emissions reductions tends to exceed that of non-biological projects, because by their very nature, the emissions reduction co-benefits are multiple, including ecosystem and habitat benefits, water quality benefits, air quality benefits, and enhanced soil and productivity benefits.
  - Environmental co-benefits with agriculture can be and often are significant, but most of these co-benefits are hard to quantify, and/or cannot yet be monetized.
  - Allowing for co-benefits to be recognized or included in criteria for project selection, protocol assessment and development (i.e., determination of which protocols to develop), could help to further incentive investments in agricultural offsets.
    - Over time, monetization of co-benefits and creation of ecosystem service markets can further "grow" this opportunity by adding income streams to agricultural offset projects, thus helping to build the business case.

USDA GHG CIG Project Challenges

- Project Timelines
  - While the USDA GHG CIG project cycle is three years, it is clear that the project development cycle is much longer, particularly for these first-of-a-kind projects. Protocol development, farmer recruitment, project implementation, and credit delivery can take five or more years to complete.

- USDA Conservation Programs
  - Although most USDA GHG CIG projects benefit from USDA conservation programs as an entrée to participation in GHG mitigation projects, existing conservation program requirements created some challenges, as did the topic of GHG mitigation as a primary focal point of the projects, which required semantic and approach-based adjustments to farmer engagement. Farmers are far more likely to engage in dialogue about enhanced operational efficiencies or efficient input utilization than about GHG reduction.
  - Strict "additionality[1]" requirements related to some GHG offset programs complicate the ability of producers to participate in both conservation programs and carbon market

---

[1] "Additionality" refers to the concept that GHG emissions reductions credits must result from additional action or action that likely would not have happened in the absence of the incentive provided by the carbon market. C-AGG identified additionality as one of five core principles in its April 2010 report, stating: "Only net reductions of atmospheric GHG concentrations beyond business as usual should be rewarded."

offset programs, despite the fact that producer costs are rarely covered by potential carbon market proceeds. Additionality requirements also perversely penalize innovators and early adopters of beneficial GHG emissions reduction or sequestration practices.
    - While the availability of EQIP funding to USDA GHG CIG projects was greatly appreciated and potentially highly valuable to the success of the USDA GHG CIG projects, the timing and ability to target the EQIP funding to these projects proved a disconnect, and thus an opportunity lost.
        - The lack of Technical Assistance funds available to State NRCS offices proved challenging in securing engagement and responsiveness from many State NRCS offices, as the EQIP funding was viewed as an additional burden to staff.

- Producer Engagement
    - A significant lesson learned is that agricultural producers will engage in projects not based on GHG mitigation opportunities, but rather on enhanced income generation or productivity, input utilization efficiency, and perhaps, to help prevent regulatory threats. We must meet producers where they are at, and identify the pain points or opportunity points that will encourage their participation in GHG mitigation projects in ways that enhance their operations.
        - These obstacles to engagement are not just about semantics – they are cultural and socio-economic. Agricultural producers make management decisions based on knowledge, costs, equipment, available support systems (e.g. technology transfer or availability of best management practice guidance), market signals, and not insignificantly, based on what their peers and neighbors are doing.
    - Practice changes of any kind require decision support systems, and the bigger the practice change, the more important the support system is to inducing the desired change. This is particularly true for practice changes that involve long-term management investments (e.g. capital investments, infrastructure, and equipment). These changes are viewed largely as business decisions, and without the decision support systems, including business case scenarios showing adequate return on investment, even smaller practice changes that might reduce yield or income are viewed as risky – particularly if the financial benefits of participating are uncertain or delayed.
    - Messengers are important. Farmer-to-farmer interactions are most likely to lead to producer engagement and adoption of new practices. Often, innovators have a strong peer following and are viewed as trusted peers/partners who will take risks, tweak the system to maximize benefits, and optimize financial and co-benefit options for the "win-win" situation.
        - Due to offset market additionality requirements, innovators and early actors are generally prohibited from participating in offset markets, which penalizes the leading edge producers who take on the risks of new management practices and who pave the way for wider scale adoption and potential participation in new activities and new programs.
    - Simple educational materials with a sophisticated assessment of benefits and support systems (including available tools) are necessary.

However, in C-AGG's 2012 Executive Summary on Additionality in Agricultural Offset Protocols, we agree that additionality as it applies to the agricultural sector has a somewhat unique context, and thus should be addressed uniquely, as well.

    - Onerous program participation requirements, including high data input and collection needs, and data collection that is not within the current realm of most agricultural producers, is a significant hurdle to producer engagement.
    - Project developers who interpret program opportunities for farmers and deliver the opportunities in a manageable fashion are required to engage farmers. Farmers should never have to see or read a GHG Offset Protocol, or calculate GHG emissions reductions for a protocol.
    - USDA's COMET-Farm tool is a valuable, user-friendly, web-based tool to help introduce individual producers to GHG mitigation opportunities, and with further development can potentially be used for data collection needs and efforts related to agricultural offset protocol opportunities.

- Data Needs are High; USDA Data Sharing Opportunities Should be Investigated
    - GHG methodologies and protocols are data intensive, and there is insufficient data for some project types or agricultural cropping or livestock systems to quantify GHG emissions associated with "common" agricultural practices (baseline estimation), as well as emissions reductions or sequestration associated with certain practices.
        - E.g., there is insufficient data available for specialty crops and cropping systems in some regions, such as CA.
    - Temporal and spatial differences in GHG fluxes (particularly with regard to N_2O) and measurement tools and approaches remain challenging, and require additional research and data collection, and data sharing;
    - A cohesive attempt to identify the most critical data needs for offset protocols and projects is required, and collaboration with USDA and other relevant government agencies could identify access to USDA data that can benefit projects, protocols, models, and overall program development.
        - Data that can be directly downloaded into models or protocol interfaces, or otherwise available in a compatible and accessible format can greatly benefit protocol development, including data management, measurement, and verification systems;
        - Data directly collected from producers needs to be compatible with their ability to collect and deliver the data, e.g., in a format used by/already collected by producers (e.g. amount of diesel used in a certain timeframe, not CO_2 equivalents of fuel used), and needs to be translated elsewhere and by others within the offset system or program.

- Landscape Uncertainties Related to Program Design, Protocol Development, and Agricultural Opportunities
    - Without US federal mandatory GHG regulations or requirements, and mandatory and voluntary programs related to agricultural offset program development and design still underway, these project have been largely leading the way in helping to tease out and test:
        - necessary program architecture to accommodate agricultural offset requirements, such as:
            - aggregation approaches;
            - cost-effective, realistic verification approaches;
            - model-based GHG estimation approaches;

    - the need to tailor offset protocol opportunities (based on and derived mainly from very different point-source pollution systems) to highly diverse biological ecosystems subjected to weather and climate variability as well as heterogeneous management approaches and operations;
    - the need for a high degree of flexibility to allow farmers to farm and to manage their operations while also meeting programmatic requirements;
      - flexibility and innovation are not optional within agricultural operations; and
    - barriers to practice change are often high – e.g., technical, operational, equipment/capital investment, inputs, management-related – and require proper technical and operational support in the form of tailored decision support systems and tools for the agricultural sector;
      - The reverse of this is that once implemented, successful practice changes are unlikely to revert.
  - The Cash Match Funding for some of the USDA GHG CIG projects was compromised or lost due to a reduction in value of voluntary carbon market credits coupled with the long timeframe required to fully develop these projects and deliver credits to market.

- Costs and Benefits
  - Business case and value proposition uncertainties exist due to the still formative nature of carbon markets and the role of agricultural offset opportunities within them, and the resulting difficulty in estimating credits or the value of credits from any given agricultural offsets project;
  - These uncertainties have limited or stifled full-blown investor, developer (project or protocol), and producer engagement in these early projects – which makes the GHG CIG project investments all the more critical to developing the business case and the certainty needed to develop these opportunities;
  - Not enough successful business case successes exist to convince investors to engage in agricultural offset protocols at this time, further limiting opportunities; and
  - Further programmatic and protocol design investments are necessary to apply the learnings and complete the success of the significant investments made in these projects, to date.

<u>GHG CIG Project Future Recommendations</u>

- Additional funding for current USDA GHG CIG projects is strongly recommended to allow successful completion of these projects, to deliver credits to markets, and to provide necessary successful business case scenarios for future producer engagement.

- Funding of additional USDA GHG CIG projects in the future is also recommended, to further develop this critical opportunity area for the agricultural sector.
  - Typically, methodology or protocol development requires expertise and significant investment of time, often as long as two years. Once developed, producers must be identified and engaged, and the project must be implemented, which can take anywhere from 1-3 years. After monitoring and verification – which can add up to another 6 months to 1 year, credits can be delivered;
  - The current value of carbon market offsets is unlikely to cover agricultural practice change costs and potential risks borne by participating producers, so additional

investments are necessary while program infrastructures and rules and certainty are still in flux and under development; and
  - Credit stacking, particularly with existing conservation programs, and developing ecosystem service markets, can aid in project economics.

- Funds are often required up front to engage producers and pay for necessary practices change investments. Offset payments are delivered only after implementation and verification, etc., which leaves a huge temporal financing gap for project developers as well as agricultural producers, thus creating additional engagement risk to project developers, investors, and producers. USDA GHG CIG project investments are invaluable sources of gap funding in the development stages of these markets and projects.

- Quantification methodologies require further investment
  - USDA enhancements to tools and GHG support services to agricultural producers (e.g., COMET-Farm, the GHG Quantifier Tool) can aid in producer engagement in existing and future GHG offset markets, but harmonization and standardization remain important issues to consider, given the potential impact to producers of multiple programs with varying data needs, and potentially, varied outputs.
  - Transparency and rigor are critical to GHG tools and calculators, and are particularly necessary for market-based transactions, which require higher rigor and certainty than conservation programs.
    - Compliance markets likely require the highest degree of rigor and certainty, as compared to voluntary markets, with conservation programs and sustainable supply chain initiatives likely requiring less comparative rigor.
  - C-AGG supports the development of and investments in low-cost, high value quantification methodologies, including the appropriate development of and use of models (including biogeochemical process models) for agricultural offset programs.
  - Intensity-based metrics should be considered for agricultural offset program opportunities.

- Critical programmatic and structural issues for agricultural offsets, including issues such as additionality, aggregation, verification, data sharing, permanence (in the case of sequestration), and related issues, such as decisions support systems and tools for the agricultural sector, require additional development and stakeholder input and support to further demonstrate and deliver voluntary, market-based GHG mitigation opportunities for the sector that encourage producer participation and deliver multiple societal and economic benefits. USDA GHG CIG projects can further help address these needs.

Avoided Grassland Conversion Carbon Project

Summary

Grassland conversion, both native prairie and restored grasslands such as those under the Conservation Reserve Program, is an ongoing resource concern that has been amplified in the last several years in response to a myriad of factors: high crop commodity prices, new crop technologies, and policies that inadvertently incentivize the expansion of cropland production. Ranchers and other grass-based producers have had limited additional economic incentives to protect these Grasslands, which provide an important source of forage and also critical environmental benefits including soil carbon sequestration and storage. This innovative project is both developing the policy structure for producers to maintain grasslands through participation in the carbon marketplace and also testing this structure through a pilot project. An initial group of five to fifteen individual producers, including cow-calf production and mixed (cow-crop) operations will participate in this project. Approximately 5,700 acres of native grassland and an additional 700 acres of wetlands in the Prairie Pothole Region of the Northern Great Plains will be protected for wildlife and livestock use. Project partners include Ducks Unlimited, The Nature Conservancy, The Climate Trust, Environmental Defense Fund and Terra Global Capital.

Successes

- Project partners have co-authored an Avoided Conversion of Grasslands and Shrublands offset project methodology, which is nearing completion of a peer review process and validation by the American Carbon Registry. This will be the first methodology of its kind.
- Ducks Unlimited has aggregated a pool of producers that are interested in participating in the project, and once the methodology has been certified for use, will begin the certification process for project- derived offsets.
- Project partner, The Climate Trust, brokered a purchase agreement for project verified offsets with a large multi-national corporation.
- The EQIP sign-up associated with the project was wildly successful, generating nearly $12 million in producer requested assistance during a brief 30 day sign-up period. Contracts are still being finalized, but to date $3.1 million has been committed to the highest priority applications and producing a list of 8 to 10 producers interested in participating in future carbon program enrollments.

Challenges

- Methodology approval has taken longer than anticipated due to policy changes within certification programs and other circumstances, which have delayed the progress of the project.
- Data availability for model-scaling has been proven difficult. Direct measurement of soil carbon through soil sampling is prohibitively expensive, requiring a scaling approach and use of existing data supplemented with targeted additional measurements. Coordination of existing data sets, making calibration and validation data for existing programs (DAYCENT, Comet Farm) more readily accessible would make this task easier for future applications.
- Permanence- Soil carbon projects require long-term protection to insure that project carbon benefits are real. This has required the use of perpetual conservation easements, which are expensive and often unpopular with producers. The expense of the easement exceeds the current market value of carbon offsets that can be realized from a project, requiring outside funds from non-GHG funding sources, limiting potential scalability of the project.

Please contact Randal Dell for additional inquires at rdell@ducks.org or at 701.355.3593.

Bovine Innovative Greenhouse Gas Solutions (BIGGS)

Summary

The purpose of Bovine Innovative Greenhouse Gas Solutions (BIGGS) Pilot Project is to enable beef and dairy producers to create and sell voluntary carbon offsets to buyers. Our intention is for stakeholders in the U.S. beef and dairy supply chain to successfully participate in a voluntary greenhouse gas (GHG) offset program that is science-based and meets their triple bottom-line needs and concerns. The BIGGS pilot project is adapting and testing GHG protocols from Alberta that generate voluntary carbon offsets and demonstrate decreased carbon intensity of beef and milk produced in the beef and dairy sectors.
The project is being implemented over a 3-year period.

Years 1 & 2 – Protocol adaptation, Design and development, Implementation

Years 2 & 3 – Implementation, Operations, Market demonstration and Evaluation

The project is designed to develop best practices/systems associated with voluntary bovine GHG offsets:

- Streamline complex data management requirements;
- Create diverse systems producers can use to quantify voluntary offsets;
- Monetize and serialize verifiable carbon offsets;
- Close knowledge gaps associated with bovine-targeted voluntary GHG offsets; and
- Assess the costs, benefits and potential production efficiency gains realized by feedyard and dairy operations when implementing the GHG-reducing practices.

This project's goal is to capitalize and leverage Alberta's experience and aggregate records from a total of 25,000 head of dairy cattle and 500,000 head of beef feedyard animals. Project partners include dairy and feedyard cooperators across the states of Texas, Kansas, Nebraska, New Mexico, Ohio, Wisconsin, Michigan and California.

Successes

- The Reduced Carbon Intensity of Fed Cattle protocol (amalgamation of 3 Alberta Beef protocols) was successfully adapted through the Protocol Scientific Adaptation Team process[2] and submitted to American Carbon Registry for public comment period (fall 2013).
- The Dairy protocol adaptation process is near completion – sensitivity testing on herd components will greatly streamline implementation of the protocol, with a focus on dry cows and lactating heifers only.
- At least 3 new scientific papers have been submitted, describing meta-analyses and research results as a ouput of the work. The papers address enteric methane relationships with use of (1) monensin, (2) lipid content of the diets and (3) forage quality; as well as new nitrogen retention curves for dairy and beef cattle.
- A common data management/quantification framework is being developed to enable aggregation.

Challenges

- The evolving policy landscape with carbon registries/programs has delayed methodology adaptation, approval and project implementation.
- The time need to prepare and submit scientific manuscripts to refereed journals, as well as coordinate the review of several protocols, and gain scientific consensus, was underestimated in our project timeline.

Please contact Matt Sutton-Vermeulen for additional inquires at mattsv@prasinogroup.com or at 515-343-5149.

---

[2] The PSAT process was led by Dr. Ermias Kebreab, UC Davis and consisted of extensive scientific work and review by a team of 15 scientists from across the US and Canada.

Estimating Nitrous Oxide Reductions from Nutrient Management in the Chesapeake Watershed

Project Partners: Chesapeake Bay Foundation (CBF), Environmental Defense Fund, Virginia Tech, DNDC Applications LLC, EcoFor LLC, Sterling Planet (SP), Washington Gas Energy Services (WGES)

Summary:
The goal of the three year project is to encourage adoption of enhanced nutrient management techniques by facilitating the process by which Chesapeake Bay farmers can participate in, and financially gain from, carbon offsets markets. Specifically, we are developing a region-specific, user-friendly version of the Denitrification-Decomposition (DNDC) model and will use it to estimate the nitrous oxide emissions reductions associated with different nutrient management approaches: soil testing/adaptive management on farms in South Central Pennsylvania and variable rate technology (i.e., GreenSeeker) on grain farms on Virginia's Eastern Shore. This project will allow us to compare and contrast these approaches in terms of greenhouse gas benefits, nitrogen application reductions, and obstacles to greater implementation.

A unique aspect of this study is that we are leveraging dollars from a partnership the CBF has with WGES and SP whereby WGES and SP are donating some of the proceeds from the sale of carbon offsets to WGES customers into a Carbon Reduction Fund that CBF is managing. The purpose of this Fund is to implement projects, primarily with agricultural producers, which generate carbon offset credits while also reducing water pollution to the Chesapeake Bay.

Successes:

- The DNDC model has been calibrated for corn, rye, soy and wheat rotations in this region using a long term dataset from a USDA-Agriculture Research Service Project in Beltsville, MD. In addition, a web-based system for entry of cropping information needed to create DNDC simulation input files has been developed.
- In Pennsylvania, we have successfully recruited seven producers to participate in the project and have obtained 2012 agronomic information from these farms.
- The EQIP sign-up associated with the project in VA was very successful; 6 farmers committed to use GreenSeeker on more than 11,000 acres of corn and small grains, generating nearly $900,000 in producer requested assistance.

Challenges

- Accessing historic agronomic and nutrient management data from participating producers has been the biggest challenge of the grant. To adequately calibrate the DNDC model and follow the American Carbon Registry protocol requires 5 years of "baseline" data, including nutrient application dates, yields, harvesting dates, etc. The majority of farmers do not have this level detail in their nutrient management files. In addition, some farmers are reluctant to share information they do have because of privacy concerns.
- Technological and software glitches with GreenSeeker. There have been challenges getting the GreenSeeker to work due to difficulties in meshing software between the unit and the sprayer. So, we lost one year of implementation on this grant because not all of the available units were available.

For more information contact Beth McGee (CBF), bmcgee@cbf.org or 443-482-2157.

PROJECT SUMMARY

Rangelands throughout the West hold tremendous promise for soil carbon sequestration due to their large scale. Today, ranchers and grassland managers have few economic incentives to manage these rangelands for carbon and other ecosystem benefits. This USDA funded CIG aims to change this with the development of rangeland based carbon offset projects—so that tomorrow, ranchers will be able to participate in emerging carbon and ecosystem service marketplaces. This project has two main goals: 1) determine a set of cost-effective best management practices that increase soil carbon sequestration and other ecosystem services on rangelands; 2) develop accounting protocols based on these practices.

PROJECT STATUS

Almost three years into our project, several rangeland conservation and management practices are under assessment including: avoided conversion of grasslands to croplands and improved rangeland management through grazing changes, and compost amendments. The assessment of these practices includes field sampling across several states then analyzing and integrating these samples into the CENTURY model. We have also begun conducting an analysis of the environmental co-benefits of rangeland conservation and management practices and an economic feasibility study.

We have made significant progress in writing two greenhouse gas accounting protocols to date: Avoided Conversion of Grasslands to Croplands (ACoGS) and Compost Amendments on Rangelands (Compost). In collaboration with Duck's Unlimited, the Climate Trust, The Nature Conservancy (TNC) and Terra Global Capital, the ACoGS protocol is due to be approved by American Carbon Registry in the fall of 2013. In collaboration with our partners, Terra Global Capital and the Marin Carbon Project, we are finalizing our Compost protocol and plan to submit it to ACR before the end of the year. EDF has begun a series of stakeholder outreach sessions in California, the Southwest, and the Midwest.

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted **USDA-NRCS, Washington DC**	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment) **69-3A75-11-131**	Page 1 of 1 pages

4a. DUNS Number **614663276**	4b. EIN **39-1611274**	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type ☑ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	7. Basis of Accounting ☑ Cash ☑ Accrual

8. Project/Grant Period (Month, Day, Year) From: **January 1, 2015**	To: **March 31, 2015**	9. Reporting Period End Date (Month, Day, Year) **March 31, 2015**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0**
b. Cash Disbursements	**806,034.45**
c. Cash on Hand (line a minus b)	**0**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000**
e. Federal share of expenditures	**550,000.00**
f. Federal share of unliquidated obligations	**0**
g. Total Federal share (sum of lines e and f)	**550,000.00**
h. Unobligated balance of Federal funds (line d minus g)	**0.00**
Recipient Share:	
i. Total recipient share required	**550,000**
j. Recipient share of expenditures	**256,034.45**
k. Remaining recipient share to be provided (line i minus j)	**293,965.55**
Program Income:	
l. Total Federal program income earned	**0**
m. Program income expended in accordance with the deduction alternative	**0**
n. Program income expended in accordance with the addition alternative	**0**
o. Unexpended program income (line l minus line m or line n)	**0**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official **Ry Thompson, Ecologist/Project Manager** **Applied Ecological Services, Inc.**	c. Telephone (Area code, number, and extension) **(608) 897-8641 ext. 57** d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **04/30/15 (through 15th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted **USDA-NRCS, Washington DC**	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment) **69-3A75-11-131**	Page 1 of 1 pages

4a. DUNS Number **614663276**	4b. EIN **39-1611274**	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type ☐ Quarterly ☐ Semi-Annual ☐ Annual ☑ Final	7. Basis of Accounting ☑ Cash ☑ Accrual

8. Project/Grant Period (Month, Day, Year) From: **April 1, 2015**	To: **July 31, 2015**	9. Reporting Period End Date (Month, Day, Year) **July 31, 2015**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0.00**
b. Cash Disbursements	**1,109,325.16**
c. Cash on Hand (line a minus b)	**0.00**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000.00**
e. Federal share of expenditures	**550,000.00**
f. Federal share of unliquidated obligations	**0.00**
g. Total Federal share (sum of lines e and f)	**550,000.00**
h. Unobligated balance of Federal funds (line d minus g)	**0.00**
Recipient Share:	
i. Total recipient share required	**550,000.00**
j. Recipient share of expenditures	**559,325.16**
k. Remaining recipient share to be provided (line i minus j)	**0.00**
Program Income:	
l. Total Federal program income earned	**0.00**
m. Program income expended in accordance with the deduction alternative	**0.00**
n. Program income expended in accordance with the addition alternative	**0.00**
o. Unexpended program income (line l minus line m or line n)	**0.00**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official **Steve Apfelbaum, Chairman / Principal** **Applied Ecological Services, Inc.**	c. Telephone (Area code, number, and extension) **(608) 897-8641 ext. 17** d. Email Address steve@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **10/15/15 (through 16th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

Lessons Learned from Soil Carbon Studies of the Palouse Region
(Updated October 2015)

Steven I. Apfelbaum and Ry Thompson
Applied Ecological Services, Inc.
17921 Smith Road, PO Box 256
Brodhead, WI 53520
608-897-8641

Contents

Executive Summary

Applied Ecological Services has updated a previous submitted "Lessons Learned" report voluntarily provided to USDA, NRCS by AES and The Earth Partners that attempted to reflect on the experiences in the development of a large-scale project, entitled the Palouse Soil Carbon Project, based on a hypothesis that soil carbon increases at a faster rate under no-till agriculture than under traditional agricultural plowing practices. Since that earlier document was prepared, we have further refined our understanding of no-till farming, and redrafted our Verified Carbon Standard (VCS) approved "Soil Carbon Quantification Method as a "Low Disturbance Cropping" method with American Carbon Registry (ACR). The project is an ecosystem-scale demonstration of methods of measuring carbon stocks in soil and vegetation and of providing market-based incentives for farmers to undertake activities that improve soil carbon and reduce greenhouse gas (GHG) emissions from agriculture. The partners worked closely with Shepherd's Grain, a wheat producing co-operative that focuses on setting standards for sustainable practices and grain quality for farmers in order to access higher-value markets for their wheat products. Assisted by a US Department of Agriculture / Natural Resources Conservation Service (NRCS) Conservation Innovation Grant (CIG)[1], the partners have:

- Validated a modular methodology for soil-related carbon credit projects, developed by The Earth Partners through the VCS, a leading voluntary carbon standards organization.[2]
- Created a second modular methodology for soil-related carbon credit project, developed by AEs and *Native*Energy, and submitted to the ACR under the name "*Methodology for Soil Carbon Sequestration from Low Disturbance Cropping*". This new "performance and measurement-based method" within ACR is allowed, while VCS doesn't recognize or allow early adopter farmers into carbon transactions for additionality reasons.
- Collected and analyzed 750 one-meter-deep soil samples from across a seven-million acre area of the Palouse region, centered in the state of Washington in the Northwestern U.S.
- Aggregated farmers under contract managing over 100,000 acres of land, with an additional ~200,000 acres of farmers interested in participating in predominantly in dryland (non-irrigated) wheat production farm lands.

Based on this work, the partners have identified key technical lessons for the development of soil carbon improvement projects:

- In general, the use of models to forecast soil carbon levels and accumulation rates is likely to result in significant levels of uncertainty, due typically to the existence of insufficient data for calibration of the models in a specific area, especially for deeper soil layers. While good general models exist, they must be tuned with a significant amount of site-specific data on the amount and timing of soil changes associated with changes in farming methods to reduce the uncertainty of the model results. For many areas and farming methods, these data do not currently exist.
- Sampling may be a successful and cost-effective method for quantifying soil carbon, but in many cases it will only be viable for large-scale projects due to the fixed costs associated with implementing a methodology, aggregating producers, and verifying and validating the carbon. Based on the variability found in the Palouse region, the minimum effective project size likely

[1] http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/

[2] VM0021 VCS Soil Carbon Quantification Methodology v1.0 (http://v-c-s.org/methodologies/VM0021, last visited 27-03-2013)

ranges from 100,000 to 180,000 acres. However, minimum project size is critically dependent on soil variability, carbon accrual rates, and carbon prices.

- Agricultural carbon projects must be able to allow for farmer flexibility in practices and land ownership as well as for ecological variability. This requirement for flexibility has implications for methods used to determine project activities, identify project boundaries, assess additionality, and ensure permanence.

Lessons learned related to farmer engagement, aggregation, and contracting for carbon projects include:

- Efficient aggregation of farmers requires agreement structures that define the basic relationship between the farmer and the aggregator while creating a context within which details regarding practices, credit allocations, and other specifics may be determined at a later time and may change over time as needed.
- In aggregations of farmers, not all participants will be undertaking the same practices or having the same carbon sequestration results. Aggregation structures must therefore contain systems for allocating benefits that recognize differentials in results. There is a trade-off between simplicity and precision: systems must be simple and clear enough to create well-defined links between practice and benefit, while being flexible enough to acknowledge differences in starting conditions. The system must also plan for the ongoing fine-tuning of allocation systems as additional data are gained.
- Nomenclature is highly confusing in the agricultural community with reference to on-farm practices. The term "no-till" is use to explain many different farming practices that do not involve tillage. But, not all on the ground results are even similar. And, USDA, NRCS definitions, those of equipment manufacturers, those of farmers and farming associations all vary considerably. And, there are various methods being used to develop equivalency computations (Russel models) such that even non-no-till farming can still be considered no-till farming. This understanding was used to define a new category of no-till that has explicit bracketing in terms of the impact on the land. Low Disturbance Cropping has been defined to include only 1-pass no-till (all crop residue management, seedbed preparation, seeding, and fertilizing are accomplished in a single pass) or agriculture that disturbs less than 30% of the soils and retains over 50% of the crop residue. All other forms of no-till are multiple pass systems and impact greater than 30% of the soil surface and typically retain less than 50% of crop residues.
- Because farmer flexibility is a requirement, and this flexibility may include temporary or permanent changes in practice—as well as farmers leaving the project—permanence mechanisms, which provide insurance that the global warming reductions are lasting, must be able to address farmer flexibility in a way that does not unduly reduce the payments to farmers, as might occur if too much of the benefit was allocated to an insurance pool. Methods of allocating payments and paying for insurance must also not unduly penalize long-term participants, as compared with temporary participants. The development of appropriate permanence structures that meet these requirements will likely necessitate the development of insurance methods that share risk among farmers, aggregators, and certification bodies.

The Palouse Soil Carbon Project has significantly advanced the understanding of soil conditions and farm practices in the Palouse as well as provided information on a wide range of problems, issues, and opportunities related to the development of agricultural soil carbon projects in general. This has resulted in the creation of the basic structures required to undertake similar projects in other locations, including the Soil Carbon Quantification Methodology or Low Disturbance Cropping Methodology, sampling techniques, and approaches to aggregating farmers. It has also provided knowledge related to key variables, such as soil variability, which will be critical to assessing project viability. However, due to variance in agricultural landscapes, soil processes, and farming practices, each project will require a unique combination of carbon measurement and project management approaches to fit it to the specific situation.

Context

Agriculture is the dominant form of human land management, with approximately 49 million square kilometers (33% of the world's land area) managed for annual and perennial crops and for grazing. Every form of agriculture has the potential to impact the world's soil carbon store, currently estimated at 1500Gt of C in the upper 100cm of the world's soils[3]. If one tonne of additional carbon were sequestered per hectare per year in 10% of the world's agricultural soils, 1.8 billion tonnes of CO_2 would be removed from the atmosphere annually. Furthermore, agricultural soils are currently recognized as likely being a net source of greenhouse gases (GHGs), due to current management practices, although the magnitude of that effect is unclear.

> ***Project Partners***
>
> **Applied Ecological Services, Inc. (AES)** served as the scientific and technical lead, focusing on the landscape-scale stratification, sample allocation and implementation, and statistical analysis of the soils dataset to establish baselines and projected accrual of soil carbon.
>
> ***Native*Energy (NE)** is overseeing the carbon methodology, carbon markets, landowner engagement and business models for climate-smart land use, served as the business and market lead, focusing on the producer recruitment and aggregation, development of the business model and cultivation of the markets.
>
> **Shepherd's Grain** is a specialty value-chain business that markets high-end wheat flour grown sustainably by over 40 family farmers in the Columbia Plateau region of eastern Washington, northern Oregon and western Idaho, using sustainable and certified farming methods.
>
> **USDA-NRCS:** The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) awarded a Conservation Innovation Grant (CIG) to the project partners to support the development of the Palouse Soil Carbon project.

Soil carbon (carbon held within the soil, primarily as part of soil organic matter content) is the largest terrestrial pool of carbon on earth and is important as a global carbon sink for GHGs. Yet, despite this potential to both reduce emissions from soils and to store atmospheric carbon in soils, the development of methods to incentivize and measure the effects of enhanced soil management techniques on soil carbon has lagged behind GHG measurement and management in most other sectors of the economy. This is true for a number of reasons, including:

- Soil carbon is dispersed across a variable landscape, unlike point-source combustion engine tailpipe fossil fuel and chemical emissions.
- Measurement of soil carbon requires laboratory testing, unlike forest biomass carbon pools, where measurement can be conducted in the field using well-developed techniques.
- Soil carbon has proven difficult to assess with accuracy using remote sensing, unlike trees or other above-ground ecological elements, where robust algorithms exist to assess biomass carbon pools utilizing high-resolution remote sensing imagery.
- Soil carbon models, while well designed, are handicapped by limited data availability for accurate calibration. This is particularly true with regard to deeper soil strata.
- Our knowledge about soil carbon and soil carbon processes is rapidly evolving. For instance, it has only recently been recognized that soil carbon in deeper soil layers (below 30—60cm) may also be quite dynamic.
- Agriculture is typically undertaken by individual farmers, each with his or own management methods and history, which impact the amount and trend of soil carbon on their land. In the

[3] Batjes, N.H. (1996), Total carbon and nitrogen in the soils of the world. European Journal of Soil Science, 47: 151–163. doi: 10.1111/j.1365-2389.1996.tb01386.x

northern countries, this might mean areas of hundreds or thousands of hectares, but in the developing world, farms can average less than 1 hectare each.

- Soil carbon is highly sensitive to soil-forming and landscape processes, and in some cases, it can vary significantly within a few tens of meters, depending on the landforms, soil processes, and land utilization history.
- Changes in soil management may have multiple effects, some of which may be positive for reducing global warming, while others are negative. For instance, changes may increase soil carbon content but also increase methane emissions.

For these reasons and others, development of agricultural soil carbon methods and improvement projects has been slow. The scale and the variability found over the landscape, as well as ever-changing land uses, have created policy, science, and marketplace confusion over how to evaluate landscape-scale investments in mitigating climate change. However, soil carbon also has some very significant characteristics that make pursuing methods and projects in this area important. These include the following:

- Soil carbon in well-managed landscapes is low-risk. Although erosion can result in the significant movement of soil carbon and potential releases to the atmosphere, soil carbon is not vulnerable to sudden release in the way that biomass carbon is vulnerable to release from fire.
- Soil carbon enhancement is a win-win process. Although in some soil types significant amounts of carbon may be held in inorganic forms, the majority of the soil carbon impacted by agricultural techniques is held in the form of soil organic matter. Increased soil organic matter is generally very beneficial for agriculture, enhancing water and nutrient holding capabilities. It is widely accepted that the carbon content of soil is a major factor in overall soil health.
- Soils may store carbon reliably over very long periods of time.
- Agricultural certification and climate-smart agriculture may be highly complementary, resulting in improvements in long-term agricultural sustainability.
- The history of soil carbon loss in many agricultural soils means that very significant amounts of atmospheric carbon could be sequestered in soils before these soils are ever returned to their base state. (In contrast, in forests, especially in the northern hemisphere, fire control and commercial management has, in many areas, driven biomass carbon content above historic levels, resulting in an increased risk of biomass carbon loss.)

In addition to the ecological and management complexities of soil carbon, significant process and financial barriers exist to incentivizing soil carbon accrual. A review of C-AGG[4] and T-AGG[5] (and other reports[6] on the challenges of bringing soil carbon to carbon markets) identifies perceived problems including the following:

4 http://www.c-agg.org/

5 http://nicholasinstitute.duke.edu/initiatives/technical-working-group-agricultural-greenhouse-gases-t-agg

6 Sandra Corsi, Friedrich T, Kassam A., Pisante, M., de Moraes Sa, J., 2012, Soil Organic Carbon Accumulation and Greenhouse Gas Emission Reductions from Conservation Agriculture: A literature review, FAO Integrated Crop Management Vol.16-(http://www.fao.org/fileadmin/user_upload/agp/icm16.pdf, last viewed 27-03-2013)

- Carbon accruals are too expensive to measure, and default models either do not produce robust enough accounting or are too conservative, given variances across the landscape. This results in insufficient carbon payment incentives to drive long-term changes in practices.
- Predicting carbon accruals at the average farm scale is too uncertain, and variances in accruals over time make carbon payments poor incentive mechanisms to create changes in farming practices (particularly if done annually).
- Smaller project boundaries, such as at the average farm-scale, create high transaction costs and discounting to manage the risks inherent in land-based carbon (permanence, eligibility, additionality, leakage).
- Significant progress and investment has been made to develop monitoring, reporting and verification (MRV) tools at the regional scale. This progress has been made in REDD+ to address the issues above, but tools at regional/landscape level to support on-farm carbon accounting (including soil, cover cropping and input management) have not been developed. This leaves a disconnect at the regional scale between the development of REDD+ carbon accounting and climate-smart agriculture.

The Palouse project was designed as a laboratory within which operational-scale solutions could be developed and tested against some of those challenges. The project examines the impact of strategies such as aggregating farms to create economies of scale, employing measurement with modeling, and developing other techniques to address many of the obstacles and challenges that have limited the ability to bring climate-smart agriculture (including non-soil carbon GHG contributors related to nitrogen and methane management) into the marketplace.

The Palouse Soil Carbon Project

The Palouse Soil Carbon Project is an ecosystem-scale demonstration of how to measure carbon stocks in soil and how to engage farmers in activities that improve soil carbon and reduce greenhouse gas emissions from agriculture. Through in-field measurements and modeling projections, the project focused on documenting the soil carbon and GHG emissions benefits of and fertilizer practices. The project is focused on a 7-million acre area of the Palouse region (*see maps in Figures 1 and 2*), where farmers and landowners on over 100,000 acres of wheat production land are contractually participating in a large-scale carbon program. Undertaken with Shepherd's Grain, a farmer-run organization that focuses on producing high-quality sustainable grain through sustainable farming practices, this project has the opportunity to be one of the largest agricultural carbon projects in the world.

Objectives of the project included:

1. Development of technical data on soil carbon measurement and projection, which can inform policy, and supporting further research into soil carbon enhancement as a method of GHG mitigation. The project utilizes Geographic Information System (GIS) landform and geomorphic modeling and mapping to design, evaluate, and implement a regional, on-the-ground baseline analysis of soil carbon levels across the Palouse landscape.
2. Demonstration of an efficient (cost and time) aggregation model for soil carbon. Assembling landowners over large areas at relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. Through our work with landowners, the team has developed, tested, and refined a low-cost aggregation model.
3. Demonstration of an agricultural eco-regional carbon accounting approach through the landscape-level implementation of the VCS-verified Soil Carbon Quantification Methodology developed by The Earth Partners.[7]

Introduction to the Palouse Agro-Ecosystem

The Palouse grassland ecosystem formed in loess soils (wind-blown silt) deposited during glacial melting during the Pleistocene epoch. The relatively recent surface loess deposits are Holocene aged. Loess mantles much of southeast Washington, northwestern Idaho and parts of northeastern Oregon. Loess is the most uniformly sized soil parent material on earth. This uniformity results in relatively predictable patterns of soil development that are controlled by temporal and spatial distributions of water, nutrients, and energy, which, in turn, are influenced by local topographic conditions.

Loess of the same age blankets most of the fertile Midwest as well, extending from central Canada into the upper southern United States and forming deep, fertile deposits adjacent to the Mississippi River as far south as southern Mississippi. Therefore, the results of this project will be applicable to much of North America's most fertile farmland.

Serious soil deterioration and erosion occurs with conventional tillage and the use of conventional fertilizers such as anhydrous ammonium over vast acreages of U.S. farmlands. The same type of deterioration and emissions occurs in the steep Palouse agro-ecosystem landforms that are covered with silt loam soils with low cohesion. Very high rates of soil erosion have been associated with conventional tillage in the Palouse. In combination with high rates of application of conventional fertilizer, these erosion rates have contributed to high levels of nitrogen and other fertilizer constituents in surface and ground water runoff.

Downstream receiving water bodies include habitat for critically endangered salmonid fishes and also receive and collect eroded soils and fertilizers. Under anaerobic conditions in the ground water and pooled surface waters, nitrous oxide and methane emissions contribute to secondary effects of agriculture in such watersheds as the Snake and Columbia rivers in Washington State.

[7] VM0021 VCS Soil Carbon Quantification Methodology v1.0 (http://v-c-s.org/methodologies/VM0021, last visited 27-03-2013)

Development of project design approaches and methods with the potential to be relevant for carbon markets like California Air Resources Board (C-ARB) and other emerging compliance markets.

Figure 1: Palouse Region Study Area (Columbia Plateau Ecoregion)

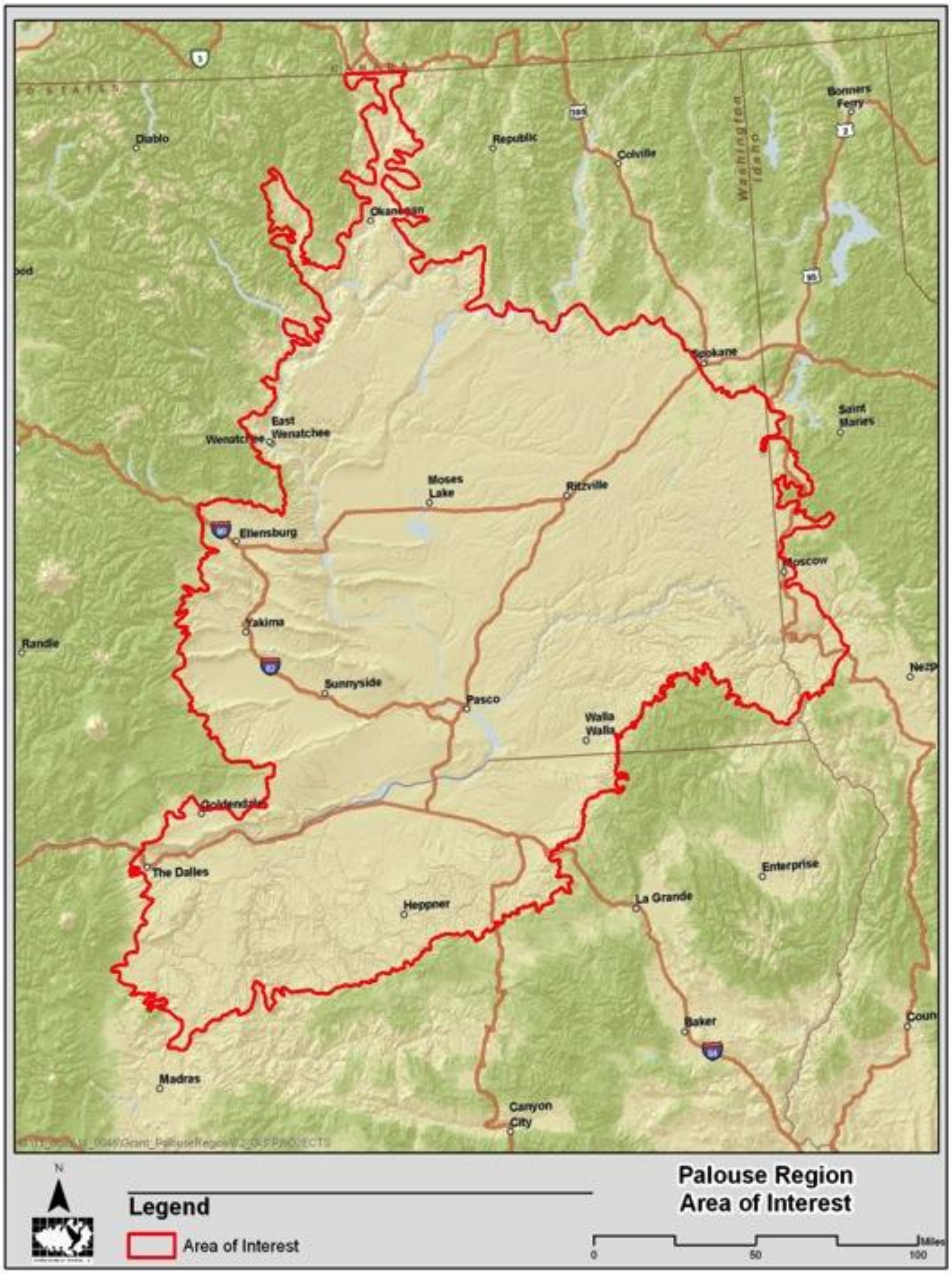
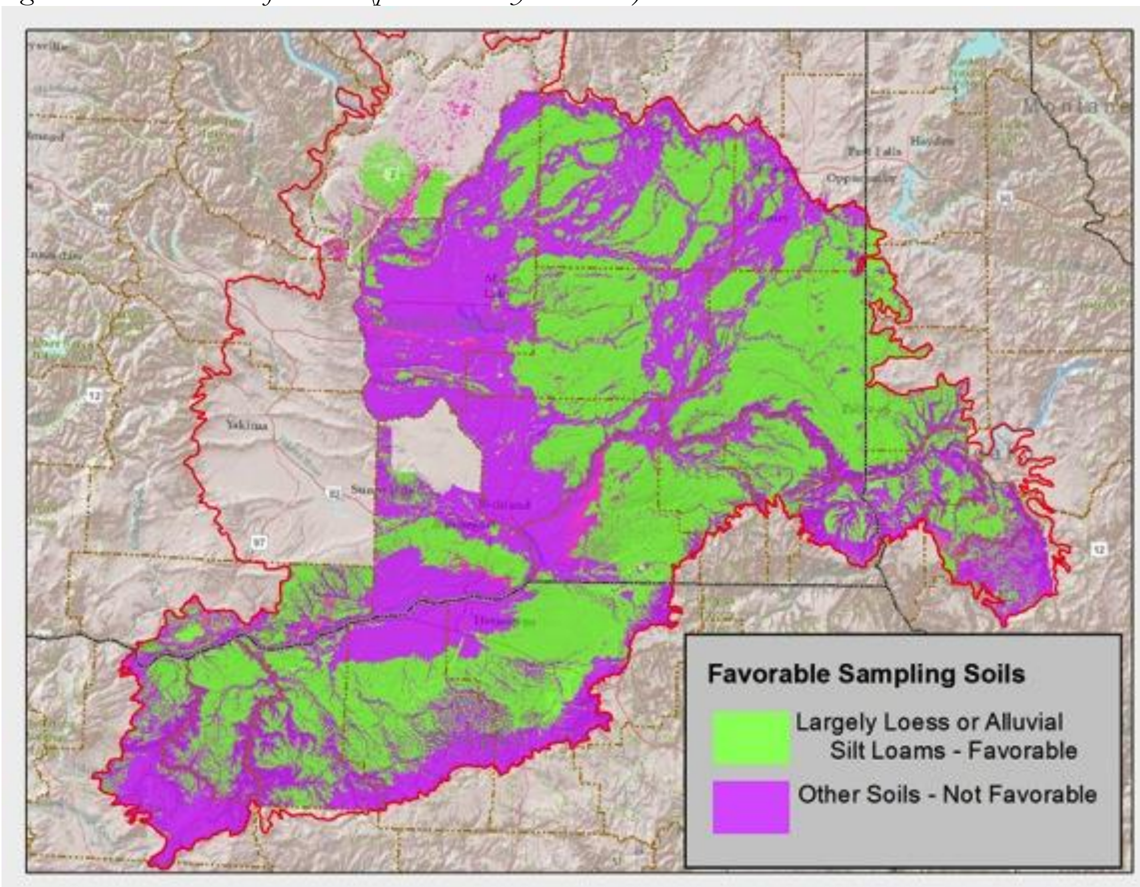


Figure 2: Palouse Area of Interest (predominantly loess soils)



As shown in figure 2, from within the study area, specific regions were chosen for more the project, based on mapped soil types. The goal of this approach was to reduce the sampling variability by reducing the range of soil types examined. Regions noted as "Not Favorable" on Figure 2 would likely also have good potential for agricultural soil carbon accumulation, but were excluded from the project because their soil conditions and dynamics were likely to be substantially different from those found in the core area.

Project Methods

The methods used to assess the soil carbon baseline and develop projections of the potential for future soil carbon accrual are based on the methods used in The Earth Partners' Soil Carbon Methodology. These methods included the following steps:

1. **Pre-sampling:** Pre-sampling of soils was used to determine the statistical variance around key soil chemistry variables (e.g., fractioned soil organic and inorganic carbon and bulk density). It was also used to provide information that assisted with the stratification of the project region. Pre-sampling allows investigators to make initial estimates of the number of samples required during the sampling stage.
2. **Stratification:** Stratification is the process of dividing a land area into relatively homogenous sub-areas based on variations in soil texture, carbon density, and other dynamic factors that govern GHG interactions. Project areas are often heterogeneous in terms of micro-climate, soil condition, vegetation cover, and management history. Stratification allows sampling and

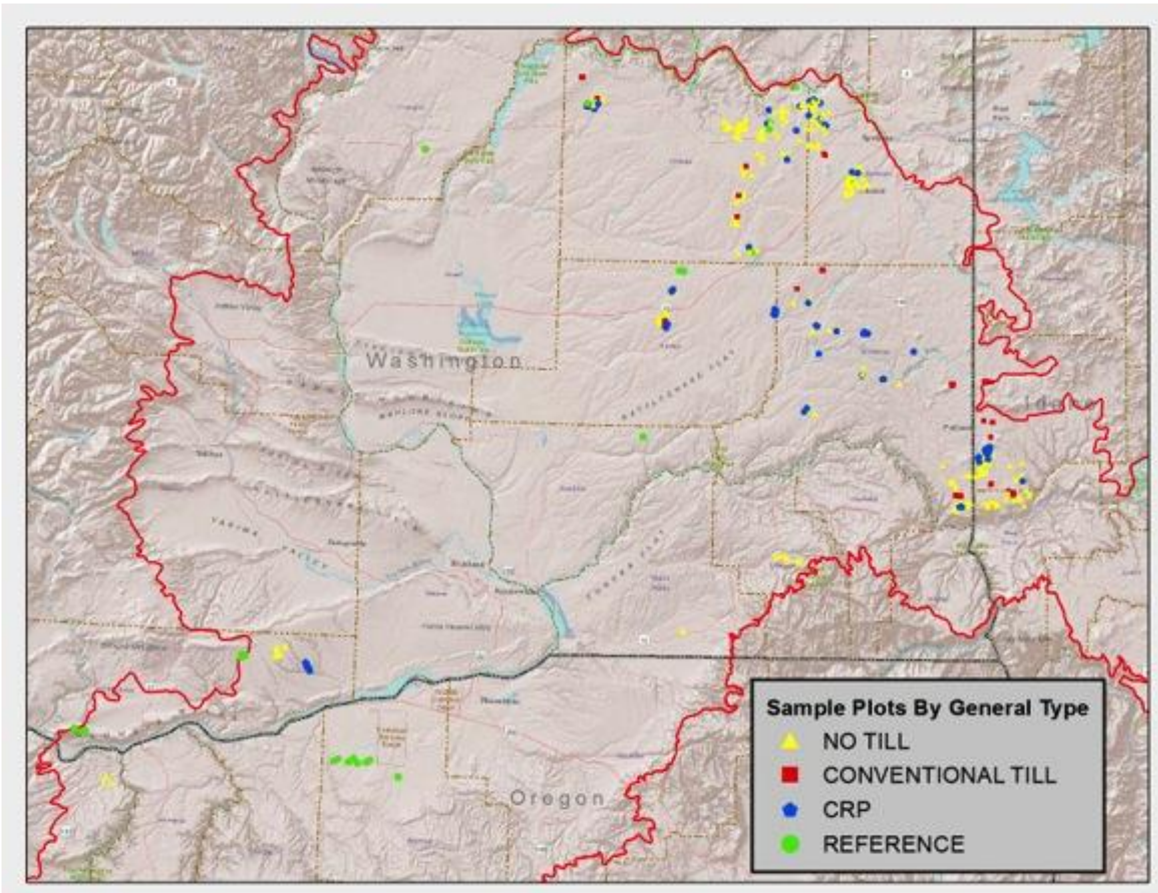
quantification to focus on more homogenous areas. Stratification for the Palouse Soil Carbon Project utilized GIS mapping information, land surveys, climate databases, and other data sources. The initial stratification was then adjusted after sampling and modeling. Stratification reduced the number of permanent samples plots required for each homogeneous subset. It enabled more accurate results with higher confidence intervals because of the lower variance within each homogeneous unit. Accurate stratification provides critical support for effective modeling of future conditions.

3. **Sampling:** Sampling is used to develop statistically rigorous information on the carbon content of carbon pools within the strata. In this project, a stratified random sampling technique was undertaken prior to project commencement to establish initial conditions and assist in developing a baseline for the project. Sampling will also be undertaken periodically thereafter to serve as the basis for the verification of the carbon benefits of the project activities. For the soil carbon pool, sampling should be undertaken to at least a 1-meter depth (where possible) to capture the soil carbon dynamics of the deeper soil layers. The samples taken prior to project commencement can also be used as source material for a cross-sectional study, to enhance the ability of the project developer to predict the effects of the activities which will be undertaken as part of the project.
4. **Modeling:** Results from the field sampling, farmer surveys, aerial imagery, and information on land use, tillage practices, and residue management practices were used to refine the GIS modeling and carbon modeling. The modeling established projections of regional net changes, and field-by-field net changes in soil carbon accrual, based on their duration in no-till agriculture and under conventional tillage, baseline starting conditions, and myriad other variables (soil type, texture, moisture regime, meteorological growing conditions, and season length). Because the sampling in this project covered areas that had been undertaking improved farming practices for 20 or more years, the models could be used to forecast the results of practice changes in fields that were still being managed using conventional techniques.
5. **Baseline development** Based on the information gathered in the previous steps, projection of a soil carbon baseline was conducted. Where the data on soil conditions, tillage practices, and other factors indicated that ongoing loss of soil carbon was occurring, a flat baseline equal to the initial sampling results was conservatively used, which reduced the complexity and uncertainty of forecasting future soil carbon dynamics under the baseline condition. Otherwise, projection of the baseline was used, which took into consideration a wide range of tillage practices, biophysical processes, economic indicators, and other processes.

Soil Carbon Sampling: Lessons Learned

During the sampling phase of the Palouse Soil Carbon Project, more than 750 1-meter soil cores[8] were collected in cultivated and conservation reserve fields and natural areas sites across the 7-million acre area. Sample sites were chosen within each stratum, using a stratified random approach, but they included only private fields and publicly owned sites where access had been secured. To the extent practicable, equal numbers of samples were taken in each stratum. This is one of the single largest 1-meter deep soil core data sets now available in the USA (*see Figure 3*).

Figure 3: Soil Sample Locations



Each soil core was described in the laboratory by a soil pedologist and then divided into 3-4 soil samples based on the horizons (soil layers) observed. Each sample underwent laboratory testing for a range of variables including bulk density and organic and inorganic soil carbon content.

The results of this extensive soil carbon sampling have provided a number of key lessons:

- The 750 samples provided data meeting statistical requirements (standard error of the mean ≤ 10% at 95% confidence) in some but not all of the strata. However, because the goal of the sampling was partly to undertake a cross-sectional study of the impacts of no-till practices, a large number of strata were identified; including strata where no-till had already been implemented for 20 or more years. Therefore, the typical number of samples in a stratum was

[8] The aim of the study was a depth of 1 meter, though the actual results have several cores less than 1 meter due to various conditions encountered in the field. In the cultivated subset of 442 cores, 90% of the cores were ≥80cm, and 50% were ≥95cm.

between 20 and 25. For this project, approximately 250 additional samples were required to meet statistical requirement in all strata. Given that in general, the soil carbon variability was quite high for a large, relatively homogenous area (as discussed in the next bullet point), this result is likely reasonably representative of many sites. It would appear that for landscapes of this sort, 30—35 samples per stratum are likely to be sufficient in most cases. On the other hand, one of the partners involved in this study undertook a pre-sampling study in a hyper-variable landscape, typified by active deposition of alluvial soils, and found that as many as 150 samples might be required for a single stratum. This result probably represents the extreme of sampling requirements for soil carbon.

- Standard parametric regression analysis was completed by the project statisticians. This analysis of landscape-scale soil carbon relationships in the Palouse suggested that three key variables (precipitation, slope position, and years in continuous no-till[9]) accounted for 37% of the variance over the landscape. This result includes all statistical outliers to create the most conservative estimate of the relationships. Though this may not seem high, this is a significant accomplishment for a landscape/ecosystem-scale study of this type and can be "tightened" as outliers are explainable anomalies, and can be eliminated from the data set.

Table 1: Palouse Soil Dataset Summary Statistics (Cultivated Dataset)

	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI	% Error
History Codes 1-5	Total C kg/m^2	A+B+C	8.99	3.52	441	0.168	95%	0.05	0.975	440	1.965	0.33	8.66 to 9.32	3.7%
	Organic C kg/m^2	A+B+C	8.65	3.66	441	0.174	95%	0.05	0.975	440	1.965	0.34	8.30 to 8.99	4.0%
History Code 1	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI	% Error
	Total C kg/m2	A+B+C	8.18	3.27	99	0.328	95%	0.05	0.975	98	1.984	0.65	7.53 to 8.83	8.0%
	Organic C kg/m2	A+B+C	7.94	3.28	99	0.329	95%	0.05	0.975	98	1.984	0.65	7.29 to 8.60	8.2%
History Code 2	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI	% Error
	Total C kg/m2	A+B+C	9.79	3.90	79	0.439	95%	0.05	0.975	78	1.991	0.87	8.91 to 10.66	8.9%
	Organic C kg/m2	A+B+C	9.35	4.21	79	0.473	95%	0.05	0.975	78	1.991	0.94	8.41 to 10.29	10.1%
History Code 3	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI	% Error
	Total C kg/m2	A+B+C	8.74	3.56	116	0.331	95%	0.05	0.975	115	1.981	0.66	8.08 to 9.39	7.5%
	Organic C kg/m2	A+B+C	8.45	3.72	116	0.345	95%	0.05	0.975	115	1.981	0.68	7.77 to 9.14	8.1%
History Code 4	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI	% Error
	Total C kg/m2	A+B+C	9.21	3.08	95	0.316	95%	0.05	0.98	94	1.986	0.63	8.58 to 9.84	6.8%
	Organic C kg/m2	A+B+C	8.78	3.18	95	0.326	95%	0.05	0.98	94	1.986	0.65	8.13 to 9.43	7.4%
History Code 5	Measurement	Layer	Mean	SD	N	SEM	CL	α	p*	DF	t-score	ME	95% CI	% Error
	Total C kg/m2	A+B+C	9.50	3.79	52	0.526	95%	0.05	0.98	51	2.008	1.06	8.44 to 10.55	11.1%
	Organic C kg/m2	A+B+C	9.11	4.01	52	0.557	95%	0.05	0.98	51	2.008	1.12	7.99 to 10.23	12.3%

- With this analysis, the variance that cannot be accounted for appears to be primarily related to historical land uses and disturbance prior to the commencement of no-till management on individual farm fields. Erosion has been a major factor in soil dynamics since the onset of farming and is highly specific to site and conditions. In addition, the implementation of no-till

[9] Though no time-series data has been collected for this study, we are using a predictor that has the years in no-till as a proxy for the direct influence of years of no-till on soil carbon.

farming in many fields has been inconsistent because of a history of continuously changing market drivers for commodity grain. Variations in fertilizer formulations through time and across fields are also likely to have had an effect on soil carbon trajectories.

- Sampling to a one-meter depth in the Palouse landscape suggests that the primary soil carbon accruals are currently occurring in the upper layers of the soil. It appears that the shallower soil layers are the most severely impacted by erosion, variable management practices, fertilizer formulations, and other management practices, and are now showing recovery, albeit highly variable. The deeper layers appear to be stable and have more uniform soil carbon levels that appear not to be responding significantly to soil carbon accruals in the upper horizons.
- Nearly 100 duplicate soil samples, collected from various strata across the landscape, were analyzed to quantify in-field variability. Statistical analysis indicated a very high correlation between duplicate samples (*See Table 2*). This provides additional confirmation of the modeling approach that combines landscape-scale (cross-sectional) with field-scale (micro) replicated data and repeat sampling over time.

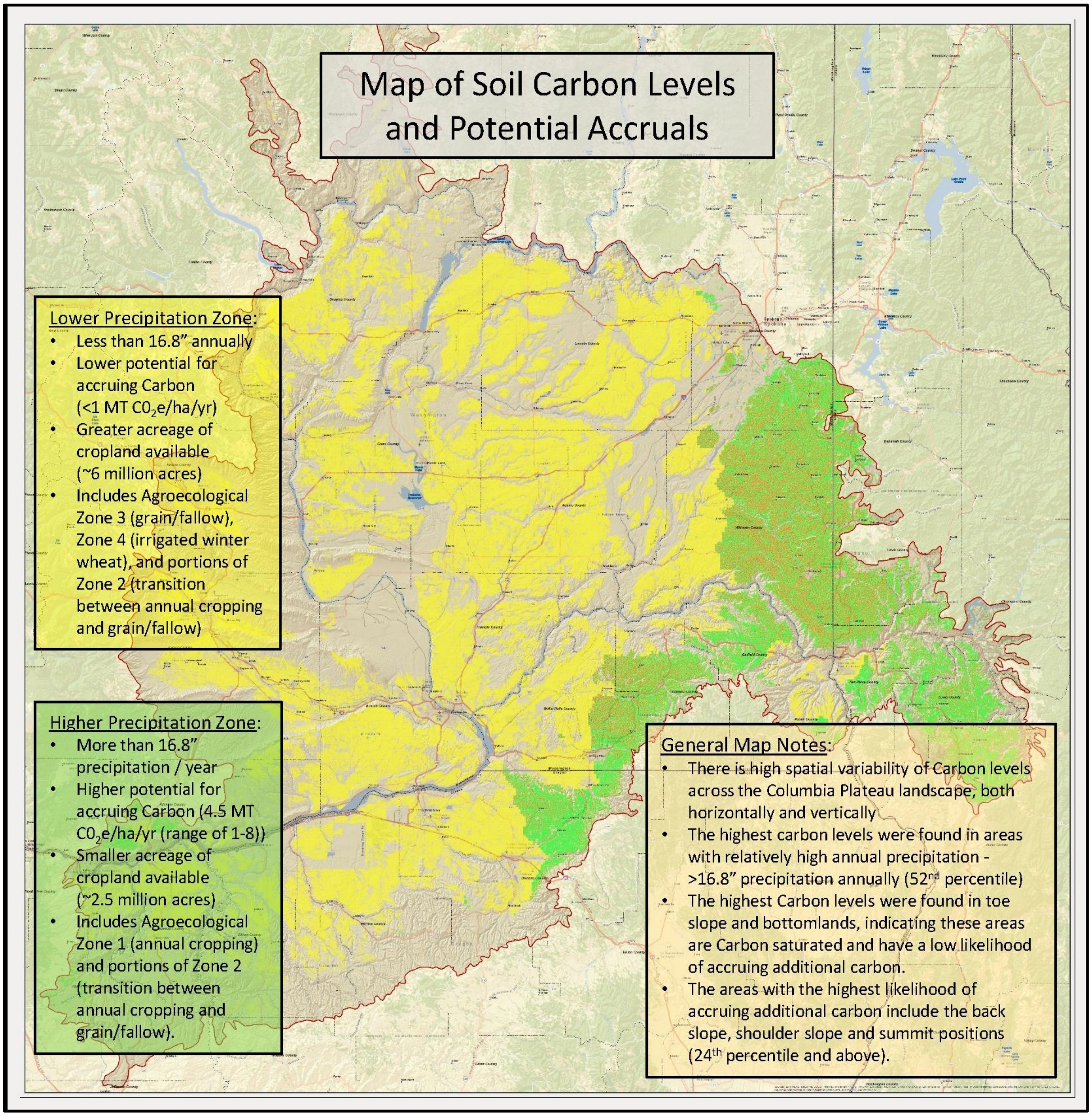
Table 2: Palouse Duplicate Soil Dataset Summary Statistics (Cultivated Dataset)

Variable	Duplicates?	N	N*	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Full Core OC	NO	504	2	8.430	4.205	0.320	5.514	7.743	10.712	24.904
	YES	204	0	8.628	4.077	1.761	5.625	7.854	10.746	21.684
Full Core Length CM	NO	504	2	83.837	19.843	13.000	80.000	93.000	97.000	100.000
	YES	204	0	88.912	13.740	23.000	87.000	95.000	97.000	100.000
80CM cores (H1-H5)	NO	386	120	3.778	3.778	0.858	5.779	7.875	10.596	20.794
	YES	177	27	3.729	3.729	1.669	6.024	7.717	11.087	19.009

For the full data set, we see that the duplicates have less variability as measured by the standard deviation (StDev) for both the full core organic carbon and full core length. The difference between the duplicates and the remainder of the data is appropriately reduced in the 80 cm adjusted data set for the H1-H5 management codes. We have no evidence that the cores that are part of duplicate pairs differ in important ways from the cores that are not part of duplicate pairs.

Using this data and analysis, baseline soil carbon levels and soil carbon accrual rates have been established for the region (*see Figure 4*). The baseline conditions and rates respond to the location (meteorological zone), slope position and aspect (upper and lower slopes in NE vs SW aspects) and will be applied in the new ACR method and Project Plan.

Figure 4: Map of Soil Carbon Levels and Potential Accruals



Agricultural Soil Carbon Projects: Lessons Learned

Defining project activities

To develop a carbon project, there must be a clear activity or set of activities that the project will undertake and which may be demonstrated to be additional, and result in atmospheric GHG reductions. For non-agricultural projects, where the project is usually under the control of a single person or entity, defining the project activities is typically simple and may be contained in a management plan or planting design. However, an agricultural project cannot (nor would it be beneficial to) dictate exact management strategies to farmers enrolled in the project. Farmers may need, for instance, to use a different plowing practice in a specific year, to respond to crop changes, weed problems, weather or other variables. As such, a more sophisticated approach to defining project activities is needed.

Based on the Palouse project, the following appear to be viable strategies, for which specific programmatic changes in specific carbon certification rules may be needed:

- Development and use of tools and procedures for assessing the additionality of a menu of activities, rather than single activities or a set suite of activities.
- Development of positive lists of activities which are defined as being additional, potentially applicable to certain areas and with certain conditions, as discussed in the section below entitled "Positive Lists for Determination of Additionality".
- The above two bullet points reflect the early lessons learned. Further insights and data informed us that 1-2% of Palouse farmers were doing 1-pass farming with a reduced soil disruption of less than 30% and retaining more than 50% of the crop residue. Most farmers were doing 2-3 pass no-till farming with greater than 30% soil disruption and less than 50% crop residue retention. This information, and that most of the farmers we sampled in the Shepherd's Grain group were doing the more protective no-till, helped us understand that in addition to defining activities, that language needed to be more explicit and that a simple listing of activities would not be sufficient to parse the details of what actually is done in the field by the farmers.
- A positive list of "additionality activities", will fall short of what is actually needed to define additionality for the following reasons: activity as defined by regulations, farm programs, equipment manufacturers, and farmers, doesn't necessarily correlate with measured performance.
- Additionality should be defined by measured performance. Repeat sampling at the field scale showed r-squared regression relationships between paired field samples of over 90%; and the landscape scale r-squared measures were ~40%. With these levels of precision, it is reliably possible to detect performance differences in soil carbon levels and this should be the basis for an additionality determination. This means that instead of additionality based on a whether a farmer is using pre-existing land use practice, at or below some arbitrary threshold of adoption, that measurements taken at a time-zero can be statistically compared to repeat measurements to value the carbon accrual changes, specifically increased levels of soil carbon.
- Scaling of soil carbon efforts to meaningful scales to positively benefit earth's planetary climate will require performance-based and measured additionality, rather than positive lists and arbitrary thresholds of adoption to guide what is acceptably included as additional.

Project Boundaries and Changing Participants

Conventionally, in land-based projects, fixed physical project boundaries can be identified geographically within which the project will occur. As discussed elsewhere in this report, agricultural projects tend to require large-scale aggregation of many users, from tens or hundreds of large producers in the northern hemisphere, to hundreds or thousands in some developing nations. In addition, agricultural projects cannot insist that individual farmers commit to continuing to participate in the project for the entire project timeframe. There is thus a significant likelihood that some areas of land will drop out of the project during its timeframe.

At the same time, if projects are successful, they should offer powerful incentives for new farmers to join the projects, and this would be the optimal outcome, in terms of expanding GHG mitigation benefits. Therefore, carbon certification bodies and compliance programs must develop robust mechanisms to address this issue. Whereas some mechanisms exist in some programs for the addition of new areas of land after the commencement of the project, they generally have limited time horizons or other limitations on bringing additional area into a project. Enhanced mechanisms for dealing with constantly changing project boundaries, while maintaining additionality and permanence, will likely be required.

Aggregating Producers

Assembling producers over large acreages at relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. The Palouse project provided an on-the-ground opportunity to develop, test, and refine a low-cost aggregation model. Aggregation involves several issues discussed below, such as flexibility of practice, the ability of producers to opt in and out, the method for allocating benefits, and other issues. These need to be included in agreements between the farmers and the project developer. These agreements may include a master agreement that sets the standards by which specific issues, such as benefit allocation, are to be determined but which leaves the specifics of these issues to be determined in periodically reviewed sub-agreements. This structure will allow necessary flexibility, recognizing that changes in carbon markets, producer practices, enrollment and other variables will occur over time. It also allows initial enrollment to be streamlined, by reducing the number of issues which need to be addressed at that stage.

The Palouse project team developed standard partnership and contract structures to streamline landowner interactions and engagement. To date, this program has contractually enrolled producers representing more than 100,000 acres. A future enrollment phase will seek to include additional producers. Because the sampling has captured the variance in soil carbon and practices present in a broader region (rather than just on the farms of the currently enrolled farmers), the addition of more farmers can be undertaken without large expenditures for new sampling, thus reducing implementation costs.

Producer aggregation has been aided by clearly identifying the benefits to the individual producers, including:

- Producers receive valuable information about their land (e.g., detailed property maps, soil reports, and analysis of impact of different land use practices over time).
- Producers begin to accrue rights to carbon assets once the baseline has been developed and producers have contractually committed to the project.

In enrolling producers using the standardized contract approach, the variable costs are the time and labor required to connect, meet, discuss, and work with producers. Activities include the following:

- Identifying groups of farmers and co-convening meetings when they are together such as during annual association meetings to introduce the program.
- Working one-on-one with interested farmers to enroll them, which require contract discussions, projections on economic benefits, and discussions about access for on-going soil carbon measurements.

Capturing the Benefits of Scale

A key project design issue to be considered is the relative uniformity of the soils and practices across the project area. While all soil carbon improvement projects are likely to include variability in soil, weather or terrain, projects which cross major soil morphology, weather or farming practice boundaries are likely to require significantly greater sampling. These will probably be unable to achieve the scale benefits of the Palouse project.

For example, a project that includes 75,000 acres of farms on an old glacial lake bottom with predominantly clay soils and 125,000 acres of land in an alluvial area with recently deposited silty loam soils would, from the perspective of sampling, in fact be two projects. If both settings were packaged under one project, this would be possible by defining multiple baseline conditions and different accrual rates. However, this does require sampling adequacy for each landscape. Many of the benefits of scale could be lost if this landscape variability was not able to be captured in projects. The stratification used in this Palouse project has been focused on identifying and only including the most uniform area of the Palouse region to maximize scale benefits. For purpose of this demonstration project we have excluded from sampling the drainage ways and scablands scoured of their soils and in many locations all that remains is bedrock. This decision to exclude these areas was not arbitrary and appears to be a good decision in this Palouse project.

In addition to site uniformity, the project may also choose not cross major farm practice boundaries. In the Palouse region, for example, there are specialty crop farmers in parts of the landscape that are very different than the uniform stratified landscape included within the project boundary. For instance, irrigated wheat production lands occur in this region, typically in locations in sandy alluvial soils along major rivers where irrigation is readily available. The inclusion of these farms would have resulted in needing to account, both from the carbon quantification and the benefit allocation perspective, for a completely different set of practices and issues.

The same issues would likely occur across major crop boundaries, such as corn to wheat. Many relatively uniform agricultural landscapes contain multiple crops in rotation, and these practices can significantly enhance soil productivity and soil carbon accumulation. However, where projects include large areas with completely different agricultural practices and crops, some benefits of scale may be lost, and the project may become unduly complex.

Sampling vs. Modeling

There are two major approaches to quantifying soil carbon: modeling and sampling/direct measurement. Quantifying means "estimating the levels of carbon in the soils" in this project. An ability to quantify soil carbon benefits from changes in agricultural practice or land management using modeling as a primary tool would clearly be preferable from a cost perspective. However, the existing models suffer from a lack of high-quality soil carbon data showing benefits over time and thus have unacceptably large margins of error. Thus, sampling to a definable level of sufficiency, accounting for the statistical variance, must predate modeling to estimate and project soil carbon levels.

Most carbon models constructed to date have been created for major agricultural settings and soils, such as the Midwestern U.S. Corn Belt.[10] Furthermore, cross-sectional studies, which compare areas of land that have undergone different practices, are in many cases not able to produce high accuracy data on soil carbon rates of change associated with practice change, due to unknown differences in starting conditions.

In addition, neither the scientific literature nor the models developed using data from this project are always conclusive. For example, considerable controversy among soil scientists still exists on the value of no-till agriculture compared to conventional tillage. One overarching synthesis, based on a review of hundreds of studies, suggested that under no-till practices, soil carbon accruals occurred in the upper horizons, but soil carbon losses occurred below the upper horizons because root growth (and therefore carbon accrual) did not travel as deep into the soil under no-till. We share in this updated lessons learned report that we are confident that the studies that have evaluated soil carbon accruals and no till have not had sufficient precision around how no-till was defined and as a consequence this alone has contributed to the controversy. In fact, even in the Palouse region, the prevailing soil science has not brought clear definitions into the process of design of the research that is and has been conducted. Most research has been on "direct seeding" benefits (which is an even more amorphously defined term used in the family of no-till vernacular). When we compared the soil carbon accrual rates in our study (which is focused on only farmers using "Low Disturbance Cropping") with that of others, our measured accrual rates were higher across the study region than what other studies have found. When previous authors were queried on how they were defining no-till or direct seeding, they clearly were not focused on measuring "Low Disturbance Cropping" effects.

Therefore, sampling as a quantification method may be the only option where there is significant uncertainty on the actual carbon stocks and likely changes in carbon stocks as a result of a land-use changes or management activities, which will be the case in many areas. In the long term, data derived from repeat sampling of projects—essentially longitudinal studies—will provide the information needed to calibrate soil carbon models such that in the future, modeling will become a more viable approach to quantification.

Economics of Sampling and Laboratory Analysis

The need to use sampling as a quantification method leads to a requirement for larger-scale projects during this early stage of soil carbon project development. In most landscapes, sampling costs are not linearly connected with project size. In many agricultural landscapes, they soon reach a plateau where increased project size results in little increase in sample point numbers or costs. The minimum area

---

[10] Long-term soil carbon measurements and data sets are available from the Palouse region (Columbia Basin Agricultural Research Center near Pendleton, OR and the Agricultural Research Center at Washington State University in Pullman, WA) and other regions that have documented soil carbon changes over one hundred years or more under various continuous cropping and rotation scenarios. These datasets are useful to understand carbon accrual and soil carbon degeneration relationships that have operated over time. Models such as Century, Comet VX, and Comet Farm have used the long-term data sets for model creation and calibration in the Palouse and elsewhere. However, long-term data sets do not account for new farming technologies, including no-till farming. For this reason, literature data sets typically provide only part of the carbon accrual story desirable. The data sets have been augmented in such regions with more recent data sets and time-series relationships developed often over the past 30 years in which technologies such as no-till methods have been tested side by side with conventional tillage. Furthermore, most models are based on soil sampling to a depth of 30 centimeters as a standard practice compared to 1-meter depth in this project.

that results in acceptable economics for a project will depend not only on sampling costs but also on carbon price and the amount of additional carbon sequestered per unit area per year.

For a carbon project, the quantification of carbon pools will typically be undertaken once every 3 to 5 years. From the experience of AES, revenues must be shared between farmers and the project developers. And because there are expected to be significant additional costs for project design, verification, management and farm aggregation, total costs for sampling (at project start-up and at each subsequent verification event) should not exceed 15% of gross revenues.

The work undertaken in this project provides some guidance on the relation between scale and costs. Although the sampled field area was approximately 100,000 acres, the sampling included statistically allocated points from within a 7-million-acre stratified project area. Costs are developed at two scales for this report: the 100,000-acre sampled scale with actual costs summarized, and for the entire 7-million-acre area, where total project costs are divided by this larger acreage:

Looked at from the perspective of only the acreage in the sampled farms, over the 100,000-acre sampling area, for this USDA demonstration project, the costs incurred were approximately $1.35 per acre. Combined, the total cost per core for field sampling and laboratory analysis was approximately $213 per acre.

However, because this project stratified a ~ 7 million acre region, and has defined the baseline conditions and variance over this larger area, this means that any farmer meeting the program criteria can become part of the process and the regional statistical baseline measurements should apply. Under this costing scenario all in costs for this demonstration drop to $0.17 cents per acre fully loaded including all field sampling and laboratory costs, the costs for creating the VCS and ACR methods, and receiving method validation, and PDD validations and all other anticipated costs.

- Collection of 710 soil cores occurred during a two-month period with two crews in the field. The total effort cost $114,915 for 1,915 hours of crew time. This is an average of 2.7 person-hours required per soil core (including all travel and field time), costing $162 for each core.
- Laboratory analysis of the 710 soil cores collected during the baseline soil sampling cost $36,085. After the cores were described, they were split into an average of 3 samples (one for each soil horizon) for sample preparation, and analysis of bulk density and carbon, costing $17.50 per sample or $51 per core.

These are costs only, and normal rates of return for these activities are not expected, so an average cost of about $280 per core would probably represent commercial costs.

And while these numbers reflect actual costs, translating them to the landscape for which they apply is a more useful exercise. If these costs only apply to the actual 100,000 acres sampled then the costs per acre above apply. However, if the denominator is the 7 million acre area, the above fully loaded cost per acre of ~ $0.17 applies. We believe this later measure of cost is most appropriate: because of the very high R-squared regression coefficient (well over 90%) between paired sampled collected at a "within field scale" suggests that repeat sampling at the field scale, which will be the primary method used to monetize individual landowner farm performance and thus the economic benefits to the individual carbon transaction enrolled farmer.

Using only the sampled-land scale and the variances over the sampled landscape of 100,000 acres, additional costs have been estimated in *Table 3 to evaluate if an* estimated 250 additional samples would be desired to reduce the variance and increase the r-squared regression coefficient. Based on these inputs, primarily dictated by the findings over the sampled 100,000 acres of field, the sensitivity shown in *Table 3* gives a range of outcomes, in terms of changes in prices, areas and sequestration rates. We have not updated *Table 3* in the updated version of this report. But, the previously unstated assumptions built into this analysis included an investment return expectation of venture capital and institutional investors. Impact investor and many other types of investors now accept far lower returns.

Also, by changing the all-in costs and using the entire project acreage of 7 million acres clearly, the investment returns would be significantly greater than presented in this example from the early lessons learned report.

Table 3: Sensitivity analysis for project scale and related variables (variables changed highlighted in yellow)

Project basics	**Base Case**	**Price changes**		**Carbon sequestration rate changes**			**Area changes**		**Downside Case**
price/tonne CO2	$5	$3	$7	$5	$5	$5	$5	$5	$3
acres in project	100,000	100,000	100,000	100,000	100,000	100,000	60,000	140,000	180,000
year project life	20	20	20	20	20	20	20	20	20
tC/acre/yr sequestered	0.4	0.4	0.4	0.2	0.3	0.6	0.4	0.4	0.3
buffer deduction	20%	20%	20%	20%	20%	20%	20%	20%	20%
Sampling									
samples taken at each sampling event	1000	1000	1000	1000	1000	1000	1000	1000	1000
Sampling events over 20 years	5	5	5	5	5	5	5	5	5
$/sample	$ 280.00	$ 280.00	$ 280.00	$ 280.00	$ 280.00	$ 280.00	$ 280.00	$ 280.00	$ 280.00
Results									
Revenue	$11,680,000	$7,008,000	$16,352,000	$5,840,000	$8,760,000	$17,520,000	$7,008,000	$16,352,000	$9,460,800
Sampling costs	$1,400,000	$1,400,000	$1,400,000	$1,400,000	$1,400,000	$1,400,000	$1,400,000	$1,400,000	$1,400,000
Percentage of revenue	**12%**	**20%**	**9%**	**24%**	**16%**	**8%**	**20%**	**9%**	**15%**

The base-case scenario shows that a 100,000-acre project meets the goal of having sampling costs at or below 15% of total project revenue. However, several of the sensitivity analyses show sampling costs exceeding the 15% goal. For a commercial carbon project, the goal would probably be to have the sampling costs at or below the goal for a somewhat less favorable case. The last column shows that, using somewhat pessimistic assumptions, the project would have to include approximately 180,000 acres to meet the goal.

Because this baseline sampling was designed to capture the strata found within the entire 7-million acres—and because the baseline study allows for additional farmers to enroll and does not necessarily require sampling of their fields—we also compute cost estimates using the 7-million-acre project boundary as the denominator. This suggests a total averaged cost per acre of $0.17/acre for all activities, including sampling and lab analysis.

While aggregating hundreds of thousands of acres in a single area requires significant effort on the part of aggregators—and commitment on the part of farmers—aggregations of this scale are eminently practical in many large farming areas such as the Palouse region—especially in the event that there is a clear pathway to monetizing carbon assets (i.e., carbon market or subsidy program). In the past, there have been cost objections raised to field sampling to quantify soil carbon. This project demonstrates that although large areas must be involved, sampling can be a viable approach to soil carbon quantification. Furthermore, using sampling approaches in actual projects is likely one of the best paths toward developing the accurate knowledge necessary to support modeled approaches in the future.

Allocating Benefits to Producers

Each farm is likely to have somewhat unique management, based on the farmer's preferences, history, equipment, and methods. While inclusion in a project would clearly involve farmers meeting some basic practice standards, it would not be practical or desirable to require identical practices from each farmer. Individual farmers will respond appropriately to site, weather, crop, market and other variables applicable to their farms. The project must allow them to maintain this flexibility as long as they meet agreed-to operating principles and some standard land use/land management behaviors and/or performance results.

Because initial conditions and management practices among farms will not be perfectly uniform, rates of carbon accumulation will vary from farm to farm and often from field to field. Furthermore, farmers will need the flexibility to undertake practices in a given year which are known to produce less carbon accumulation. As a result of this variability, not all farmers will be accumulating carbon at the same rate on their land. Any system of aggregation must include methods for fairly distributing carbon benefits, based on farmer performance, such that enhanced practices are rewarded.

While R-squared levels at the field sampling scale suggested > 90% repeatability at measuring the estimating within field soil carbon levels, sampling all fields on each farm is not a practical solution to the problem of allocating carbon accrual benefits at the farm level. Therefore, the allocation of benefits will have to be based on a division of total benefits realized based on a modeled approach that has been regionally calibrated through stratified sampling. Any allocation system should meet the following criteria:

1. **Transparent.** The allocation system should result in a score that the farmer can calculate and understand. Using a sophisticated model such as Century to allocate carbon benefits would not meet these criteria, although the model might be used to develop the allocation system. Use of a transparent system is required to allow farmers to understand and assess the incentives for better practice.
2. **Proportional**. Because the absolute amount of benefit provided by the project over a 3- to 5-year period will not be known ahead of time, the system cannot allocate absolute benefits. Instead, it should determine proportions of the total benefits due to each farmer.
3. **Provides feedback**. Although sampling to high statistical accuracy cannot be undertaken on each farm, the system should provide a basis for using sampling results to identify areas where the allocation system appears not to be reflecting actual results and allow the system to be adjusted. Noting such discrepancies could also identify key areas where research efforts could pay big dividends, in terms of enhancing our understanding of soil carbon processes.
4. **Periodically updated**. Based on results and further research, the system needs to have a regular, transparent method for updating the weights given to each practice. Updating should be careful and conservative, given the limitations of the data availability, but should aim to optimize the effectiveness of the project as an incentive for farmers to undertake practices that provide the greatest GHG benefits.

The Early Adopter Problem

The classic "semi-regulatory" definition of what is additional in carbon transactions has been defined as practices or activities that are not in common use. Common-ness has been defined by a threshold of adoption of the activity or practice, through an analysis of cost barriers to enter the practice or use, and by an arbitrary subjective determination "as to if the existing parties using the practice or activity" would have used the activity or practice anyway, if there wasn't a new carbon marketplace revenue stream potentially associated with this activity or practice.

Because soil carbon can be reliably and cost effectively measured, the measured performance rather than arbitrary thresholds and criteria that seemed to be based on trustworthiness of the intentions behind farmer participation, seem most valuable considerations to re-define additionality. And, there's another reason the definition of additionality needs to fundamentally change. Land use change must be part of the global climate mitigation solution because it's one of the only sectors that can be taken to scale. Land-use change and improved soil carbon (and reduced GHG soil related emissions) is the only practical and more immediate opportunity on earth for scaling up solutions to address climate mitigation needs. This must occur regardless of the definition of additionality because ~40% of GHG emission stem from agriculture and forestry, and now ~14% of additional GHG emissions is related directly to deteriorating soil management and erosion on earth. If additionality definitions do not allow the 4.5 billion hectares of the agricultural and grazed rangelands on earth to become incentivized to participate in mitigating atmospheric climate, we will have perhaps no other reliable GHG mitigation methods that can operate quality and at scale. The definition of additionality must change to a measurement and performance-based definition. We must abandon the non-functional and impractical definition of additionality used to date by Kyoto and most existing registry programs.

If measurement and performance defines what is additional, then nearly every landowner, every farmer, every rancher, and even urban city dwellers who improve their soil carbon levels in durable and measurable ways can participate in mitigating earth's excessive atmospheric GHG levels.

That said, to date, additionality criteria have always been recognized as critical for ensuring that credit is only given where actions result in real reductions in GHGs over and above those that would have occurred in the absence of the project. However, it is also recognized that additionality criteria can penalize those who have undertaken leading-edge actions that reduce GHGs without programs or markets that provide benefits for these actions, and without reduction of GHGs being the goal of the actions. In the early years of international negotiations, Costa Rica, which was an early adopter in the protection of natural forests, raised this point as a problem with the proposed CDM system.

Since early adopters may have undertaken changes in practices regardless of whether carbon incentives existed, it is clear that their actions are not additional in the conventional sense. On the other hand, it is also clear that they are often critical in the development of new practices—and that without them, these practices might not gain widespread acceptance, even with the existence of GHG mitigation incentives. Essentially, the presence of early adopters is often a key to overcoming a common practice barrier that incentives from carbon sequestration alone might not be able to overcome.

This problem is closely related to the problem of accelerated adoption. Adoption of new agricultural practices is often slow and gradual, but over time, practices which reduce GHGs, and which have other benefits may become standard practice, even in the absence of GHG mitigation incentives. However, the addition of GHG mitigation incentives may substantially speed up the adoption of the practices, yielding real benefits in terms of GHG reduction.

Solutions to the early adoption problem and the problem of gradual adoption of a practice without GHG mitigation incentives require solutions at the structural level. One potential solution is that discussed in the "Positive Lists" section below, where lists include declining percentages of benefits over time for activities on the positive list. However, other solutions may also exist.

Baseline and Additionality Issues

Common practice baselines

To make agricultural practices change a significant tool for addressing GHGs, structures and methods used must be able to function within a compliance market, such as the California market. California is promoting the development of common practice baselines that simplify the demonstration of additionality and the forecasting of baseline conditions.

California currently only has an agricultural common practice baseline for rice cultivation. Common practice baselines are pre-determined through extensive research and/or modeling examining the following:

- Average types and levels of practice across an industry or sector.
- Average carbon content of carbon emissions or pools based on these practices.

The results of the research undertaken in this project have significant relevance for the development of common practice baselines for agriculture and soil carbon improvements. The extensive sampling undertaken as part of this project revealed that carbon content of soils are highly variable, even within one of the more uniform areas of the Palouse, and are influenced by a wide range of conditions. Such conditions include topographic position, the moisture index of soils related to crop productivity, past management and disturbance history, soil processes, and other factors. However, statistical analysis of these data suggests that despite this variability, it would be possible to develop a meaningful common practice baseline figure for soil carbon content in a region such as the Palouse.

However, the use of a common practice baseline would necessarily imply the use of modeled approaches to estimating the carbon benefits of specific practices for project-level accounting. Using a common practice baseline with a sampled quantification approach for actual carbon benefits would typically result in a high degree of variability, with some farmers showing huge carbon accrual and others showing large carbon losses. These variations would not be indicative of actual changes in the carbon content of soil but would rather be the result of differences in initial conditions, which in many cases would not match the common practice baseline.

In this Palouse project, farming methods used by the enrolled farmers are converging on a suite of similar practices. This convergence is being driven by the need to meet Shepherd's Grain certification requirements for no-till, as well as by improved knowledge of fertilizer relationships required to meet the protein content of the grain, and other environmental and behavioral influences. However, despite this convergence, soil carbon content and accrual rates remain heterogeneous due to differences in initial field conditions.

As discussed in previous sections, the use of a modeled approach to carbon benefits arising from specific practice changes necessarily involves large uncertainties. Much of the existing calibration data was based on studies that sampled superficial soil layers only and missed significant changes at depth.

Notwithstanding these uncertainties, it would be possible to design a system that relies on common practice baselines and modeled benefits. However, if the goal was to ensure that accounted atmospheric carbon benefits had a high probability of being real, the results of the models would have to be interpreted extremely conservatively, likely resulting in the under-accounting of carbon benefits in many cases.

The alternative would be the creation of a system which may be vulnerable to challenge on the basis of failure to be adequately conservative, and the creation of GHG offsets with potentially serious credibility problems that could undermine the credibility of the compliance system.

In general, based on the outcome of the work conducted in this project, the use of strictly modeled approaches appears to carry high risks of systemic problems. However, without modeled approaches, common practice baselines are unlikely to prove useful in an agricultural soil carbon setting.

Positive Lists for Determination of Additionality

Positive lists consist of identified activities that are pre-determined to be additional and eligible under the Carbon Standard, based on extensive research on current practices in the sector. For instance, in a given area (state or sub-state region), research might discover that only 2% of farmers use no-till methods. Based on that research, no-till in that area might be designated as eligible and additional. While this approach does mean that some crediting might occur for actions that would have already occurred (the 2% of farmers using no-till without incentives from carbon benefits), appropriately developed positive lists could minimize this issue while still offering positive incentives to those early adopters who are creating and validating new practices with atmospheric benefits.

Positive lists could also be designed with declining benefits to address issues of gradual adoption and to eliminate the accounting of excess benefits based on early adopter participation. In this case, for a given practice, projections might show that, over time, many or most farmers would have commenced the practice even in the absence of incentives for carbon benefits.

The positive list would then include a declining curve, such that either all farmers received a gradually declining percentage of the total carbon benefits that they generated, or that carbon benefits for a given farmer were pro-rated based on when they started their management changes. This system could ensure that total carbon benefits are not exaggerated and could prorate benefits to incentivize early adopters while eliminating the crediting of carbon which is not additional by reducing the credit given to other producers, proportional to the credit given to early adopters.

The development of positive lists could be a key tool in addressing the "menu of activities" problem discussed in the section above presenting the definition of project activities.

Permanence

Permanence in agricultural projects is complex, addressing farmers who cannot realistically be tied to hundred-year commitments, and undertaking the management of lands whose ownership and usage rights may be subject to change. Not only do farmers need flexibility, both with regard to practice and land ownership, but they frequently may farm on leased land.

However, to meet market requirements, soil carbon benefits associated with improved farming practices must be permanent, usually defined as lasting at least 100 years. Some mechanism is therefore required to ensure permanence of project carbon while allowing the farmers appropriate flexibility. Conventionally, permanence is ensured through the use of buffer pools that withhold a percentage of the carbon from the market to cover unforeseen losses. For agricultural carbon, there are several potential structures that could address loss risks associated with farmer flexibility:

1. **Risks assumed by certification bodies.** Regulatory and verification bodies could appropriately take some of the risks associated with the inherent uncertainties of agricultural projects. These bodies, by reason of the scale and scope of projects with which they are

involved, might be better placed to assess and appropriately retain buffer pools covering these risks. Usually, such buffer pools are only intended to address unforeseen circumstances. However, these pools could be extended to cover anticipated losses associated with independent actions by farmers. Depending on the bodies involved and the depth of the buffer pool, such an arrangement might result in some of the same conservative over-insurance issues as those noted below for aggregator risk assumption.

2. **Aggregator risk assumption.** In this approach, the legal contracts contain no permanence requirements regarding length of farmer participation and no penalties for farmer withdrawal. The contracts also do not allocate carbon losses resulting from farmer withdrawal to the farmers. In essence, the aggregator provides an insurance function, in the form of a risk pool, consisting of either retained carbon credits or cash. The aggregator can design a landscape-scale carbon assurance buffering system, reflective of past and present patterns of land use, crop change, and tillage method changes (i.e., land use dynamics). Modeling of the land-use dynamics may be based on the online farmer survey and aerial imagery. The result of the modeling may be used to drive buffer pool requirements. For example, annually 20% of 1-year-old no-till fields, 15% of 3-year-old no-till fields, 8% of 5-year-old no-till fields, and 0% of 10-year-old or older no-till fields may be converted back to conventional tillage. Based on these data, a model of total carbon losses associated with this behavior may be built as a basis for assurance buffering needs. This model can continue to be validated and updated through the tracking of actual farmer conversions and re-conversion behavior.

   While this is probably the simplest structure, it has several potential problems. The system is likely to amount to a subsidy of farmers who temporarily participate and a penalty to the long-term participants, as the aggregator will have to reduce the returns to all farmers to cover their risk. In addition, because the aggregator will carry the risk, and because there is likely to be significant model uncertainty, the tendency will be for the aggregator to insure, with high certainty, that the buffer pool covers the potential risk. The aggregator will thus tend to overcharge for the risk. This could also take the form of a model similar to the first, except that in this case, the farmers as a group agree to bear the risk of farmer withdrawals. This could potentially reduce the cost-per-farmer for such withdrawals, as it may reduce carrying costs and expectations of returns, but it retains the problem of penalizing the most committed farmers.

3. **Aggregator-farmer co-operative risk assumption.** In this model, the liability associated with farmers leaving the project is defined and shared between aggregator and farmers, and individual farmers may bear some liability for leaving the project. This strategy could follow a typical insurance program with individual farmers liable for the equivalent of deductibles and payments of deductibles covered through performance bonds or other sureties. The remaining risk would be covered by a buffer pool approach. In this case, farmer participation could allow structures in which buffer requirements slowly decline as participation stability is established, allowing some of the buffer pool to be sold, to the benefit of the farmers. This approach would partly overcome the problem of the implicate subsidy for short-term participants.

4. **Individual risk assumption.** In this case, carbon benefits paid to farmers are accompanied by contingent liabilities—requirements to repay the benefits if they drop out or remove a specific piece of land from the program. Farmers could gain considerable flexibility from this approach, as it would, for instance, allow them the possibility of not enrolling all of their land and maintaining a portion of it as a buffer against losing a lease or that of choosing a different management strategy for part of their holdings. This structure could also allow for the option

of gradual repayment, based on the rate at which carbon is lost from the land where improved practices are no longer occurring. However, there are also some complexities to this approach. Because the liability would probably have to be against the farmer rather than the land, to allow for the situation of leased land, the aggregator could be assuming significant counter-party risk. In addition, if the system were to be completely unbiased, the repayment would have to be in carbon credits, or their equivalent in cash at the current market price at time of repayment, which would make the size of the potential liability open ended, as carbon prices could fluctuate considerably.

None of these systems achieves a perfect result, and the appropriate system will probably be a hybrid that shares risk among the verification/certification/regulatory bodies, the farmers and the aggregator in a way that maximizes flexibility, minimizes the penalization of committed farmers, and ensures that the aggregator's insurance role does not consume a large proportion of the benefits.

In the case of the Palouse project, risk has been reduced by working with an existing association of farmers, Shepherd's Grain, who were already motivated to work together and share the benefits of their association. Situations such as this have significant potential to reduce the complexity of the required structural issues and associated contractual language regarding withdrawal risks.

Programmatic Synergy

The management activities that result in soil carbon increases may also have other benefits, including the "green labeling" of products, reductions in downstream water quality issues and other environmental benefits, and enhanced crop productivity and resilience. Many of these benefits are already the focus of existing associations, marketing programs, government training programs and certification schemes. In the Palouse, organizations such as Shepherd's Grain and the Pacific Northwest Direct Seeding Association are advocates and resources for no-till farming. In addition, USDA-NRCS is a valuable partner, given its deep, local relationships with producers. Relationships between these associations, organizations, certification groups, and carbon programs can potentially enhance the success of all and reduce total producer costs for achieving multiple goals. For instance, the validation of a carbon project may be undertaken in conjunction with green certification, and quantification of downstream benefits, reducing the costs for all of the programs compared to individual approaches.

Appendix G – Semi-Annual Report #5

Applied Ecological Services, Inc. (AES)
Semi-Annual Progress Report No. 5: July 1 – December 31st, 2013
USDA-NRCS CIG-GHG Project No. 69-3A75-11-131
January 31, 2014

PROJECT DESCRIPTION / ABSTRACT

Applied Ecological Services, Inc. (AES), in partnership with The Earth Partners, LP (TEP), and a consortium of secondary partners (the AES/TEP Team) seek to develop a large-scale agricultural carbon project in partnership with Shepherd's Grain members and surrounding farmers in the loess hills of the Palouse and Columbia Plateau region. Intensive farming across the region has resulted in the near extinction of the native grasslands, and the exhaustion of the soil and hydrological resources of the region. The introduction and widespread application of sustainable, low-carbon farming practices have the potential to restore the fertility and ensure the longevity of one of the United States' most important breadbaskets. Demonstrating the value to landowners of increased soil carbon stemming from these improved agricultural practices is a critical component in facilitating the large-scale adoption of such practices. To this end, this project seeks to provide a roadmap for developing large-scale, high-quality, and low-cost soil carbon transactions.

Building off literature reviews and preliminary sampling completed in 2009, we propose to further develop and extrapolate these models at a larger, landscape scale across the entire Columbia Plateau eco-region. Utilizing TEP's Soil Carbon Quantification Methodology, we seek to measure, monitor, validate, and monetize carbon credits stemming from low carbon agricultural practices such as no-till, direct seeding, crop rotation, and improved soil management. We believe that this project demonstrates both the importance of large-scale low carbon farming practices to Greenhouse Gas reduction policies and the role of quantitative soil carbon methodologies in creating compliance-grade offset credits. It will also provide a roadmap for aggregating landowners over large areas at low cost. We seek to demonstrate a model for marketing and monetizing the resulting carbon credits. This will be one of the largest land-based carbon projects to date.

We seek to achieve the following outcomes in this project:

- **Demonstrate the model at scale.** Our proposed project is broken into two phases: In Phase 1, we intend to develop a low-carbon agricultural partnership with landowners on 100,000 acres of Shepherd's Grain land. In Phase 2, we intend to partner with landowners on over 300,000 acres across the Palouse and larger Columbia Plateau eco-region. This can be expanded at a much larger scale because the project can build off of the analytic and technical work we will have done (GIS mapping, stratification, soil sampling, model projections, etc.).
- **Demonstrate a low-cost aggregation model**. Assembling landowners over large acreages at a relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. Through our planned work with landowners on 300,000 acres, the AES/TEP team will develop, test, and refine a low-cost aggregation model. To this end, the AES/TEP team is building on significant existing experience in aggregating landowners, developing standard partnership structures, and streamlining landowner interactions and engagement.
- **Showcase a successful land-based carbon transaction.** While agricultural carbon credits cannot currently be monetized in the marketplace, this project seeks to ensure that credits derived from this project will be accepted by the CA Air Resources Board (ARB) under AB-32 or other emerging compliance markets, as well as voluntary markets like VCS and ACR. To this end, we have developed a unique partnership of farmers, project developers, carbon investors, scientists, and government.
- **Develop data, maps and templates that will inform policy and support further research.** We will utilize GIS landform and geomorphic modeling and mapping to design, evaluate, and implement a regional, on-the-ground baseline analysis of soil carbon levels across the Palouse and Columbia Plateau eco-region. The resulting data and maps will represent a type of integrated information that is lacking in the region, which will be useful for government agencies, scientists, universities, and other researchers.

FIFTH SEMI-ANNUAL PROGRESS REPORT

1. USDA-NRCS CIG-GHG Project Number and Contract Period

69-3A75-11-131 – August 1, 2011 to July 31, 2014

2. Project Title

Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region

Project Director / Principal Investigator

Steven I. Apfelbaum, Chairman of the Board/Principal Ecologist, Applied Ecological Services, Inc.

3. Date of Report / Period Covered

January 31, 2014 for Report No. 5: July 1 – December 31, 2013

4. Executive Summary

During the second half of 2013, the Project Team focused primarily on the following tasks:

- Task 1 – Business Origination with Shepherd's Grain – The team continued developing relationships with Shepherd's Grain producers
- Task 2 – Mapping, Screening and Stratification of the Palouse – No additional activities were completed under this task.
- Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region – No additional activities were completed under this task.
- Task 4 – Analysis and Baseline Development – No additional activities were completed under this task.
- Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers – The team continued discussions with potential project partners interested in serving as cash match partner and co-developing the carbon project.
- Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members – Farmer engagement focused on a conference presentation in Pasco, WA, meetings in Portland, OR, and internal strategy discussions amongst the project team.
- Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members – The team continued discussions with potential project partners interested in serving as cash match partner and co-developing the carbon project.
- Task 8 – Reporting and Knowledge Dissemination – Communication with NRCS administrative and technical contacts occurred on an as-needed basis during this reporting period. Attendance at the C-AGG meeting in Washington, DC occurred during this reporting period. Outreach and presentations at other regional conferences occurred during this reporting period.

5. Proposed Changes requiring Prior Approval

In accordance with the Prior Approval Requirements outlined in Section IV of CIG Contract #69-3A75-11-131, the project team proposes the following modification:

- No changes are currently proposed, though the project team is nearing a resolution on potentially replacing the cash match partner. The project team will continue to work directly with NRCS staff to resolve this situation through email and telephone updates and discussions in early 2014.

6. Accomplishments

Task 1 – Business Origination with Shepherd's Grain

TEP and AES continued to build on the relationships developed with Shepherd's Grain producers and neighboring producers. Ongoing coordination with Shepherd's Grain continues through the project period to provide updates on project status and project challenges faced. AES worked closely with Perfect Blend, a biotic fertilizer company based west of the Palouse region in Othello, WA, to present on the Palouse project and carbon markets at their Biotic Conference in December, 2013. This is discussed in more detail in Task 6 below.

Task 2 – Mapping, Screening and Stratification of the Palouse

No mapping or stratification activities were completed during this project period.

Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region

No sampling or analysis activities were completed during this project period.

Task 4 – Analysis and Baseline Development

No analysis or baseline development activities were completed during this project period.

Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers

Discussions between AES and Native Energy of Burlington, Vermont began in December 2013 about the potential for their group to replace EKO Asset Management Partners as the cash match partner on the project. Native Energy is very interested in co-developing the project in the Palouse region with funds from their "help build" program. As partners, they would co-develop the project and help broker any carbon credits generated from the project. Many of their existing clients and partners are very interested in the program. It is anticipated that AES will received a proposal to consider during early February, 2014.

Discussion between AES and The Climate Trust were held in Portland, OR in December 2013. Though they do not have the flexibility with the funds they manage to co-develop the project, they are very interested in any carbon credits or offsets generated from the project and have encouraged the project team to continue the conversation as the project continues to develop if a replacement cash match partner is secured. It is anticipated that RFPs for purchase of carbon credits or offset will be issued by The Climate Trust in 2014 and beyond.

Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members

During this reporting period, Steve Apfelbaum presented to approximately 200 grain growers from the region at the Perfect Blend Biotic Conference 2013. Steve's presentation was titled "Ecosystem Services and Credits" and emphasized soil carbon and GHG emission credit projects. He focused on the Palouse CIG soil carbon sequestration project and walked producers through the project study design and technical work completed to date, discussed the market opportunity, and invited farmers to learn more about participation. During his visit to the region, Steve met with several Shepherd's Grain farmers who were in attendance at the conference. Presentation details and slides are provided in ***Appendix C: Perfect Blend "Biotic 2013" Conference Presentation (December 2013).***

Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

As stated above in Task 5 above, discussions between AES and Native Energy of Burlington, Vermont began in December 2013 about the potential for their group to replace EKO Asset Management Partners as the cash match partner on the project. Native Energy is very interested in co-developing the project in the Palouse region with funds from their "help build" program. As partners, they would co-develop the project and help broker any carbon credits generated from the project. Many of their existing clients and partners are very interested in the program. It is anticipated that AES will received a proposal to consider during early February, 2014.

As stated in Task 5 above, discussion between AES and The Climate Trust were held in Portland, OR in December 2013. Though they do not have the flexibility with the funds they manage to co-develop the project, they are very interested in any carbon credits or offsets generated from the project and have encouraged the project team to continue the conversation as the project continues to develop if a replacement cash match partner is secured. It is anticipated that RFPs for purchase of carbon credits or offset will be issued by The Climate Trust in 2014 and beyond.

Task 8 – Reporting and Knowledge Dissemination

Ongoing communications with USDA administrative and technical contacts continue on an as-needed basis to ensure all administrative and budget questions and issues are addressed for the CIG grant. On September 23, 2013, the project team had a conference call with representatives from the USDA-NRCS offices in Portland, OR (Adam Chambers and Steve Campbell) and Washington, DC (Gregorio Cruz and Stacy Swartwood) to detail the technical accomplishments of the project to date, discuss the financial challenges we face with the loss of our financial investor, and seek guidance from Administrative staff on next steps to address our project challenges.

During the call, Gregorio Cruz clearly stated that Administrative issues regarding the grant are outside of his area and he recommended speaking with our Administrative Contact for the project. After the departure of Dan Lukash, our project team was not notified of a new NRCS Administrative Contact for the project and were never notified that our semi-annual reports, where we detailed project issues (*in Section 5. Proposed Changes requiring Prior Approval*) were not reaching the appropriate NRCS Administrative staff. A follow-up email from Gregorio Cruz recommended that we contact Frankie Comfort, Grants Specialist for the Central region, though several phone calls and emails to Mr. Comfort before, during and after, the government shutdown in October went unanswered.

A conference call with Adam Chambers was held in December 2013 to discuss the project status and additional efforts to locate a potential cash match partner. On December 23, Adam requested a "comprehensive budget overview" be provided to NRCS detailing the status of all cash and in-kind accounting for the project. This report was provided to Adam Chambers, Steve Campbell, Jacqueline Roscoe, and Sheila Leonard on January 15, 2014 after informal discussion with Adam to ensure the appropriate information and level of detail was being provided. An official response from NRCS has not been received as of the date of this report.

Ry Thompson attended a pre-conference dinner attended by CIG-GHG grant recipients at the Coalition on Agricultural Greenhouse Gases (C-AGG) meeting in Washington, DC in early November, 2013, and attended the C-AGG meeting and briefings with USDA and NRCS staff that followed.

As discussed in the sections above, Steve Apfelbaum presented to ~200 farmers at a Biotic Fertilizer conference in Pasco, Washington organized and sponsored by Perfect Blend of Othello, WA.

7. Next Steps

As described in previous reports under 5. Proposed Changes requiring Prior Approval, the project team is facing serious challenges in attracting an alternate cash investor to provide the cash match required to complete the project. The project team continues to search for an investor through the end of 2013 and early 2014.

If the project team comes to an agreement with Native Energy, it is anticipated that work would continue as proposed in the proposal/contract, as modified by the semi-annual reports under 5. Proposed Changes requiring Prior Approval. It is likely that a no-cost extension would be requested for the project, as required to compensate for the project time lost during 2013 when the project team was seeking a replacement cash match partner.

If an investor is not secured, the project team will have no other option but to close the GHG-CIG (grant). In that event, we would propose to provide a brief final report that builds on, and complements, the previous semi-annual reports. We propose that these would serve as the body of work completed under this CIG.

8. Cost Status

See ***Appendix A – SF 425 Federal Financial Reports*** for the financials for this period.

9. Schedule/Milestone Status

During the fifth bi-annual report period, the project was largely at a standstill, due to the funding issues detailed in previous reports. No further effort was put into the PDD at this stage. It is anticipated that resolution of the funding issues will be resolved in early 2014 as we review a proposal by Native Energy, a potential cash match partner to replace EKO Asset Management Partners. Until additional funding is secured, no major activities will be completed on the project and the milestones will not be achieved as originally proposed. A project schedule with milestones as completed for the project is presented in ***Appendix B – Updated Project Schedule with Milestones***. If the alternate cash match partner is secured, a no-cost extension may be necessary to complete the project during late 2014 or early 2015.

APPENDICES

Appendix A – SF425 Federal Financial Reports for July – December 2013
Appendix B – Updated Project Schedule with Milestones
Appendix C – Perfect Blend "Biotic 2013" Conference Presentation (December 2013)

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted **USDA-NRCS, Washington DC**	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment) **69-3A75-11-131**	Page 1 of 1 pages

4a. DUNS Number **614663276**	4b. EIN **39-1611274**	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type ☑ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	7. Basis of Accounting ☑ Cash ☐ Accrual

8. Project/Grant Period (Month, Day, Year) From: **July 1, 2013**	To: **September 30, 2013**	9. Reporting Period End Date (Month, Day, Year) **September 30, 2013**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	0
b. Cash Disbursements	806,034.45
c. Cash on Hand (line a minus b)	0
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	550,000
e. Federal share of expenditures	550,000.00
f. Federal share of unliquidated obligations	0
g. Total Federal share (sum of lines e and f)	550,000.00
h. Unobligated balance of Federal funds (line d minus g)	0.00
Recipient Share:	
i. Total recipient share required	550,000
j. Recipient share of expenditures	256,034.45
k. Remaining recipient share to be provided (line i minus j)	293,965.55
Program Income:	
l. Total Federal program income earned	0
m. Program income expended in accordance with the deduction alternative	0
n. Program income expended in accordance with the addition alternative	0
o. Unexpended program income (line l minus line m or line n)	0

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official **Ry Thompson, Ecologist/Project Manager** **Applied Ecological Services, Inc.**	c. Telephone (Area code, number, and extension) **(608) 897-8641 ext. 57** d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official [signature]	e. Date Report Submitted (Month, Day, Year) **10/31/13 (through 9th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page of
USDA-NRCS, Washington DC	**69-3A75-11-131**	1 of 1 pages

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	**39-1611274**		☑ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☑ Cash ☐ Accrual

8. Project/Grant Period (Month, Day, Year)		9. Reporting Period End Date (Month, Day, Year)
From: **October 1, 2013**	To: **December 31, 2013**	**December 31, 2013**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	0
b. Cash Disbursements	806,034.45
c. Cash on Hand (line a minus b)	0
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	550,000
e. Federal share of expenditures	550,000.00
f. Federal share of unliquidated obligations	0
g. Total Federal share (sum of lines e and f)	550,000.00
h. Unobligated balance of Federal funds (line d minus g)	0.00
Recipient Share:	
i. Total recipient share required	550,000
j. Recipient share of expenditures	256,034.45
k. Remaining recipient share to be provided (line i minus j)	293,965.55
Program Income:	
l. Total Federal program income earned	0
m. Program income expended in accordance with the deduction alternative	0
n. Program income expended in accordance with the addition alternative	0
o. Unexpended program income (line l minus line m or line n)	0

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number, and extension)
Ry Thompson, Ecologist/Project Manager **Applied Ecological Services, Inc.**	**(608) 897-8641 ext. 57**
	d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **01/31/14 (through 10th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503

	Year 1				Year 2				Year 3				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
	Aug 15 - Sep 30, 2011	Sep 1 - Dec 31, 2011	Jan 1 - Mar 31, 2012	Apr 1 - Jun 30, 2012	Jul 1 - Sep 30, 2012	Oct 1 - Dec 31, 2012	Jan 1 - Mar 31, 2013	Apr 1 - Jun 30, 2013	Jul 1 - Sep 30, 2013	Oct 1 - Dec 31, 2013	Jan 1 - Mar 31, 2014	Apr 1 - Jun 30, 2014	Jul 1 - Jul 31, 2014
Project organization and set-up													
Introductory meetings													
Partnership development with Shepherd's Grain (SG) and surrounding landowners													
Partnership agreement finalized with farmers				◆									
Development and dissemination of educational materials													
Development of live farm field activity web site													
Mapping, screening, and stratification of the Palouse													
Mapping and stratification completed			◆										
Preparation for sampling													
Sampling across Palouse region													
Laboratory analysis of samples													
Statistical analysis and baseline development													
Review of analysis by experts and technical team													
Baseline developed for carbon project								◆					
Finalize soil method validation through VCS or other body													
Methodology validated						◆							
PDD drafting and review for SG and surrounding landowners													
Formal submittal of PDD to independent validator													
PDD delivered to market									◆				
Aggregation beyond SG and surrounding landowners													
Partnership agreement finalized with famers										◆			
Host meetings and discussions with high potential carbon buyers													
Drafting of deal structures to monetize credits													
Carbon deal structured												◆	
Engage ARB or other emerging compliance markets													
USDA communications													
Semi-annual Report (Due 1/31/12, 1/31/13 and 1/31/14)			◆				◆				◆		
Annual report (Due 7/31/12 and 7/31/13)					◆				◆				
Final Report ~~(Due 10/31/14)~~ (Update: Completed 7/31/13)									◆				

Project Seeking Cash Partner in Year 3

Attendance is FREE!!!
Reserve your seat today,
seating is limited.

EMAIL: dhorn@perfect-blend.com or CALL: Dave at 509 713-3644

PERFECT BLEND BIOTIC FERTILIZERS

DO NOT MISS THIS EVENT!!!

RSVP by Wed Nov 27th

EMAIL: dhorn@perfect-blend.com

to reserve your seat

AgroBIOTICS
the science of plenty

YOU ARE INVITED

To a Special Briefing on:

- Biotic Fertilizer Research Updates and New Approaches to Soil Management from the USDA ARS National Lab Director
- Biological Farming 101 – Steps to Greater Productivity
- Greenhouse Gas / Carbon Credits and the Palouse Soil Project
- A New Comprehensive Approach to Soil Health Testing
- Combining Carbon with Fertilizers for Efficiency and Soil Health

December 5, 2013 at RED LION HOTEL in PASCO, WA

Start time: 8:30 am - Continental breakfast (provided)

2 Morning sessions: 9:00 -12:00 / Lunch (provided) / **2 Afternoon sessions:** 1:00 to 3:30

SPEAKERS AND TOPICS

Dr. Jerry Hatfield - Keynote Speaker — **USDA ARS Biotic Fertilizer Research**
Director - *USDA-ARS National Laboratory for Agriculture*

Steven I. Apfelbaum, M.S. — **Environmental Credits and the Palouse Soil Project**
Principal Ecologist, Founder & CEO - *Applied Ecological Services*

Gary Zimmer — **Biological Farming & Carbon Based Fertilizers**
President – *Midwestern BioAg*

Dr. Ray Ward — **Next Generation Soil Health Testing**
President and Co-owner - *Ward Laboratories, Inc*

Attendance is FREE but you must pre-register NOW!!!

PLEASE RSVP **by Wed Nov 27** to reserve your seat and luncheon.

Reserve your seat today, seating is limited!

EMAIL: dhorn@perfect-blend.com or CALL: Dave at 509 713-3644

SPEAKERS

Dr. Jerry Hatfield - Keynote Speaker — **USDA ARS Biotic Fertilizer Research**

Director - *USDA-ARS National Laboratory for Agriculture*

Dr. Jerry Hatfield has served as the Laboratory Director of the USDA-ARS National Soil Tilth Laboratory in Ames, Iowa since 1989 and is considered one of the leading soil scientists in the world. He has turned his investigative attention to microbial activity and soil biodiversity and their links with the soil organic carbon pools in the soil, and how fertility programs utilizing biotic fertilizers affect the soil complex. His revolutionary findings have been incorporated into an advanced genetics x environment x soil management (G x E x M) platform that Jerry has developed.

Gary Zimmer — **Biological Farming & Carbon Based Fertilizers**

President – *Midwestern BioAg*

Gary Zimmer is a farmer, agri-business man, author and educator, and leader of Midwestern BioAg, a biological farming consulting and products company. Dedicated to improving farming through restoring and balancing soils, this passionate advocate for biological and organic farming has spoken to and worked with farmers across the U.S. and in Canada, Europe, Australia, New Zealand, China, and South Africa. The ideas Gary has gleaned over a lifetime spent studying agriculture are utilized on the Zimmer family 1,000 acre organic dairy/crop farm in Wisconsin, Otter Creek Organic Farms.

Dr. Ray Ward — **Next Generation Soil Health Testing**

President and Co-owner - *Ward Laboratories, Inc*

Dr. Ray Ward is president and co-owner of Ward Laboratories, has a PhD in Soil Fertility and has spent his career developing new and economical approaches to measuring soil health. Soil biological testing at Ward Laboratories analyzes phospholipid fatty acids, or PLFA, a representation of living soil microbial biomass which is a snapshot of soil community structure. Also conducted is the Haney Test, a dual extraction procedure that assesses overall soil health and to track changes based on management decisions. This test examines total organic carbon and total organic nitrogen to determine C:N ratios used to make general crop recommendations and also includes the Solvita CO_2 Burst Test.

Steven I. Apfelbaum, M.S. — **Environmental Credits and the Palouse Soil Project**

Principal Ecologist, Founder & CEO - *Applied Ecological Services*

Steve Apfelbaum is one of the leading ecological consultants in the U.S., providing technical restoration advice and win-win solutions where ecological and land-development conflicts arise. Steve has been a lead author of the new Verified Carbon Standard Association (VCS) Soil Carbon quantification method that allows carbon stocks in an agricultural landscape to be measured and monetized. This marketplace model is now being applied with growers in the Palouse under a USDA/NCRS grant to AES. During its second year of implementation participation in the program is expected to triple to cover over 300,000 acres.

Attendance is FREE but you must pre-register NOW!!!

PLEASE RSVP **by Wed Nov 27** to reserve your seat and luncheon.

Reserve your seat today, seating is limited!

EMAIL: dhorn@perfect-blend.com or CALL: Dave at 509 713-3644

Applied Ecological Services, Inc.

Ecosystem Services and Credits

Sustainable Solutions For More Than 30 Years

Soil Carbon and GHG Emission Credit Projects

Background

- Applied Ecological Services and The Earth Partners LP received a USDA-NRCS Conservation Innovation Grant
- Objective is to develop a large-scale agricultural carbon project in the Palouse region
- Shepherd’s Grain partnership with over 30 producers over past two years implementing on-the-ground science
- One of the largest land-based carbon projects in the US receiving significant attention from USDA-NRCS, policy makers, and carbon investors

Major goals of the project

- Measure and quantify soil carbon levels through rigorous scientific process
- Aggregate landowners and develop a large-scale project
- Monetize carbon credits in the market when markets develop or buyers emerge
- Monetize N20/CH4 emission reduction from fertilizer management changes

  - Add value to the sustainable agriculture practices of Palouse producers
  - Influence agricultural policy to reward producers for their sustainable practices

Soil sampling, Whitman County

Soil Carbon Method

- AES and The Earth Partners developed a method to measure and monitor carbon stocks in agricultural systems

- Peer-reviewed by leading scientists and is validated by the Verified Carbon Standard (VCS)

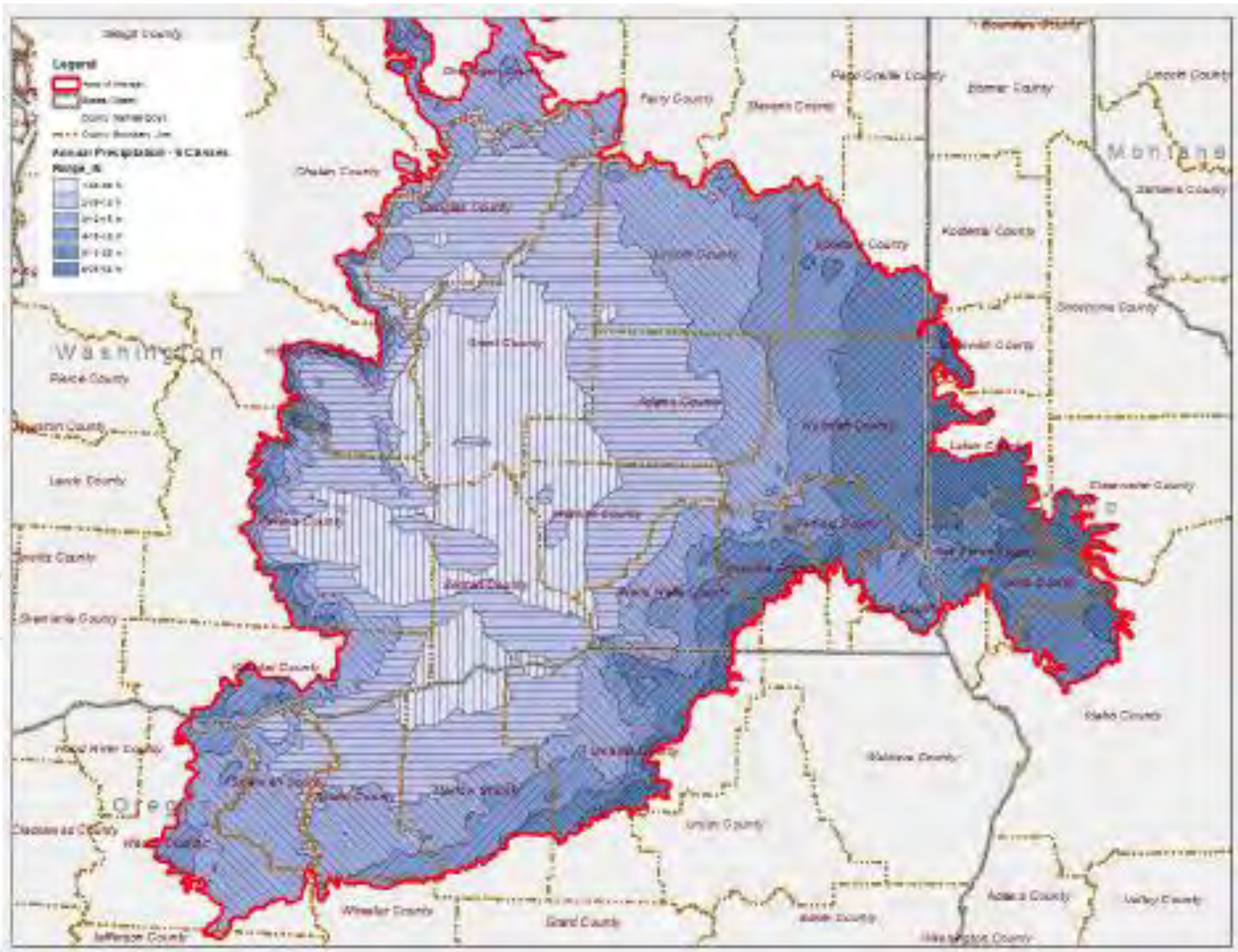
- Allows producers to claim carbon from their management practices based on direct measurement — not restricted by historical research

The Method is built on modules

Module	Description
MODULE 1	APPLICABILITY
MODULE 2	ADDITIONALITY
MODULE 3	BOUNDARIES
MODULE 4	STRATIFICATION
MODULE 5	SOIL CARBON
MODULE 6	LIVING PLANT BIOMASS
MODULE 7	PROJECTION OF FUTURE CONDITIONS
MODULE 8	WOODY BIOMASS HARVESTING AND UTILIZATION
MODULE 9	LONG LIVED WOOD PRODUCTS
MODULE 10	ESTIMATION OF DOMESTIC ANIMAL POPULATIONS
MODULE 11	EMISSIONS FROM DOMESTIC ANIMALS
MODULE 12	EMISSIONS OF NON-CO2 GHG'S FROM SOILS
MODULE 13	SUMMATION OF GHG POOLS, REMOVALS AND EMISSIONS
MODULE 14	EMISSIONS OF GHG'S FROM POWER EQUIPMENT
MODULE 15	DISPLACEMENT LEAKAGE
MODULE 16	MONITORING PLAN
MODULE 17	NON-CO2 EMISSIONS FROM BURNING
MODULE 18	ESTIMATION OF LITTER POOLS
MODULE 19	ESTIMATION OF DEAD WOOD POOLS
MODULE 20	MARKET LEAKAGE

- Selection of sub-sets of applicable modules as determined by project characteristics
- Each module stands alone, containing detailed instructions, definitions, tailored catalogue, etc.

Mapping/stratifying the landscape



Over 7 million acres stratified

- Incorporating results of pre-sampling
- Integrating variables like Elevation, Precipitation, Soil Type

Sample Allocation by Strata

			Direct Seed History													
			2011 or None Conventional H1		2007-2010 1-5 Yrs H2		2000-2006 6-12 Yrs H3		1992-1999 13-20 Yrs H4		1990 or earlier 21 + Yrs H5		CRP Any H6		MISC (Irrigated) H7	REFERENCE H9
Precip Zone	Slope Position	Aspect	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Sampled	Sampled
P2	UP	SW		4			5	5	1	1			5	6		1
P2	UP	NE					5	5	1	1			5	5		3
P2	LO	SW		2			5	5	1	1			5	6		7
P2	LO	NE		2			5	5	1	1			5	5		11
P3	UP	SW	1	3	5	5	5	5	5	5	1	1	5	3		3
P3	UP	NE	1	5	5	5	5	5	5	5	1	1	5	5		2
P3	LO	SW	1	8	5	5	5	5	5	5	5	5	5	4		9
P3	LO	NE	1	5	5	5	5	5	5	5	5	5	5	5		8
P4	UP	SW	2	2	5	4	5	5	5	5	5	5	5	4	1	4
P4	UP	NE	2	4	5	2	5	5	5	5	5	5	5	6	1	8
P4	LO	SW	2	5	5	3	5	5	5	5	5	5	5	6	5	5
P4	LO	NE	2	3	5	4	5	5	5	5	5	5	5	5	1	4
P5	UP	SW		3	5	5	5	5	5	5	5	5	5	5		6
P5	UP	NE		7	5	5	5	5	5	5	5	5	5	7		4
P5	LO	SW		2	5	5	5	5	5	6	5	5	5	4		6
P5	LO	NE		4	5	5	5	5	5	5	5	5	5	4		7
P6	UP	SW		4	5	5	5	5	5	5			5	5		5
P6	UP	NE		6	5	5	5	5	5	5			5	5		5
P6	LO	SW		7	5	5	5	5	5	4			5	6		7
P6	LO	NE		5	5	5	5	5	5	5			5	5		4
Pre-Allocated or Sampled Plots			12	81	80	73	100	100	84	84	52	52	100	101	8	109
Target # of Plots			100		100		100		100		100		100			100

Sampling Map and Fieldwork

Analysis

Number of Cores and Samples Collected
608 sampled locations +
102 total duplicates
710 cores total, 2062 lab samples (~3/core)

Samples by type

H1 – Conventional	(81 samples)
H2 – 1-5 yrs No-till	(73 samples)
H3 – 6-12 yrs No-till	(100 samples)
H4 – 13-20 yrs No-till	(84 samples)
H5 – 21+ yrs No-till	(52 samples)
H6 – CRP	(101 samples)
H7 – Misc/Irrigated	(8 samples)
H9 – Reference Area	(109 samples)

Then further allocated by several strata categories: slope position, aspect, precipitation zone, etc.

Soils Lab Analysis
- Core description & splitting by horizon
- Course Fragments
- Bulk Density
- % Organic Carbon
- % Inorganic Carbon
- % Total Carbon

Statistical Findings

- **At the landscape scale (~ 7 million acres)** , without discounting for outliers, over 40% of the variability of sample results is accounted for by collected data.
- **At the field scale**, without discounting for outliers, over 95% of the variability of sample results is accounted for by the collected duplicate samples.

- Greater amount of carbon in wetter precipitation zones and upper slope positions

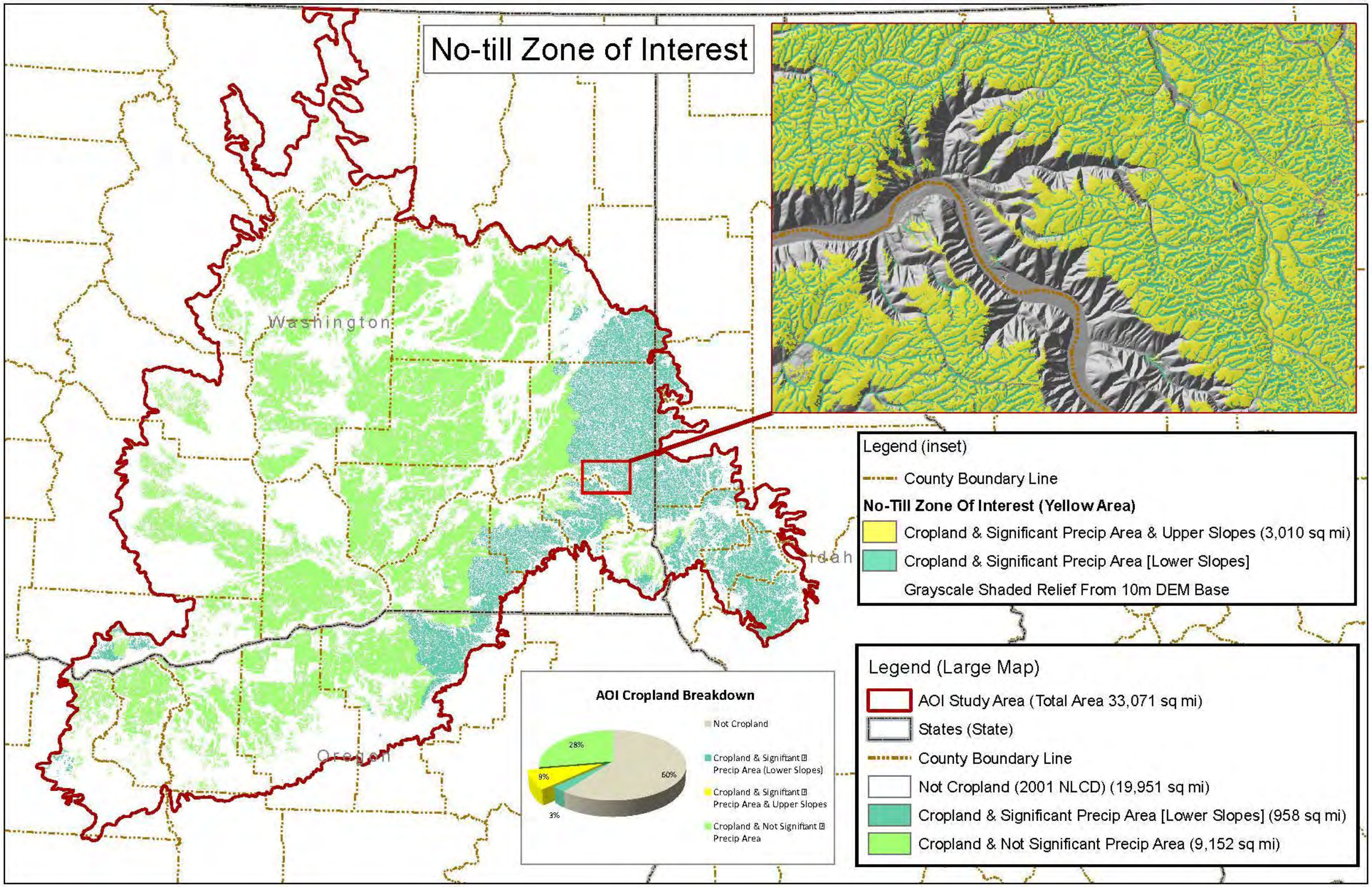
- Increased number of years of no-till is associated with more soil organic carbon in upper A horizon, even accounting for precipitation and slope position.

- Many instances of deeply buried carbon in the landscape, and accruals at deep levels

Statistical Findings

- An annual average accrual rate for wetter region and upper slopes documented the effect of no-till years to be 0.135 kg/m^2 per year, and for the drier zone(s) was 0.006 kg/m^2 .
- Wetter locations were defined as land that recieves a 30 year avg. annual precipitation above the landscape median;
- Where this relationship existed, soil carbon accruals averaged 23 tons / ha of Carbon accrual over 17 years.

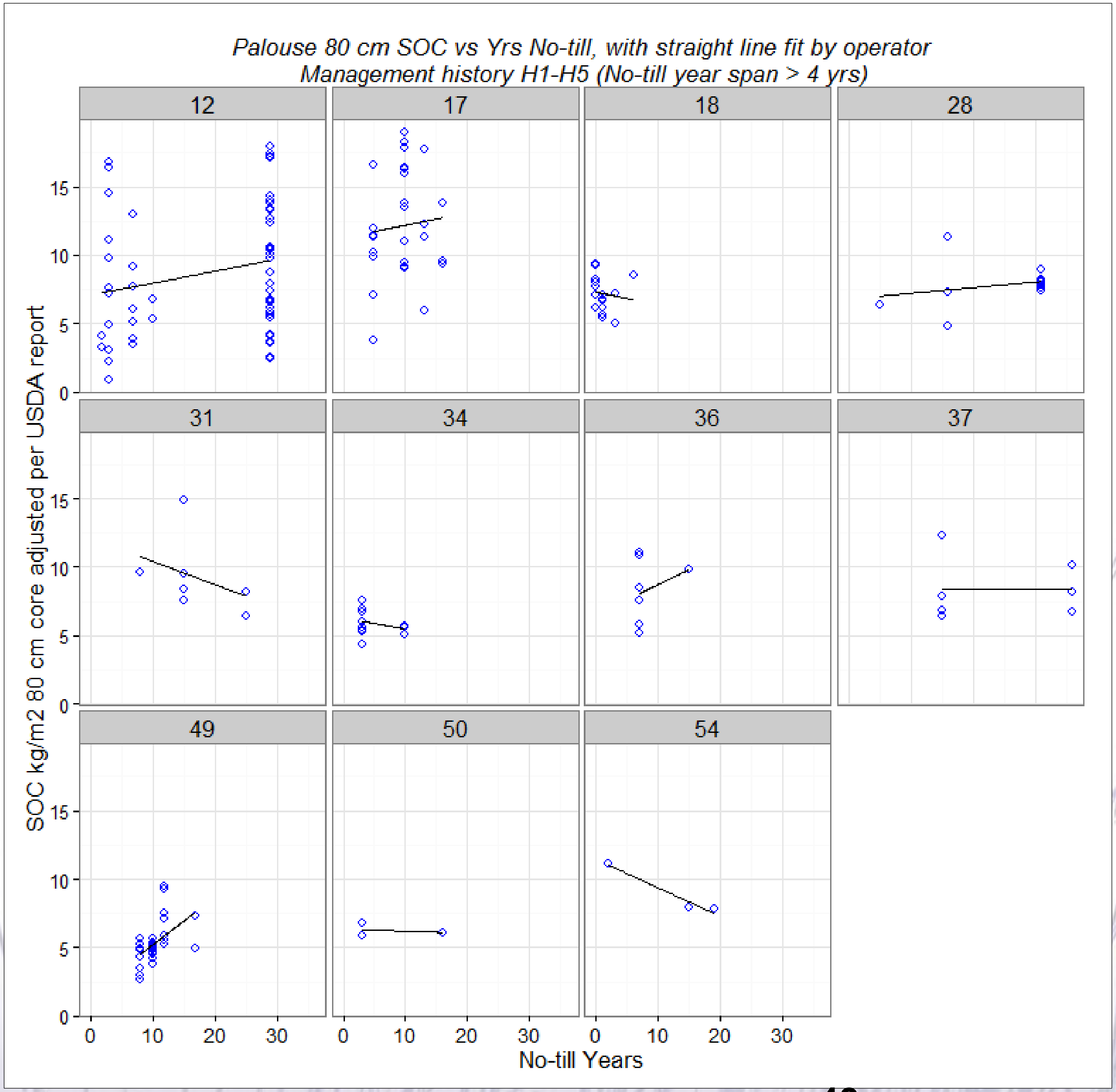
Statistical and GIS Analysis



Challenges

- Soil carbon accruals are strongly influenced by the land use history. The starting point in the regeneration process is different for every farm and recovery is faster in some farms than others (e.g. the better and less eroded soils).
- VCS Project Eligibility Criteria
- Early Adopter Challenges

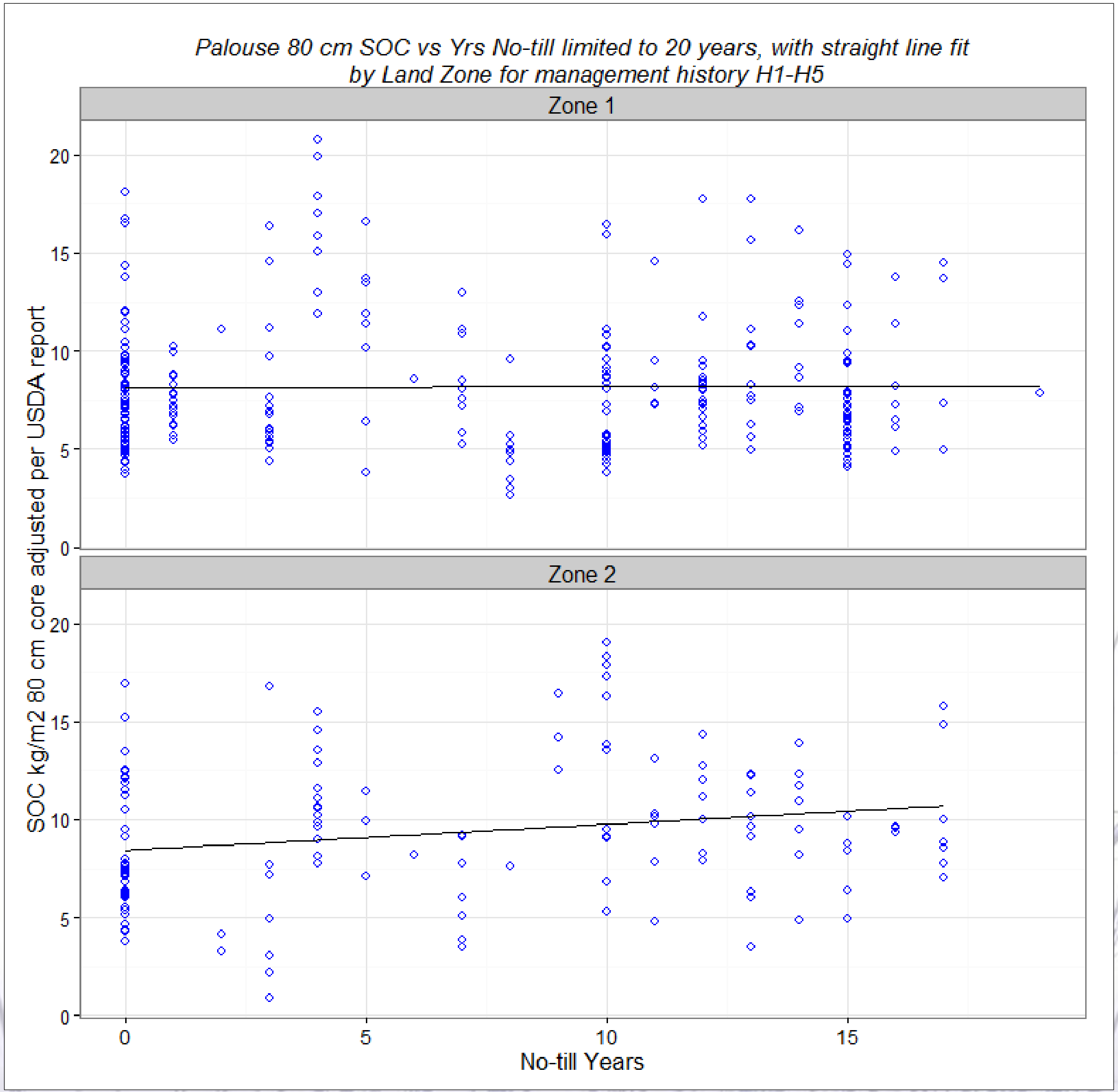
Columbia Plateau No-till Wheat Fields



SOC as a function of No-till years varies across farms and the effect is hard to detect using standard error as gauge.

Operator	Change in SOC per year of No Till (kg/m^2)	Std Error
12	0.087	0.0507
17	0.093	0.1957
18	-0.094	0.2071
28	0.041	0.0475
31	-0.170	0.1485
34	-0.083	0.0830
36	0.219	0.3021
37	0.000	0.0858
49	0.346	0.1003
50	-0.015	0.0618
54	-0.207	0.0409

Columbia Plateau No-till Wheat Fields



Zone	Change in SOC per year of No Till (kg/m^2)	Std Error
1	0.006	0.0374
2	0.133	0.0541

Zone 1 is defined as the land in the AOI with (a) 30 year avg. annual precip. below the landscape median and/or (b) local slope positions below the lowest quartile. The final regression model could not detect an effect of no-till years in these areas.

Zone 2 is defined as the land in the AOI with (a) 30 year avg. annual precip. above the landscape median and (b) local slope positions above the lowest quartile.

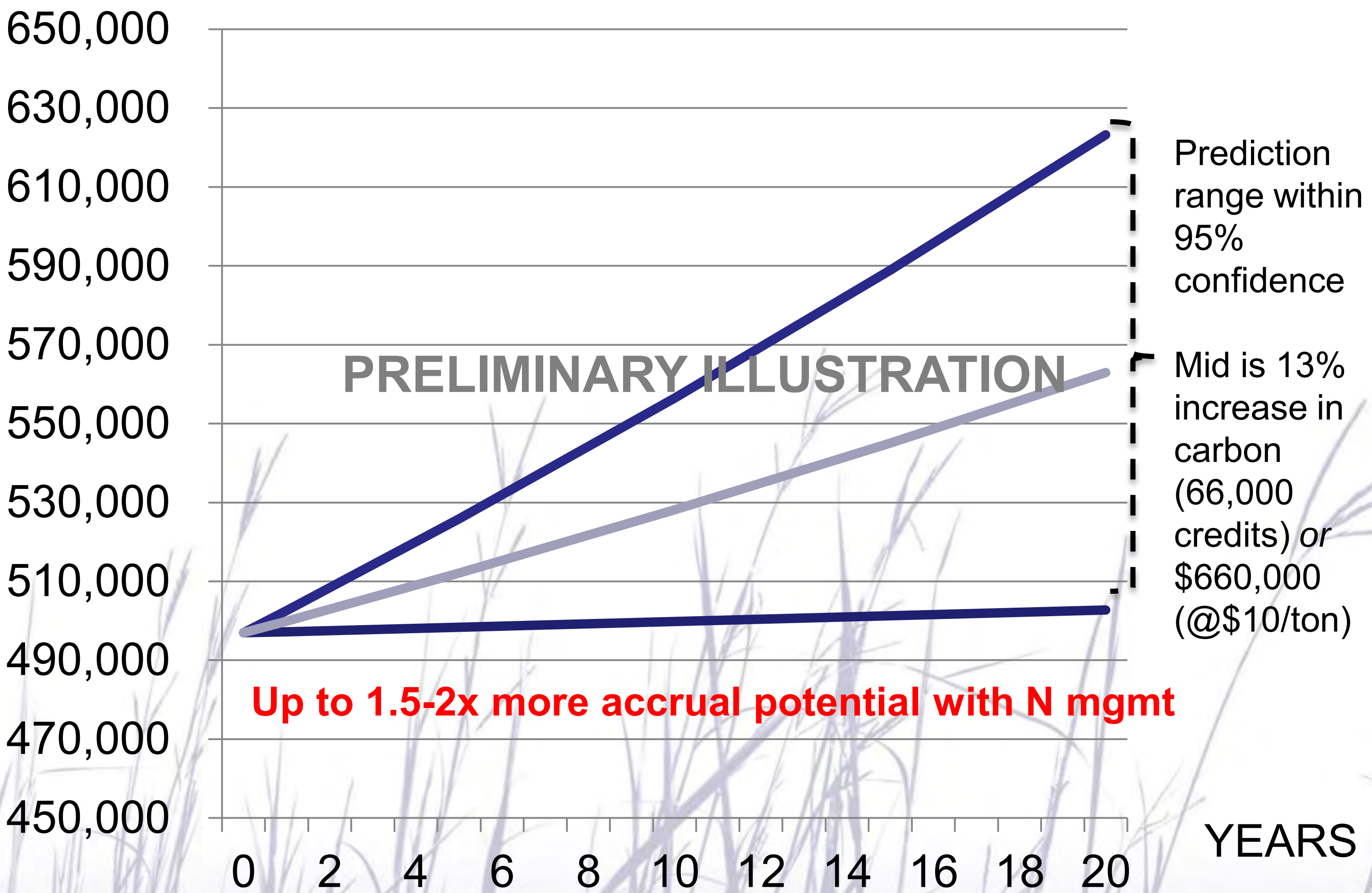
In other words, no-till management is associated with increase in SOC for wetter and relatively higher ground. Final regression model included terms for precipitation and slope position, with a comparable estimate of effect of no-till years (0.135 kg/m^2 per year).

What this can mean for a producer

Basecase average

- 6.1 kg/m^2 of carbon in topsoil
- 27.1 tons of carbon/acre in topsoil
- 99.5 tons CO_2e/acre
- 496,953 tons CO_2e on 5,000 acres

Example from an average 5,000 ac farm, tons CO_2e



EX: What is the range with 95% confidence

This table takes the spreadsheet and runs scenarios, based on the previous slide, and shows upper limits and lower limits of the confidence in the model. Large variation, as you can see.

*5,000ac farm model	Increase in Carbon (20yrs)	New tons CO2e (20yrs)	Value (@ $20/ton)	Variation
Model (low estimate)	1,571 tons	5,765 tons	$115,293	8.9% of basecase
Basecase (being presented)	17,702 tons	62,765 tons	$1.3 mn	basecase
Model (high estimate)	34,394 tons	126,226 tons	$2.5 mn	194% of basecase

Can Returns be Improved?

1. Reduce the use of volatile (aerisol and soluable emissions) nitrogen fertilizers. **(Add N20 emission reductions in credit yield computation)**
2. Change Nitrogen fertilizer formulation to Biotics to reduce N20/CH4 emissions. **(Add N20 emission reductions in credit yield computation)**
3. Use biotic fertilizers to directly increase soil organic carbon. **(Add improved soil carbon to credit yield computations)**
4. Use cover crops and consistent crop residue management to curb erosion and protect soil carbon insitu**. (Add reduced carbon loss from erosion to yield computations).**
5. Establish a crop rotation that builds and maintains soil carbon.
6. **If biotic fertilizers have lower life cycle emissions (total LCA emissions of GHG's, associated with manufacturing, transportation, etc) compared to conventional fertilizers, <u>then add increased Carbon Dioxide equivalency to the carbon credit yield computations.</u>**

7. **<u>If the above is undertaken, we believe all slope positions in dry and wetter meterologic zones could achieve the mean or better carbon accrual rates and at cost savings over conventional practices, perhaps with comparable or higher crop yields.</u>**

Ranchland Restoration with carbon, water and reduced GHG emission credits

Corona Ranch Goals

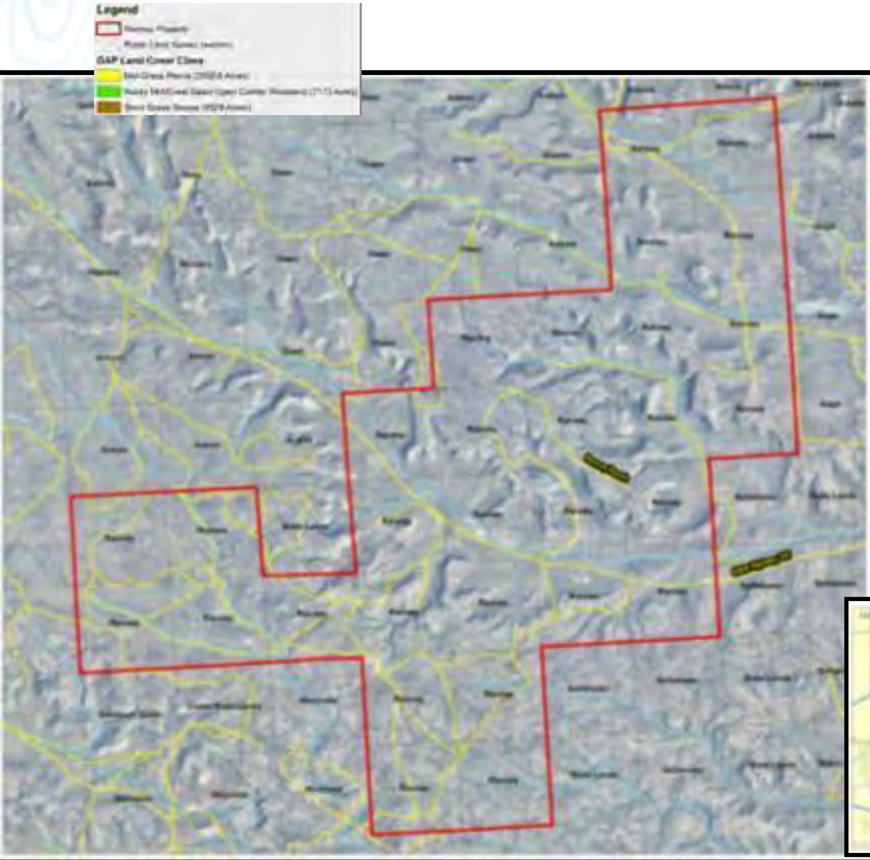
Lincoln County, New Mexico

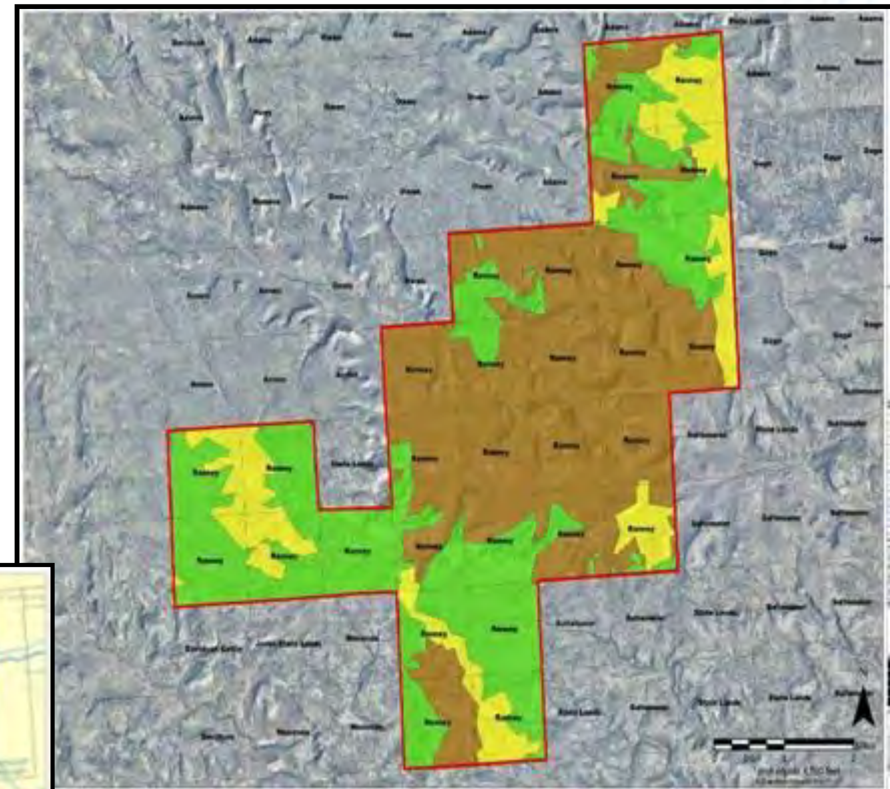
1. Increase livestock herds and convert to short rotation intensive grazing rather than continuous paddock grazing on ranches. (~500,000 acres).
2. Restore native short and mid grass prairie by changing to new grazing regimen will increase carbon sequestration and rebuild soil carbon levels.
3. Generate revenue from increased herd carrying capacity, improved carbon (demonstrations suggest 3-7 tons/ acres increases in soil organic carbon per year based on 10 year averages.
4. Demonstrate a model (carbon, easements) for securing the protection and restoration of millions of acres of western range lands.

500,000 acres of Ranch Restoration

(Soil Carbon, Conservation biomass, ranch products, etc)

Lincoln County, New Mexico





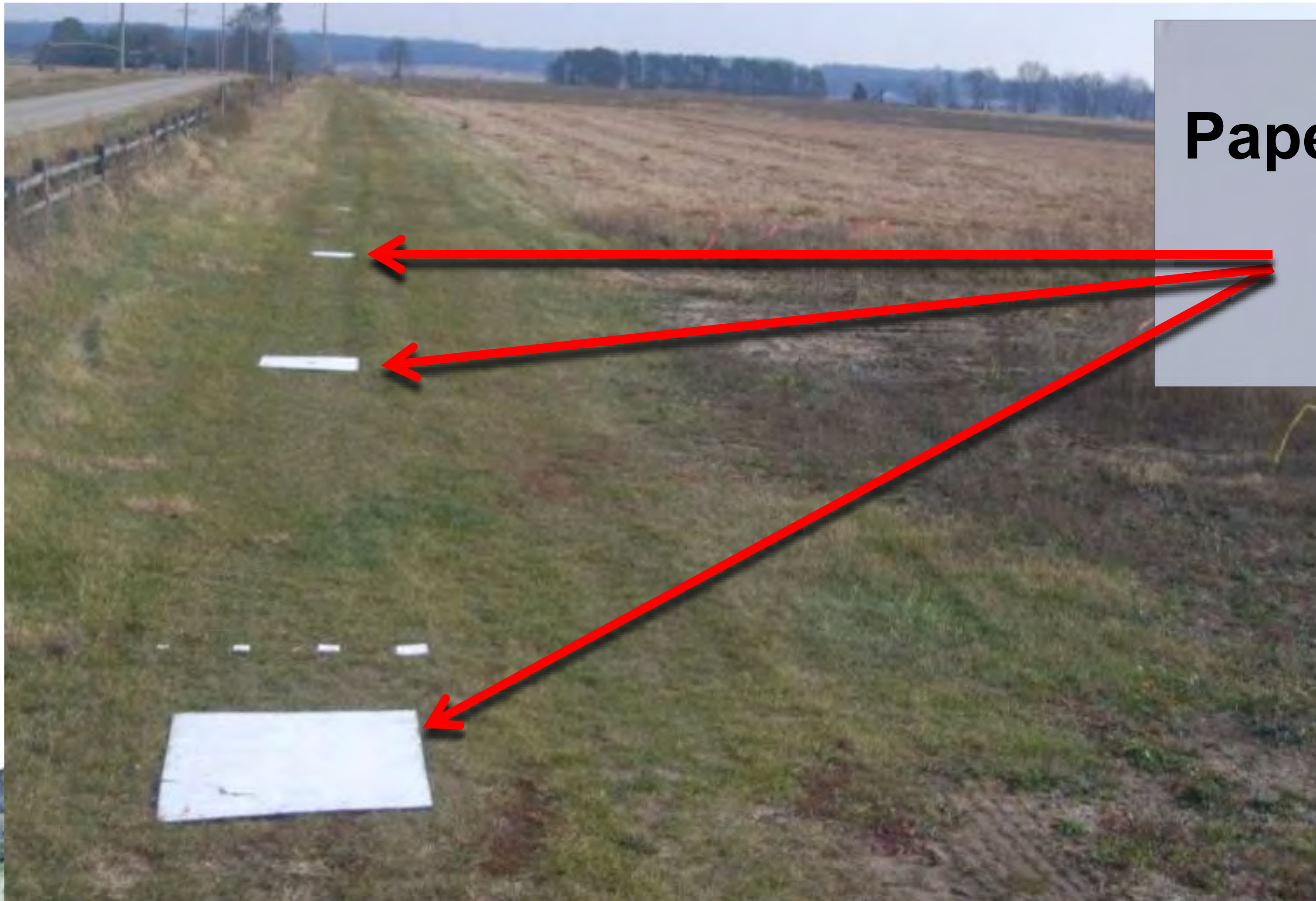
theearthpartners

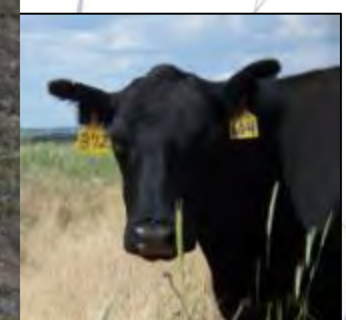
Invasive Species Impacts to Ranches

- Reduced grass/forage acreage and productivity.
- Increased runoff and erosion.
- Less groundwater replenishment, dry surface water supplies.
- Increased ranch costs, reduced revenues

theearthpartners

AES's Very High Resolution Multispectrael Imaging






TARGETS FROM 5000' AGL
2"x 2"
2" - 6"
36"x 30"

Ranch Restoration

(soil carbon biomass, ranch products, etc)

Lincoln County, New Mexico

Illustration of the biomass value of different restoration projects

	Description	Example acreage	Yields (dry tons/ year/ acre)	Net margin (Selling price $60/dry ton)	Profit over 10 years (undis-counted)
Invasive species removal 	Removal of encroaching cedar on native grasslands	10,000	5	10%	$3 million

Ecosystem Marketplace Revenues

- **Reduced GHG emissions and carbon credits**
- **Reduced soil erosion and GHG emissions**
- **Tax Credits for conservation set-asides.**
- **Cost sharings for Restoration/management**
- **Sale of hunting rights, and other functions or assets**
- **Creation of "New Water" valuation**

Appendix H – Semi-Annual Report #6

Applied Ecological Services, Inc. (AES)
Semi-Annual Progress Report No. 6: January 1 – June 30th, 2014
USDA-NRCS CIG-GHG Project No. 69-3A75-11-131
August 14, 2014

PROJECT DESCRIPTION / ABSTRACT

The purpose of the project is to develop a large-scale agricultural carbon project in partnership with Applied Ecological Services, Inc. (AES), The Earth Partners, LP (TEP), a consortium of secondary partners (the AES/TEP Team), Shepherd's Grain members and surrounding farmers in the loess hills of the Palouse and Columbia Plateau region. Intensive farming across the region has resulted in the near extinction of the native grasslands, and the exhaustion of the soil and hydrological resources of the region. The widespread application of sustainable, low-carbon farming practices have the potential to restore the fertility and ensure the longevity of one of the United States' most important breadbaskets. Demonstrating the value to landowners of increased soil carbon stemming from improved agricultural practices may facilitate the large-scale adoption of such practices. This project could provide a roadmap for developing large-scale, high-quality, and low-cost soil carbon transactions.

Building off literature reviews and preliminary sampling completed in 2009, we intended to extrapolate these ideas on a larger, landscape scale across the Columbia Plateau eco-region. The project hopes to build value for farmers by measuring, monitoring, validating, and monetizing carbon credits stemming from low carbon agricultural practices such as no-till, direct seeding, crop rotation, and improved soil management. This project demonstrates the importance of large-scale low carbon farming practices to Greenhouse Gas reduction policies and the role of quantitative soil carbon methodologies in creating compliance-grade offset credits. We believe landowners can be aggregated over large areas at low cost. We hope to demonstrate a model for marketing and monetizing the resulting carbon credits. This could be one of the largest land-based carbon projects to date.

Proposed outcomes include:

- **Demonstrate the model at scale.** The project is broken into two phases: In Phase 1, we intend to develop a low-carbon agricultural partnership with landowners on 100,000 acres of Shepherd's Grain land. In Phase 2, we intend to partner with landowners on over 300,000 acres across the Palouse and larger Columbia Plateau eco-region. This can be expanded at a larger scale because the project can build off of the analytic and technical work we will have done (GIS mapping, stratification, soil sampling, model projections, etc.).
- **Demonstrate a low-cost aggregation model**. Assembling landowners over large acreages at a relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. Through our planned work with landowners on 300,000 acres, the AES/TEP team will develop, test, and refine a low-cost aggregation model. To this end, the AES/TEP team is building on significant existing experience in aggregating landowners, developing standard partnership structures, and streamlining landowner interactions and engagement.
- **Showcase a successful land-based carbon transaction.** Agricultural carbon credits **cannot** currently be monetized in the marketplace. This project hopes that credits will be accepted by the CA Air Resources Board (ARB) under AB-32 or other emerging compliance markets, as well as voluntary markets like VCS and ACR. To this end, we have developed a partnership of farmers, project developers, carbon investors, scientists, and government agencies.
- **Develop data, maps and templates that will inform policy and support further research.** We will utilize GIS landform and geomorphic modeling and mapping to design, evaluate, and implement a regional, on-the-ground baseline analysis of soil carbon levels across the Palouse and Columbia Plateau eco-region. The resulting data and maps will represent a type of integrated information that is lacking in the region, which will be useful for government agencies, scientists, universities, and others.

FIFTH SEMI-ANNUAL PROGRESS REPORT

1. USDA-NRCS CIG-GHG Project Number and Contract Period

69-3A75-11-131 – August 1, 2011 to July 31, 2015 (one-year no-cost extension granted 5/8/14)

2. Project Title

Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region

Project Director / Principal Investigator

Steven I. Apfelbaum, Chairman of the Board/Principal Ecologist, Applied Ecological Services, Inc.

3. Date of Report / Period Covered

July 31, 2014 for Report No. 6: January 1 – June 30, 2014

4. Executive Summary

During the first half of 2014, the Project Team made good progress on the following tasks:

- Task 1 – Business Origination with Shepherd's Grain – The team continued relationship building with Shepherd's Grain producers.
- Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers – The team finalized discussions and secured Native Energy as the cash match partner and co-developer of the carbon project.
- Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members – Strategy sessions were held on the who and how of engaging more farmers and including more land in the project.
- Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members – Negotiations and evaluations regarding the most appropriate carbon registry for the project are ongoing between the team, Native Energy, VCS and ACR.
- Task 8 – Reporting and Knowledge Dissemination – The team received and responded to a project deliverable review by Sheila Leonard, NRCS Supervisory Grants Management Specialists, whereby 6 of 11 deliverables are either complete or up-to-date. The team is using the no-cost extension to report to NRCS administrative and technical contacts consistently throughout the reporting period and focus on administrative components of the grant and cash match partner. Knowledge dissemination continues through negotiation with partners, including farmers (Section 6, Task 5), and through attendance at the C-AGG meeting in Sacramento, CA.

5. Proposed Changes requiring Prior Approval

In accordance with the Prior Approval Requirements outlined in Section IV of CIG Contract #69-3A75-11-131, the project team proposes the following modification:

- Several changes to the project were proposed during the reporting period and are documented in *Section 6. Accomplishments (Task 8)* and the correspondence letters included as *Appendix E through Appendix K*. The primary changes including: 1) Finalizing NativeEnergy of Burlington, VT as the cash match partner; 2) Receiving approval from NRCS for a one-year no-cost extension for the project to extend the project through July 31, 2015, and having completed the majority of the deliverables pursuant to Ms Leonard's review.

6. Accomplishments

Task 1 – Business Origination with Shepherd's Grain

AES introduced the new cash match partner, NativeEnergy, to Shepherd's Grain through several conference calls beginning on February 28, when the NativeEnergy was introduced to the Shepherd's Grain team. We continued to build on the relationships developed with Shepherd's Grain through the project period with monthly update calls focused on project status and project challenges. Information on this relationship is discussed in more detail in Task 6 below.

Task 2 – Mapping, Screening and Stratification of the Palouse

Several additional maps were provided to NRCS staff to ensure deliverable 1 was complete, per Ms. Sheila Leonard's project review letter, dated February 11, 2014.

Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region

No sampling or analysis activities occurred during this project period.

Task 4 – Analysis and Baseline Development

No major analysis or baseline development activities occurred during this project period. Ongoing discussions on project sampling, analysis and baseline development continued with NativeEnergy as the conducted due diligence on the project and envisioned next steps required to translate the technical body of work into a viable carbon project.

Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers

Discussions between AES and NativeEnergy of Burlington, Vermont began in December 2013 about the potential for their group to replace EKO Asset Management Partners as the cash match partner on the project. From the beginning, NativeEnergy was very interested in co-developing the project in the Palouse region with funds from their HelpBuild™ program. In April 2014, NativeEnergy provided a commitment letter to AES and NRCS, as shown in Appendix J. As partners, they are co-developing the project and helping to market and sell the carbon credits generated from the project.

Since formalizing the partnership in April and coordinating with Shepherd's Grain, AES and Native Energy have created a draft Participant Solicitation Document titled "*Soil Improvements with Reduced Tillage and Improved Fertility Management in the Palouse*" and is included as Appendix C. This farmer information piece was developed for discussion with Shepherd's Grain, initially, and focuses on the project requirements necessary to meet the VCS standards for a carbon project. Primary sections of the document include:

- Project History;
- Farm Benefits;
- Eligibility Requirements (Ownership/Control, Commitment to No-Till, and Financial & Management Plan);
- Farm Responsibilities (Access to Farm, Training, and Reporting);
- Estimated Project Revenues and Costs;
- Estimated Reduced Operations and Maintenance Savings;
- About AES; and
- About NativeEnergy.

Once finalized, the document will be shared with all previously enrolled Shepherd's Grain farmers and with others in the scaling up process for engaging additional farmers in the CIG project/carbon transaction. We will update this document after further discussions with Shepherd's Grain and will schedule in-person meetings to begin the process of converting the "enrollment agreements" into carbon "transaction agreements". This meeting will also focus on putting a plan together on collaboratively scaling up the involved acreage in our program. It is anticipated that this meeting will be held Fall 2014, once most of the wheat harvest and planting is complete in the Palouse region.

Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members

Strategy sessions were held on the who and how of engaging more farmers and including more land in the project.

Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

Since formalizing the partnership agreement in April 2014, discussions between AES and NativeEnergy have focused on how to co-develop the soil carbon project in the Palouse region while navigating the VCS requirements related to early adopters/additionality, permanence and aggregation.

Since April, AES and NativeEnergy have been discussing with VCS how the "activity" before and after a carbon transaction start date can remain the same in name (e.g. "no-till farming") and still meet the additionality requirements of VCS. We have had multiple telephone calls and an in-person meeting (May 2014) with VCS staff, including David Antonioli (Chief Executive Officer), Will Ferretti (General Manager), Jerry Seager (Chief Program Officer), and Rachel Steele (Senior Program Officer). These calls have focused on asking VCS to clarify how a project such as the Palouse project can formally go through the VCS program using their standard, and the approved The Earth Partners Soil Carbon Quantification Method (VM0021).

NativeEnergy and AES have also started communication with American Carbon Registry (ACR) because it appears the VCS program creates barriers to accepting large landscape agricultural projects and allowing early adopters or anyone using the "activity" such as no-till agriculture (even for 1 year on a given field) in their program. Appendix D includes a Summary Memo comparing the VCS and ACR Programs for the Palouse Project. The challenges identified by AES and NativeEnergy continue to be discussed with VCS staff to determine if there is a path forward with their program. In the meantime, AES and NativeEnergy will continue to discuss the ACR path for the project.

The team has had productive discussions with Shell Oil Company and with California Department of Conservation (Chief Mark Nechodem) regarding the potentially large volumes of carbon credits that could be produced in the Palouse and their respective interest in purchasing credits directly, or as a means of encouraging industry to become responsible/compliant. The content of these discussions is not publicly available. The team is preparing an agenda for an introductory meeting that Mr. Nechodem will arrange between our Palouse team and the refinery businesses.

Task 8 – Reporting and Knowledge Dissemination

Ongoing communications with USDA administrative and technical contacts continued during this reporting period to ensure all administrative and budget questions and issues are addressed for the CIG grant. A few highlights of these communications are included below:

- On January 15, 2014, AES provided a Comprehensive Budget Overview table to Adam Chambers, Steve Campbell, Jacqueline Roscoe, and Sheila Leonard after informal discussion with Adam to ensure the appropriate information and level of detail was being provided (See Appendix F). The budget overview was based on a request made on December 23, 2013, Adam Chambers of NRCS requested a "comprehensive budget overview" be provided to NRCS detailing the status of all cash and in-kind accounting for the project (See Appendix E).
- On February 11, 2014, Sheila Leonard of NRCS provided a report, in letter form, detailing results of a review of the grant. In that report, the majority of the deliverables were either complete or up-to-date. Incomplete project deliverables were also identified. The letter identified eleven deliverables and documented the status of each as incomplete (4), partially complete (1), complete (5), or up-to-date (1). The letter requested a response by March 14, 2014 with an update on the status of the incomplete deliverables or estimated date for completion (See Appendix G).
- On March 14, 2014, AES provided a response letter to Sheila Leonard which addressed each of the deliverable items and a plan of action for each. A CD-ROM with a set of many of the incomplete deliverables was provided to the NRCS administrative and technical contacts. In addition, AES provided an update on the replacement of the cash-match partner and formally requested a no-cost extension for 12 months to complete the outstanding deliverables (See Appendix H).
- On April 4, 2014, Ry Thompson and Tom Hunt of AES had a conference call with Steve Campbell and Adam Chambers to discuss the deliverables provided by CD-ROM discussed above, and a brief discussion about the overall project status and anticipated next steps.
- On April 4, 2014, Sheila Leonard of NRCS provided a letter acknowledging the receipt of the March 14 AES letter. It stated that before any consideration of the no-cost extension can be given, a written verification from the cash match partner was required by April 18, 2014. After email discussions with Jacqueline Roscoe, a one week extension of this deadline was granted (See Appendix I).
- On April 18, 2014 and in compliance with Ms. Leonard's request, AES provided a commitment letter documenting NativeEnergy of Burlington, VT as the new cash match partner on the project (See Appendix J).

- On May 8, 2014, Jacqueline Roscoe Henry of NRCS provided a letter acknowledging and accepting the commitment by NativeEnergy, Inc. as the new cash match partner. Additionally, the letter documented the review and approval of the no-cost extension until July 15, 2014 (See Appendix K).

On March 4 and 5, 2014, Ry Thompson attended the Coalition on Agricultural Greenhouse Gases (C-AGG) meeting in Sacramento, CA to network with other CIG projects and remain up-to-date on new developments in the field.

7. Next Steps

As shown in the Updated Project Schedule with Milestones (Appendix B), the project schedule has been necessarily adjusted. During the next semi-annual report period, AES will continue to work with NativeEnergy and Shepherd's Grain on the co-development of the project. As discussed in Task 7 above, AES may pursue validation of a modified version of its Soil Carbon Quantification Methodology with American Carbon Registry (ACR) during the next reporting period. In parallel, work will continue on the development of the Project Design Document (PDD) and development of a legal agreement with farmers.

8. Cost Status

See ***Appendix A – SF 425 Federal Financial Reports*** for the financials for this period.

Please note: The SF425 Federal Financial Reports do not reflect any changes since mid-2013, though much work has been completed since this time. The contract with NativeEnergy has specific milestones for progress that must be met prior to billing. It is anticipated that the September and December 2014 SF 425 FFRs will reflect the influx of cash match on the project.

9. Schedule/Milestone Status

On February 11, 2014, Sheila Leonard of NRCS provided a report, in letter form, detailing results of a review of the grant. In that report, the majority of the deliverables were either complete or up-to-date. During the sixth bi-annual report period, the project began implementing the project with a new cash match partner, NativeEnergy. During this period, the USDA-NRCS Grants Administrators approved a 12 month no-cost extension for the project. A project schedule with milestones as completed for the project is presented in ***Appendix B – Updated Project Schedule with Milestones*** and extends the project tasks through July 31, 2015.

APPENDICES

Appendix A – SF425 Federal Financial Reports for January – July 2014
Appendix B – Updated Project Schedule with Milestones
Appendix C – Palouse Soil Carbon Participant Solicitation Document
Appendix D – Summary of VCS and ACR Program Comparisons
Appendix E – NRCS Documentation Request for AES CIG (12/23/13)
Appendix F – AES Response – Comprehensive Budget Overview Table (1/10/14)
Appendix G – NRCS Letter – Review of AES CIG Deliverables (2/11/14)
Appendix H – AES Response – AES CIG Deliverables (3/14/14)
Appendix I – NRCS Letter – Response to No-cost Extension Request Letter (4/4/14)
Appendix J – AES Response – Native Energy Commitment Letter (4/18/14)
Appendix K – NRCS Letter – No-cost Extension Granted (5/8/14)

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page of
USDA-NRCS, Washington DC	**69-3A75-11-131**	1 of 1 pages

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	**39-1611274**		☑ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☑ Cash ☐ Accrual

8. Project/Grant Period (Month, Day, Year)		9. Reporting Period End Date (Month, Day, Year)
From: **April 1, 2014**	To: **June 30, 2014**	**June 30, 2014**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0**
b. Cash Disbursements	**806,034.45**
c. Cash on Hand (line a minus b)	**0**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000**
e. Federal share of expenditures	**550,000.00**
f. Federal share of unliquidated obligations	**0**
g. Total Federal share (sum of lines e and f)	**550,000.00**
h. Unobligated balance of Federal funds (line d minus g)	**0.00**
Recipient Share:	
i. Total recipient share required	**550,000**
j. Recipient share of expenditures	**256,034.45**
k. Remaining recipient share to be provided (line i minus j)	**293,965.55**
Program Income:	
l. Total Federal program income earned	**0**
m. Program income expended in accordance with the deduction alternative	**0**
n. Program income expended in accordance with the addition alternative	**0**
o. Unexpended program income (line l minus line m or line n)	**0**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number, and extension)
Ry Thompson, Ecologist/Project Manager **Applied Ecological Services, Inc.**	**(608) 897-8641 ext. 57**
	d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **07/31/14 (through 12th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page of
USDA-NRCS, Washington DC	**69-3A75-11-131**	1 of 1 pages

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	**39-1611274**		☑ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☑ Cash ☐ Accrual

8. Project/Grant Period (Month, Day, Year)		9. Reporting Period End Date (Month, Day, Year)
From: **January 1, 2014**	To: **March 31, 2014**	**March 31, 2014**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0**
b. Cash Disbursements	**806,034.45**
c. Cash on Hand (line a minus b)	**0**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000**
e. Federal share of expenditures	**550,000.00**
f. Federal share of unliquidated obligations	**0**
g. Total Federal share (sum of lines e and f)	**550,000.00**
h. Unobligated balance of Federal funds (line d minus g)	**0.00**
Recipient Share:	
i. Total recipient share required	**550,000**
j. Recipient share of expenditures	**256,034.45**
k. Remaining recipient share to be provided (line i minus j)	**293,965.55**
Program Income:	
l. Total Federal program income earned	**0**
m. Program income expended in accordance with the deduction alternative	**0**
n. Program income expended in accordance with the addition alternative	**0**
o. Unexpended program income (line l minus line m or line n)	**0**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. *Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:*

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number, and extension)
Ry Thompson, Ecologist/Project Manager **Applied Ecological Services, Inc.**	**(608) 897-8641 ext. 57**
	d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **04/30/14 (through 11th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Aug 15 - Sep 30, 2011	Sep 1 - Dec 31, 2011	Jan 1 - Mar 31, 2012	Apr 1 - Jun 30, 2012	Jul 1 - Sep 30, 2012	Oct 1 - Dec 31, 2012	Jan 1 - Mar 31, 2013	Apr 1 - Jun 30, 2013	Jul 1 - Sep 30, 2013	Oct 1 - Dec 31, 2013	Jan 1 - Mar 31, 2014	Apr 1 - Jun 30, 2014	Jul 1 - Sep 30, 2014	Oct 1 - Dec 31, 2014	Jan 1 - Mar 31, 2015	Apr 1 - Jun 30, 2015
Project organization and set-up	■															
Introductory meetings		■														
Partnership development with Shepherd's Grain (SG) and surrounding landowners		■	■													
Partnership agreement finalized with farmers				◆												
Development and dissemination of educational materials		■	■	■	■											
Development of live farm field activity web site		■	■													
Mapping, screening, and stratification of the Palouse		■	■													
Mapping and stratification completed			◆													
Preparation for sampling		■	■													
Sampling across Palouse region				■	■											
Laboratory analysis of samples			■		■											
Statistical analysis and baseline development						■	■	■								
Review of analysis by experts and technical team							■									
Baseline developed for carbon project								◆								
Finalize soil method validation through VCS or other body		■	■	■												
Methodology validated						◆										
PDD drafting and review for SG and surrounding landowners							■	■								
Formal submittal of PDD to independent validator																
PDD delivered to market														◆		
Aggregation beyond SG and surrounding landowners							■	■								
Partnership agreement finalized with famers										◆			◆			
Host meetings and discussions with high potential carbon buyers																
Drafting of deal structures to monetize credits																
Carbon deal structured												◆				◆
Engage ARB or other emerging compliance markets						■	■	■	■	■	■	■	■	■	■	■
USDA communications		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Semi-annual Report (Due 1/31/12, 1/31/13, 1/31/14 and 1/31/15)			◆				◆				◆				◆	
Annual report (Due 7/31/12, 7/31/13 and 7/31/14)					◆				◆				◆			
Final Report ~~(Due 10/31/14)~~ (Update: Due 10/31/15)																◆

Project Seeking Cash Partner for much of Yr 3

Soil Improvements with Reduced Tillage and Improved Fertility Management in the Palouse

INTRODUCTION TO PARTICIPATION

Applied Ecological Services, Inc. (AES) and *Native*Energy, Inc. are seeking farming landowners and farmers interested in earning significant new revenues from increasing soil carbon levels and reducing emissions. Through committing to and practicing no-till farming and improved fertilizer management, participating landowners can earn up to an additional $15.00 per acre per year and save even more in reduced fuel costs without adversely affecting yield.

Project History

AES received a Conservation Innovation Grant from the USDA-NRCS in 2011 for a 3-year project to measure and quantify soil health in the Palouse through a rigorous scientific process. The project emphasized measuring soil carbon levels. The research has added significant value to the agricultural practices by documenting the carbon accrual benefits of no-till and minimum tillage practices.

To date, AES has sampled, measured and documented carbon accruals associated with conventional tillage and with no-till from Spokane to Pullman/Moscow, to Walla Walla and The Dalles, in what is one of the very first large landscape soil carbon measurement projects in USA. We have used the laboratory analysis data from 800 three foot long soil core samples from the central and eastern-most areas of the Palouse region. That data was used to create a model of the projected accruals a farmer should be able to achieve with a conversion to no-till with improvements in soil fertility management.

Now we are looking for farmers and landowners willing to convert to no-till farming and who are motivated to further aid research on improving soil water holding capacity, soil fertility, irrigation efficiency, and crop yield and quality. With the soil carbon data and an approved soil carbon methodology, we are able to proceed with engaging farmers to generate the carbon credits necessary to fund the improved methods and further research and development.

*Native*Energy, a leading project developer and carbon credit marketer, has committed to fund the remainder of our work and help us develop the project into a producer of verified carbon credits to sell in the voluntary carbon market. *Native*Energy has over a dozen years of experience in that market, and its extensive and growing customer base includes many manufacturers of products with grains, including Clif Bar and Annie's Homegrown.

Farm Benefits

In addition to carbon credit revenues and operations cost savings (which many of you already are benefitting from), improvements in soil carbon and health reduce the risk of drought as the improved soils hold moisture better and longer, increase crop yield, and avoid quality depression.

Farmers will be able to track and monitor soil carbon reductions and compare to neighboring farms in the same program. In addition to having bragging rights about just crop yields farmers will be able to brag about carbon and soil health improvements. We look forward to helping you tell this larger story with the data we collect and the money generated through the sale of carbon credits.

From our discussions with farmers, in addition to the new revenues and cost savings with improved soil health and soil carbon levels, farmers feel good about accomplishing something special by restoring the health of soils and providing a valued legacy for the community, their land, and their family. These farmers value being able to leave the land in a better condition than it was in when they started farming. This has always been a very important reason that farmers care about their farms and work as hard as they do to improve their land.

Eligibility Requirements

Ownership/Control

To be eligible to participate, the person or entity (the "Land Control Party") that owns or otherwise controls the land being brought into no-till (the "Subject Land") must have the legal rights to control the use of the Subject Land for the next 30 years. That means that if the farming person or entity (the "Farmer") leases the Subject Land or otherwise obtained a right to use the land from a third party, then either: (i) the lease or other right of use must have a 30-year term or be renewable in the Farmer's sole discretion for successive terms totaling 30 years (and the Farmer would be the Land Control Party), or (ii) that third party must be able to demonstrate ownership or control for 30 years and must itself make the contractual commitments required for participation in the project and have in place the financial and management plans identified below (and the third party would be the Land Control Party).

As an example, if you farm leased land under a lease that required mutual agreement to renew, your lessor is the Land Control Party. In that case, your lessor would need to sign an agreement with us not to lease the land for the next 30 years except in a lease that contains the same restrictions on tillage farming as are set forth under "Commitment to No-Till" below, and you and your lessor would need to amend your lease accordingly. You would then also need to sign an agreement with us imposing those same restrictions on you for the term of your lease.

Commitment to No-Till

To be eligible to participate, the Farmer (and the Land Control Party, if different) will have to sign a binding agreement with AES and *Native*Energy to: (i) maintain the Subject Land in crop production; (ii) till or permit your lessees to till the Subject Land only in years when soil conditions necessitate tilling to avoid material yield reduction (such as unusually wet springtime); and (iii) provide 5 business days' advance written notice to AES of your intent to till or permit tillage of some or all of the Subject Land in advance, detailing the circumstances that necessitate tilling; in all cases for a period of at least the next 30 years.

Financial & Management Plan

To be eligible to participate, the Farmer (and the Land Control Party, if different) will have to adopt and follow a financial and management plan to secure and allocate the resources needed to meet the above commitment to no-till and provide a copy of the plan to the NRCS and your lender. This is a requirement of the Verified Carbon Standard for registration of the carbon credit project. We would assist you in preparing your individual farm plans that reflect this conversion to continuous no-till farming to determine whether the project is eligible and meets the farms financial and operational needs. In order to determine whether the project is feasible for a carbon project and for the Farmer, we would provide, among other resources, financial forecasts and aerial photograph maps of each farm, showing the locations where soil carbon sampling has occurred to date.

Farm Responsibilities

Access to Farm

We will need reasonable access to your farm and your farm's business records to verify your farming practices prior to your participation in the project. The Business records will need to show field-based annual cropping records, tillage records, and fertilization records. Our process will not be like an IRS audit and will not require much of your time. We simply need to confirm your eligibility and document the baseline condition of the soil carbon in your fields so that changes in soil carbon and emissions of nitrous oxide and methane (gases given off when soils are fertilized with conventional farm chemical fertilizers) levels can be calculated. Among the specific records we will need are:

- Records of your ownership or other rights to the acreage you will include in the project
- Access to NRCS maps
- Records of your annual tillage practices on that acreage
- Records of your fertilizing practices

In addition, we will need access to your farm to conduct the measurements and then over the years, to conduct follow-up monitoring and sampling activities required for the verification and issuance of carbon credits. All such access will be at reasonable times upon reasonable notice, and will not materially disturb your operations. We use a Giddings hydraulic soil probe mounted on a John Deere Gator utility vehicle to access the soil sampling points. We will share with you the results of the lab tests.

Training

We will look to you and other creative, innovative farmers, as well as the USDA and others to seek the best strategies for improving soil carbon and soil health. We will work to learn the best performing techniques, fertilizers, equipment, and know-how. Because the Palouse is a large region, we will document what we learn and share this with all farmers in this program. Sharing will likely take the form of articles written with you and other farmers in the project, with local relevant resources such as at WSU, OSU, and UI and will likely include an annual workshop or three around the region for efficient knowledge sharing.

Reporting

We will create an interactive web site for you to easily report your project activities. Once a year, you will need to log in to the web site, access your farm map, and update the activities that occurred on your fields in the preceding year, including amount and type of fertilizers applied, dates of application, type of tillage conducted with dates, crop residue management employed with dates, cover cropping and crops seeded with dates, etc. With this information, we will calculate and report to you the estimated number of carbon credits you will have generated.

Estimated Project Revenues and Costs

We estimate that a 4,000 acre farm might incur an estimated initial cost of $190,000 - $300,000 or so to purchase new no-till equipment. It is possible that project costs could be as little as $80,000 for new equipment if you can trade in or sell your conventional tillage equipment.

Estimated reduced operations and maintenance savings

Through committing to and practicing no-till farming and improved fertilizer management, project revenues for participating landowners, a 4,000 acre farm could earn between $32,000 and $60,000 per year.

About AES

Applied Ecological Services is one of the leading ecological consulting firms in the world; we are dedicated to bringing the science of ecology to land-use decisions. AES applies science to provide practical land-use solutions that strike the most favorable balance between cultural needs, cost efficiencies and ecological sustainability. Our knowledge of ecological systems provides a solid foundation for creating balanced ecological designs and solutions that are sustainable, cost-effective and enduring. Learn more at www.appliedeco.com.

About *Native*Energy

*Native*Energy is an expert provider of carbon offsets, renewable energy credits, and carbon accounting software. With *Native*Energy's Help Build™ offsets, businesses and individuals can help finance the construction of wind, biogas, solar, and other carbon reduction projects with strong social and environmental benefits. Since 2000, *Native*Energy's customers have helped build over 50 projects that are now keeping millions of tons of greenhouse gases out of the air. All *Native*Energy carbon offsets undergo third-party validation and verification. Learn more at www.nativeenergy.com.

Memorandum

To: NativeEnergy, AES

From: Tom Stoddard

Re: Palouse Project

Date: July 3, 2014

At issue is whether to validate and verify the Palouse Project under VCS or ACR. After further review of the ACR Standard and several ACR-approved methodologies that involve soil carbon sequestration, I recommend that we set up a call with the appropriate persons at ACR as soon as possible to confirm the conclusions tentatively reached below. Depending on the outcome of that call, which, for the reasons discussed below, I would anticipate being positive, I recommend modifying TEP's VCS methodology and submitting it to ACR for approval.

In our recent calls with VCS and with Shepherds' Grain, and from subsequent discussions among ourselves, my take away is that the Project as contemplated (as a VCS) project, faces the following principal barriers:

- A 30-year commitment to no-till will present a significant barrier to signing up new farmers, increasing the importance to the project economics of the accruals to be realized by the acreage currently in no-till.

- No "break point" can be documented at which the existing no-tillers switched from R&D to commercial implementation (to form the project start date), at least not within the last few years, which would be necessary to achieve validation within the 5-year deadline from the project start date. This puts no-till in the baseline, precluding crediting further accruals on acreage currently in no-till, leaving only accruals from the "plus" activities. I suspect, given their more recent implementation and more limited scope, confidence in the "doubling" of the no-till accrual rate from the plus activities is low at this point, which likely adds too much risk for NativeEnergy to employ Help Build™ in that context.

- Exclusion of current no-tillers from no-till accrual crediting presents a further barrier to signing up new farmers:
    - New farmers will have less confidence that they will actually receive carbon revenues if they can't see that other no-tillers are;
    - Current no-tillers will have no incentive to assist in the education and outreach needed to bring in new farmers at scale.

- VCS's requirement that the project proponent have the ability to control the use of the land for 30 years forces us, in likely many instances, to contract with non-farming landowners instead of just the farmers, in the context of leased land. Many such owners will likely have no understanding of the business of farming at all, let alone the specific impact on their ability to lease their land encumbered by a no-till condition. This will present further barriers to participation.

For these reasons the Project as a VCS project appears to be too small and too risky to pursue.

From my review of additional ACR materials, I can see a relatively clear path to overcoming each of these barriers by developing the Project as an ACR project. The relevant materials are the ACR Standard and two of the approved methodologies, discussed individually below:

- The ACR Standard. This is the overarching standard that applies to all project types using all approved methodologies.

    - The ACR standard does not have a blanket minimum time commitment for all AFOLU project types, as VCS does. Rather, it deals with permanence issues entirely through the buffer. The expected length of time accrued soil carbon would remain in the ground would be, in the Project's case, determined *ex ante* based on the conservatively estimated probability of reversion to tillage and would simply drive the percent of credits to be placed in the buffer. As discussed below, there may be a path to accounting for the expected durability (repetition) of any reversion to tillage, which would present an opportunity to reduce that percent. The absence of a minimum time commitment would allow us to propose a project crediting period length that suits this project type, and could potentially permit our contracts with the farmers to allow reversion to tillage in their discretion.

    - The ACR Standard does not require the project proponent to have control over the use of the project acreage at all, let alone for 30 years. It simply requires the project proponent to have the rights to the reductions/accruals produced from the project activity. This would eliminate the need to contract with non-farming landowners.

    - The ACR Standard does not employ the "Grouped Project" concept that VCS forced us to use due to the requirement that the project proponent have control of the land. Under ACR, NE/AES could be the project proponent, and the farmers simply "other project participants." The "Grouped Project" structure is a major part of what drives out the current no-tillers from crediting of further no-till accruals – under VCS the baseline is established based on the pre-project conditions of each farm within the group. Under ACR, this would be all one project – "Improved Crop Farming Practices in the Palouse" – and that project would have a single baseline of the current average rate of soil carbon accrual (loss?) resulting from crop farming in the Palouse. Existing no-tillers would get no credit for prior accruals (and those accruals would serve to raise the average for the baseline), but they could then get credit for all further accruals in excess of that baseline.

- As with the baseline, VCS additionality testing for a grouped project is at the project activity level, so each farm included at the time of validation would have to be independently demonstrated as additional. The ACR Standard is much more flexible, designed to increase certainty for project proponents and more efficient project implementation, to produce more projects more quickly. ACR employs two alternative tests for additionality. The first is a simple three-prong test: Is the project/activity above and beyond what is required by law (surplus to regulations), is it common practice, and does it face one or more of financial, technological or institutional barriers. My understanding is that the Palouse Project is surplus to regulations, is not common practice, and faces all three such barriers, and as such would be deemed additional. The second is a performance standard approach. The approach simply asks whether the project achieves a level of performance that is significantly better than average for similar activities (tillage farming) in a geographic area. The approach does, however, require a few specifics to be added to the applicable methodology, which I don't expect to be a problem for us.

- Grazing Land and Livestock Management GHG Methodology. This methodology is helpful in that it involves the quantification of accrued soil carbon (in its terminology, "enhanced biotic sequestration"), and is accompanied by a module for quantifying it. Some aspects of it are potentially problematic, however. On the helpful side:

  - It expressly employs the "program of activities" concept we would be using, providing pre-approved methodology components we could incorporate (or borrow selectively from) into our proposal.
  - It expressly allows early adopters, and clearly articulates strong policy reasons for their inclusion – <u>which will be very helpful</u> in pushing back on the inevitable "this is just like CCX" criticism. Among the policy reasons is their inclusion helps foster the spread of the activity to new adopters. As such, if the adoption rate is <5%, early adopters can use the average baseline discussed above, but, if after 10 years the adoption rate is not >5%, inclusion of the early adopters is deemed not to have "worked," and the crediting period cannot be renewed.

  On the problematic side, this methodology requires both a 40 year crediting period and a 40-year minimum term for project continuance, monitoring and verification. However, given the provisions in the Compost Additions to Grazed Land methodology discussed below, we may not need to get each farmer to agree to a 40-year commitment – just ourselves as the project proponents.

- GHG Emissions Reductions from Compost Additions to Grazed Land Methodology. This methodology is helpful in that it permits carbon losses from tillage events within the project to be accounted for and compensated by retiring existing credits from the project. If such a true-up occurs, the acreage on which the tillage event occurs is not precluded from continuing in the project. This gives the farmer the opportunity to earn and give back to the project the amount of credits retired to compensate for its tillage event. Essentially, this ACR precedent would allow us to rely on the practical impediments to reversion to tillage farming and not require any long-term commitment from farmers.

From: Chambers, Adam - NRCS, Portland, OR [mailto:Adam.Chambers@por.usda.gov]
Sent: Monday, December 23, 2013 3:43 PM
To: Steven I. Apfelbaum
Cc: Roscoe, Jacqueline - NRCS, Washington, DC; Leonard, Sheila - NRCS, Washington, DC; Campbell, Steve - NRCS, Portland, OR
Subject: Documentation Request - AEP CIG
Importance: High

Dear Mr. Apfelbaum,

As you are aware, NRCS has learned that one or more of the matching components (cash and in-kind) for the Conservation Innovation Grant (CIG) titled "*Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region*" are in jeopardy of not materializing. NRCS would like to work with you and your project team to reconcile these matters and identify an appropriate route forward. As a first step, NRCS would like you to produce a **comprehensive overview** of the financial components of this CIG project through December 31, 2014. Please submit this summary to me **on or before January 15, 2014**.

Below I have pasted the comprehensive budget information from the CIG's project description. In the requested summary we are asking you to provide a thorough and detailed status update of every component, including cash received from EKO, AES/TEP in-kind statements, Shepherd's Grain contributions, and contributions from Dr. R. David Hammer. For cross-referencing purposes, we would also like you to provide a comprehensive summary of USDA cash received. At this time we do not need additional information on potential and/or emerging funding opportunities, the focus of this submission should remain on realized and expended matching resources.

Budget Information

Party	Year 1	Year 2	Year 3	Total	% of to
USDA cash	$196,000	$329,000	$25,000	**$550,000**	50.
EKO cash	$40,000	$180,000	$80,000	**$300,000**	27.
AES/TEP in-kind	$112,500	$45,000	$47,500	**$205,000**	18.
Shepherd's Grain	$22,000	$12,000	$6,000	**$40,000**	3.
Dr. R. David Hammer	$3,000	$2,000	$0	**$5,000**	0.
Total	**$373,500**	**$568,000**	**$158,500**	**$1,100,000**	100.

If you have any questions, please don't hesitate to contact me. **However, we ask that you please submit the requested information on or before January 15th, 2014.**

Regards,
Adam

Adam Chambers, Ph.D.
Physical Scientist, Air Quality and Atmospheric Change Team
USDA-NRCS West National Technology Support Center

1201 NE Lloyd Blvd., Suite 1000
Portland OR 97232-1202
ph. 503.273.2410 fax: 503.273.2401
email: adam.chambers@por.usda.gov

This electronic message contains information generated by the USDA solely for the intended recipients. Any unauthorized interception of this message or the use or disclosure of the information it contains may violate the law and subject the violator to civil or criminal penalties. If you believe you have received this message in error, please notify the sender and delete the email immediately.

Applied Ecological Services, Inc.
GHG-CIG Contract #69-3A75-11-131
Comprehensive Budget Overview
January 10, 2014

	Year 1		Year 1	Year 2		Year 2	Year 3		Year 3	TOTAL		TOTAL
Party	**Budget**	**Actual**	**Variance**	**Budget**	**Actual**	**Variance**	**Budget**	**Actual**	**Variance**	**Budget**	**Actual**	**Variance**
USDA Cash	$ 196,000	$ 411,785	110%	$ 329,000	$ 138,215	-58%	$ 25,000	$ -	-100%	$ 550,000	$ 550,000	0.00%
EKO Cash	$ 40,000	$ -	-100%	$ 180,000	$ -	-100%	$ 80,000	$ -	-100%	$ 300,000	$ -	-100%
AES/TEP In-Kind	$ 112,500	$ 102,142	-9%	$ 45,000	$ 98,017	118%	$ 47,500	$ -	-100%	$ 205,000	$ 200,159	-2.36%
Shepherd's Grain	$ 22,000	$ 31,875	45%	$ 12,000	$ -	-100%	$ 6,000	$ -	-100%	$ 40,000	$ 31,875	-20.31%
Dr. R. David Hammer	$ 3,000	$ 24,000	700%	$ 2,000	$ -	-100%	$ -	$ -	N/A	$ 5,000	$ 24,000	380.00%
TOTAL	**$ 373,500**	**$ 569,802**		**$ 568,000**	**$ 236,232**		**$ 158,500**	**$ -**		**$ 1,100,000**	**$ 806,035**	

NOTE: ***Reporting years adjusted slightly to follow calendar months for reporting***
Year 1: August 2011 - June 2012
Year 2: July 2012 - June 2013
Year 3: July 2013 - June 2014

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
P.O. Box 2890
Washington, D.C. 20013

February 11, 2014

Mr. Steven Apfelbaum
Applied Ecological Services, Inc.
17921 Smith Road
Post Office Box 256
Brodhead, Wisconsin 53520

RE: Grant NRCS 69-3A75-11-131

Dear Mr. Apfelbaum:

This letter is to inform you that the U.S. Department of Agriculture, Natural Resources Conservation Service has completed a review of the above reference grant. The review identified numerous deficiencies for project deliverables/products. Project deliverables are specified in the project description, section H, pages 13 and 14 of the award document. Below are NRCS' findings as of February 4, 2014:

1. Deliverable 1 - Detailed maps for the Palouse region including soil carbon levels, soil types, moisture, and other landform data.

   Incomplete - NRCS received a point shapefile of the project's soil sample locations in July 2013. There are 710 soil sample locations in Idaho, Oregon, and Washington. To date NRCS have not received any maps of soil carbon levels other than point data soil sample locations; or maps of soil types, moisture, and other landform data.

2. Deliverable 2 –Report containing the results from sampling the Palouse (raw data), baseline and projected soil carbon accruals under various scenarios, and a comparative analysis of alternative carbon accrual estimations methods.

   Partially Complete - NRCS received an Excel spreadsheet file that contains organic carbon lab analyses and calculated carbon stocks in units of kilograms per square meter to a depth of 80 cm for the 710 sample points described in item 1 above and an electronic document entitled ***Soil Carbon Final Report*** in July 2013 prepared by Kevin Little and Lynda Finn with *Informing Ecological Design, LCC;* Madison, WI.

   This report provides information on statistical analyses done on the soil carbon laboratory point data. Measured carbon levels were statistically compared with average precipitation, average annual air temperature, slope gradient and position, aspect, curvature, topographic wetness index, and number of years under no-till management.

A linear model was developed that predicts soil carbon accrual as a function of years of no-till management. The model only applies to areas within the Palouse that receive mean annual precipitation above 30-year median levels, on slope positions upslope from the toeslope.

3. Deliverable 3 –Report on the macro-level regional benefits form soil carbon improvement practices in Palouse (GHG emissions reductions, water quality and wildlife habitat enhancements, etc).

   Incomplete - A report specifically addressing the macro-level regional benefits from soil carbon improvement practices has not been received.

4. Deliverable 4 –Template of the Project Design Document for carbon transactions delivered to the marketplace, and lessons learned from engaging different carbon registries.

   Incomplete - A Project Design Document template has not been delivered to the marketplace. Carbon registries have not been engaged.

5. Deliverable 5 – Report on lessons learned from the aggregation effort including options on organizational structures for the low cost aggregation of landowners (associations, co-ops, etc) and best practice partnership structures that incentivize producer participation.

   Complete - The Applied Ecological Services Semi-Annual Progress Report No. 4 (Jan 1-June 30, 2013) contains a "Lessons Learned" report in Appendix G that addresses the issues in Item 5 above.

6. Deliverable 6 – Report on lessons learned from developing the liver farm field activity web site for farmer use for annually recording tillage, fertilizer, yields, residue management, among other variables.

   Incomplete - NRCS has not received.

7. Deliverable 7 – Report with information and costs estimates on implementing the TEP Soil Carbon Methodology, including GIS analysis, stratification, and sampling best practices and lessons learned from monitoring, reporting and verification (MRV)-i.e., "New technology and innovative approach fact sheet.

   Complete - The Applied Ecological Services Semi-Annual Progress Report No. 4 (Jan 1-June 30, 2013) contains a "Lessons Learned" report in Appendix G that addresses the issues in Item 7 above. Applied Ecological Services did produce a fact sheet and "Frequently Asked Questions" document that address the fact sheet deliverable in item 7 above.

8. Deliverable 8 – Informational brochure about the project for sharing through NRCS, farm agencies, and for direct mailing to farmers, including an expository and graphic documentation of the relationship between no-till, soil carbon improvements and potential economic returns under various scenarios, and an assessment of application to other regions and ecosystems.

   Complete - Applied Ecological Services did produce a fact sheet and "Frequently Asked Questions" document that address the deliverables in item 8 above.

9. Deliverable 9 – Participation in an USDA/NRCS event to brief attendees on program outcomes and expansion opportunities.

   Complete - Representatives from Applied Ecological Services and The Earth Partners made presentations on the Palouse Soil Carbon Project at agricultural producer meetings in the Palouse and at the Pacific Northwest Direct Seed Association Conference in 2013. NRCS representatives attended these meetings.

10. Deliverable 10 – Semi-annual and final reports.

    Up-to-date - All semi-annual and annual reports have been received to date. Grant does not expire until July 31, 2014.

11. Deliverable 11 – Supplemental narratives to explain and support payment requests.

    Complete - Applied Ecological Services has provided spreadsheets that summarize budgets and payments received. These are also addressed in the annual and semi-annual reports.

The project period for the above award is August 1, 2011, through July 31, 2014. Please provide NRCS with the missing deliverables and/or the estimated due date when they will be received no later than March 14, 2014. Failure to submit the required deliverables can result in your organization failing to comply with the terms and conditions of the grant. Failure to comply with the terms of the grant can result in NRCS terminating the grant and apply remedies for non-compliance and request recovery of any Federal funds that could be disallowed in accordance with 2 Code of Federal Regulations, Part 215.60 and 215.72.

Please submit required information to: Grants and Agreements, Office of the Chief Acquisition Officer, Room 5221 South Building, Post Office Box 2890, Washington, D.C. 20013-2890 or via email to sheila.leonard@wdc.usda.gov.

Please reference the NRCS agreement number in any future correspondence pertaining to this agreement.

Sincerely,

SHEILA LEONARD, CGMS
Supervisory Grants Management Specialist
Grants and Agreements
Office of Chief Acquisition Officer

cc:
Gregorio Cruz, Program Manager, Conservation Innovation Grants, Washington, DC
Adam Chambers, NRCS, Portland, Oregon
Steve Campbell, NRCS, Portland, Oregon

March 14, 2014

Sheila Leonard, CGMS
Supervisory Grants Management Specialist sheila.leonard@wdc.usda.gov
Grants and Agreements
Office of Chief Acquisition Officer
Room 5221 South Building, Post Office Box 2890
Washington, DC 20013-2890

RE: USDA NRCS Contract Review Findings (February 4, 2014) for GRANT NRCS 69-3A75-11-131

Dear Sheila:

AES and partners have been grateful for the USDA, NRCS support of this grant and we have made significant success in achieving the goals and deliverables we sought to deliver in our proposal dated February 1, 2011, in response to Program Announcement USDA-NRCS-NHQ-11-02. It was this proposal that became an attachment to the referenced Grant Agreement/Contract #69-3A75-11-131.

Thank you for completing the review of the project deliverables/products and providing clarity on the deficiencies that NRCS has identified. It is our intent to comply with the assessment of the NRCS Grants and Agreements Office and meet or exceed all deliverables/products originally proposed. After each NRCS finding below, we have provided a response outlining any additional details on how we will approach the outstanding deliverable and a proposed schedule for submission to NRCS. We anticipate that we will need additional time beyond the current project end date of July 31, 2014 to complete the outstanding deliverables as outlined below.

AES requests a no-cost extension for twelve (12) months to complete the outstanding deliverables, pursuant to Section IV. Prior Approval Requirements, Item e. (No-Cost Extensions of Time) of USDA-NRCS General Terms and Conditions for Grants and Cooperative Agreements. Please notify us if a separate written request letter is necessary that addresses the required information, including: length of time requested and justification, summary of progress, estimate of funds, schedule, signatures, and a status of cost sharing to date.

Our preliminary response to each of the items, and a plan of action, is provided in the following section.

1. **Deliverable 1 – Detailed maps for the Palouse region including soil carbon levels, soil types, moisture, and other landform data.**

Incomplete – NRCS received a point shapefile of the project's soil sample locations in July 2013. There are 710 soil sample locations in Idaho, Oregon, and Washington. To date NRCS has not received any maps of soil carbon levels other than point data soil sample locations; or maps of soil types, moisture, and other landform data.

RESPONSE:

AES has provided in semi-annual reports, maps of all sampling points, tabulations of all carbons sampling results at each sample point, and has also been sent maps of soils types, climatic zone and soil moisture and other landform stratification data and mapping. Numerous map sets were sent via the required semi-annual report process to Gregorio Cruz and Steve Campbell in reports delivered on January 31, 2012 (covering August – December 2011) and July 31, 2012 (covering January – June 2012).

A more complete set of maps generated during the course of the project has been assembled and will be provided on a CD-ROM with a hardcopy version of this letter sent to all recipients.

We believe that this task will be complete with the provision of these maps.

2. **Deliverable 2 – Report containing the results from sampling the Palouse (raw data), baseline and projected soil carbon accruals under various scenarios, and a comparative analysis of alternative carbon accrual estimations methods**

Partially Complete – NRCS received an Excel spreadsheet file that contains organic carbon lab analyses and calculated carbon stocks in units of kilograms per square meter to a depth of 80 cm for the 710 sample points described in item 1 above and an electronic document entitled ***Soil Carbon Final Report*** *i*n July 2013 prepared by Kevin Little and Lynda Finn with *Informing Ecological Design, LLC,* Madison, WI

This report provides information on statistical analyses done on the soil carbon laboratory point data. Measured carbon levels were statistically compared with average precipitation, average annual air temperature, slope gradient and position, aspect curvature, topographic wetness index, and number of years under no-till management.

A linear model was developed that predicts soil carbon accrual as a function of years of no-till management. The model only applies to areas within the Palouse that receive mean annual precipitation above 3-year median levels, on slope positions upslope from the toeslope.

RESPONSE:

Deliverable 2 has been submitted to NRCS in the semi-annual reports on June 13, 2013 (covering July – December 2012) and September 17, 2013 (covering January – June 2013). This has been presented as: a) results of sampling the Palouse (raw data), and a detailed statistical analysis report that provides the baseline projected soil carbon accruals under existing baseline conditions scenarios. The modeling and projections tested soil carbon accrual signals in different moisture zones and found a stronger signal in meteorological zones with greater than sixteen (16) inches of precipitation but also defined the lower levels of soil carbon accruals found in lower moisture zones. If your technical persons want us to take them through the previous submittals, please do let us know.

The final portion of this deliverable regarding the "comparative analysis of alternative carbon accrual estimation methods" has not been completed. It was scheduled to occur during Phase II of the project, which has been impacted by the departure of the original cash match partner from the project. We intend to complete this task during spring, 2014 and anticipate this report comparing alternative carbon accrual estimation methods will be provided to NRCS staff during the next semi-annual report covering Jan-June 2014.

We envision this deliverable including a brief report and literature review that documents alternative carbon accrual estimation methods currently in use, including:

- Description and analysis of the reference area analysis approach used for the Palouse Soil Carbon project;
- Description and analysis of modeling approaches currently in use with book values and sampling data, including COMET-FARM™ and others;
- Description and analysis of the sampling based approaches developed for Alberta's carbon offset program; and
- Additional methods recommended after further discussions with NRCS Technical Staff.

3. Deliverable 3 – Report on the macro-level regional benefits form soil carbon improvement practices in Palouse (GHG emissions reductions, water quality and wildlife habitat enhancements, etc.)

Incomplete – A report specifically addressing the macro-level regional benefits from soil carbon improvement practices has not been received.

<u>RESPONSE:</u>

We have begun drafting a brief report on some of the key macro-level regional benefits associated with the soil carbon management practices we have measured in the Palouse. This briefing report has not been completed and will be completed within a period of 60 days and submittal with the semi-annual report covering January – June 2014 (due in July 2014).

The final portion of this deliverable regarding the "comparative analysis of alternative carbon accrual estimation methods" has not been completed. It was scheduled to occur during Phase II of the project, which has been impacted by the departure of the original cash match partner from the project. We intend to complete this task during spring, 2014 and anticipate this report documenting macro-level regional benefits will be provided to NRCS staff during the next semi-annual report covering Jan-June 2014.

We envision this deliverable including a brief report and literature review that documents the macro-level regional benefits from soil carbon improvement practices currently in use in the Palouse and Columbia Plateau, including: reduced-till and no-till agriculture, cover crops, reduced anhydrous ammonia fertilizer use, and alternative fertilizer formulations. The scope of these benefits will include both agricultural/on-farm and off-site/regional/societal benefits. As described in the proposal, these benefits will broadly include: air quality benefits, water quality and hydrology benefits, soil health benefits, and wildlife benefits.

4. **Deliverable 4 – Template of the Project Design Document for carbon transactions delivered to the marketplace, and lessons learned from engaging different carbon registries.**

Incomplete – A Project Design Document template has not been delivered to the marketplace. Carbon registries have not been engaged.

RESPONSE:

AES has not yet completed a Project Design Document (PDD) for the Palouse Soil Carbon project. It was scheduled to occur during Phase II of the project, which has been impacted by the departure of the original cash match partner from the project. We intend to complete this task during the remainder of 2014 and anticipate providing this document in late 2014 / early 2015, provided a no-cost extension requested by AES is granted by NRCS.

AES has begun populating the Verified Carbon Standard (VCS) Project Design Document Template (v3.2) with the project-related details and technical findings that would be required for a market transaction. With The Earth Partners Soil Carbon Quantification Methodology approved through VCS in 2012 (VM0021), the Palouse project would be developed to meet the VCS project requirements and validated through VCS process.

To date, AES has been in discussions and engaged with other carbon registries and offset buyers, including The Climate Trust and American Carbon Registry among others, around the possibility of doing a transaction with the findings from the Palouse project. The Lessons Learned document (as discussed in Deliverable 5) was informed by the conversations with these registries and carbon offset buyers.

The above-referenced template for the PDD has been submitted on a CD-ROM with a hardcopy of this response letter. We anticipate continuing the process of writing, submitting and validating the PDD during the remainder of 2014. As described above, we would anticipate providing this document in late 2014 / early 2015, provided a no-cost extension requested by AES is granted by NRCS.

5. **Deliverable 5 – Report on lessons learned from the aggregation effort including options on organizational structures for the low cost aggregation of landowners (associations, co-ops, etc.) and best practice partnership structures that incentivize producer participation.**

Complete – The AES Semi-Annual Progress Report No. 4 (Jan 1 - June 30, 2013) contains a "Lessons Learned" report in Appendix G that addresses the issues in Item 5 above.

RESPONSE:

We agree that Deliverable 5 is complete.

6. **Deliverable 6 – Report on lessons learned from developing the live farm field activity web site for farmer use for annually recording tillage, fertilizer, yields, residue management, among other variables.**

Incomplete – NRCS has not received.

RESPONSE:

The report on lessons learned from developing a live farm field activity website has not been completed. Development of the website was scheduled to occur during Phase II of the project when a carbon transaction is in process, which has been impacted by the departure of the original cash match partner from the project. We intend to complete this task during the remainder of 2014 and anticipate providing this deliverable in late 2014 / early 2015, provided a no-cost extension requested by AES is granted by NRCS.

AES has given considerable thought to the content required and structure for a live farm field activity website. We've had initial conversations with the farmer group about the use of a website for documenting their field by field activities. However, we have not developed a live website during Phase 1 of this program for a few reasons:

- *Information Technology* – The world of information technology has continued to evolve rapidly since the project was proposed in early 2011. There may be a suite of off-the-shelf products, or an already developed custom product that could serve this purpose and alleviate the need to develop a custom solution with a software or web developer.
- *Budget* – It is now believed that the $20,000 originally proposed for this task may not be sufficient to develop a custom website that meets the requirements necessary for the project, namely data security and user-friendly interface for farmer/producer use.

In partnership with NRCS, we'd like to explore whether existing, appropriate solutions may be available for use. Two possibilities that come to mind include COMET-FARM^{TM} and custom database solutions developed by other carbon offset aggregators/project developers.

- The COMET-FARM^{TM} tool has been improved and standardized through a coordinated effort with NRCS, Colorado State University, several technical partners and, to an extent, some of the GHG-CIG projects. Through the USDA's process of developing its Greenhouse Gas Methods report, I understand it has been determined that the COMET-FARM^{TM} tool will be the primary tool supported and promoted by USDA's various agencies, including the NRCS, and is expected to be supported as the science evolves.
- Our project team has had preliminary conversations with two private parties about the suitability of their database systems: Key-Ag Services and Carbon Credit Solutions, Inc.
    - Key-Ag Services from Illinois has developed a web-based interface for farmers to access maps of their fields for analysis of soil sampling data and record field history and management activities. These conversations are very preliminary, however, we believe there may be an opportunity to leverage their experience and expertise to develop and customize a solution for our soil carbon project.

- Carbon Credit Solutions from Alberta, Canada has developed a SQL database for the record keeping associated with aggregating and transacting greenhouse gas offset projects in Canada. Though these conversations are preliminary, there is mutual interest in exploring the option of licensing this product for use by project developers in the US. With modifications to the code and database structure, and perhaps the addition of a web user-interface, this database could be suitable for use with the Palouse Soil Carbon project.

As stated above, we believe that there may be existing tools that would better serve the project than developing a custom solution. In partnership with NRCS, we'd like to further evaluate the options available to meet the requirements of this deliverable, as well as the needs of the project.

7. Deliverable 7 – Report with information and costs estimates on implementing the TEP Soil Carbon Methodology, including GIS analysis, stratification, and sampling best practices and lessons learned from monitoring, reporting and verification (MRV) – i.e., "New technology and innovative approach fact sheet.

Complete – The Applied Ecological Services Semi-Annual Progress Report No. 4 (Jan 1 – June 30, 2013) contains a "Lessons Learned" report in Appendix G that addresses the issues in Item 7 above. Applied Ecological Services did produce a fact sheet and "Frequently Asked Questions" document that address the fact sheet deliverable in item 7 above.

<u>RESPONSE:</u>

We agree that Deliverable 7 is complete.

8. Deliverable 8 – Informational brochure about the project for sharing through NRCS, farm agencies, and for direct mailing to farmers, including an expository and graphic documentation of the relationship between no-till, soil carbon improvements and potential economic returns under various scenarios , and an assessment of application to other regions and ecosystems.

Complete – Applied Ecological Services did produce a fact sheet and "Frequently Asked Questions" document that address the deliverables in item 8 above.

<u>RESPONSE:</u>

We agree that Deliverable 8 is complete.

9. Deliverable 9 – Participation in an USDA/NRCS event to brief attendees on program outcomes and expansion opportunities.

Complete – Representatives from Applied Ecological Services and The Earth Partners made presentations on the Palouse Soil Carbon Project at agricultural producer meetings in the Palouse and at the Pacific Northwest Direct Seed Association Conference in 2013. NRCS representatives attended these meetings.

RESPONSE:

We agree that Deliverable 9 is complete.

10. Deliverable 10 – Semi-annual and final reports

Up-to-date – All semi-annual and annual reports have been received to date. Grant does not expire until July 31, 2014.

RESPONSE:

We agree Deliverable 10 is up to date and that all semi-annual and final reports due to NRCS have been provided.

11. Deliverable 11 – Supplemental narratives to explain and support payment requests.

Complete – Applied Ecological Services has provided spreadsheets that summarize budgets and payments received. These are also addressed in the annual and semi-annual reports.

RESPONSE:

We agree that Deliverable 11 is complete.

During February 2013, AES provided notice to USDA-NRCS that its cash match partner on the project, EKO Asset Management Partners, planned to terminate its involvement with the project. Since that time, AES has been in pursuit of an alternative partner for this commitment and have had many discussions with potential partners and/or offset buyers. We want to inform USDA-NRCS that we are completing the due diligence steps necessary to engage a new cash match partner, Native Energy, LLC, in the Palouse Soil Carbon project. Over the next 45 days, we anticipate the due diligence process will be complete and we will focus our joint efforts on completion of the outstanding deliverables, as detailed above.

Since Dan Lukash notified us in May 2012 that he was no longer with NRCS, we believe we've been without a designated administrative contact for our grant agreement. As a result, we've experienced some challenges in communicating with administrative staff on the challenges and changes we've experienced with our grant. We have had some difficulty in understanding the lines of communication with administrative staff on this project, though we've had very good communications with the technical staff (Steve Campbell, Adam Chambers and others), as well CIG program staff (Gregorio Cruz). We welcome your advice and preference on the most appropriate and best way to communicate on these critical grant items moving forward. We hope to mutually agree on how this can be resolved so it doesn't add an unnecessary level of complexity as we seek to successfully close out the project in the coming 12-15 months.

In summary, we will continue to pursue the substitute source of funding, as outlined above. In the meantime, we will continue to resolve the outstanding deliverables as proposed in the responses above. We respectfully request a decision and response on our request for a no-cost extension for the project, as detailed above. If additional information is required (standalone request or contract modification documents), please let us know and we will provide those as soon as we're able.

If you have any further questions about the contents of this response letter, please do not hesitate to contact us.

Sincerely,

Steve Apfelbaum

Project Director
Applied Ecological Services, Inc.

Ry Thompson

Project Manager
Applied Ecological Services, Inc.

cc:
Steve Campbell, Technical Adviser, NRCS, Portland, Oregon
Adam Chambers, Air Quality Program, NRCS, Portland, Oregon
Gregorio Cruz, Program Manager, Conservation Innovation Grants, NRCS, Washington, DC

April 4, 2014

Mr. Steven Apfelbaum
Applied Ecological Services, Inc.
17921 Smith Road
Post Office Box 256
Brodhead, Wisconsin 53520

RE: Grant NRCS 69-3A75-11-131

Dear Mr. Apfelbaum:

Your letter dated March 14, 2014, acknowledging the NRCS review of the project deliverables and products and requesting a no-cost extension for twelve months has been received. Before consideration can be given to the no-cost extension request, a written verification from the new partner depicting their financial commitment and involvement towards the completion of the project is required.

The Conservation Innovation Grant (CIG) is authorized as part of the Environmental Quality Incentives Program (EQIP) [16 U.S.C. 3839aa-8] under section 1240H of the Food Security Act of 1985. In the 2011 CIG funding opportunity announcement, Section III., Eligibility Information, explains the 50 percent matching funds requirement. It also provides guidance on the type (cash and in-kind) and the percentage of the match that is to be considered as contribution. Further it requires that applications include written verification of commitments of matching support (including both cash and in-kind contributions) from third parties.

In order to remain in compliance with the terms and conditions of this award please provide documentation from the anticipated new partner on the cash match for this grant by April 18, 2014. Once verification is received a determination will be made on the no-cost extension request.

If verification cannot be provided by April 18, 2014 NRCS will proceed with processing the termination of this grant for non-compliance on the basis the matching funds requirement was not met. A reimbursement will be calculated for the NRCS over-the-match amount that was received and expended by Applied Ecological Services.

According to the General Terms and Conditions, Section XIV, Modifications and Terminations, "This award is subject to termination if NRCS determines that the recipient has failed to comply with the terms and conditions of the award. In the event that the award is terminated, the financial obligations of the parties will be those set for the in 7 CFR Part 3015, Subpart N."

You may submit the required documentation to the address below with attention to: Grants and Agreements, Office of Chief Acquisition Officer, Room 5221 South Building or via email to Sheila.leonard@wdc.usda.gov.

Please reference the NRCS agreement number in your response.

Respectfully,

SHEILA LEONARD, CGMS
Supervisory Grants Management Specialist
Grants and Agreements
Office of the Chief Acquisition Officer

Cc:
Gregorio Cruz, Program Manager, Conservation Innovation Grants, Washington, DC
Adam Chambers, Air Quality Program, NRCS, Portland, Oregon
Steve Campbell, Technical Liaison, NRCS, Portland, Oregon

April 18, 2014

Mr. Steven I. Apfelbaum,
Chairman/Senior Ecologist
Applied Ecological Services, Inc.
17921 Smith Road
PO Box 256
Brodhead, Wisconsin 53520

RE: Commitment to Applied Ecological Services, Inc. for CIG-GHG 2011 proposal - "Agricultural Soil Carbon Demonstration with PNDSA and Shepherd's Grain in the Palouse Ecosytem"

Dear Mr. Apfelbaum

This letter summarizes NativeEnergy, Inc.'s pledged match that is committed to Applied Ecological Services, Inc. (AES) Conservation Innovation Grant 2011 Greenhouse Gas proposal – "Agricultural Soil Carbon Demonstration with PNDSA and Shepherd's Grain in the Palouse Ecosytem". The pledge commitment is outlined as follows, and is definitively set forth in the Project Development and Funding Agreement delivered to you by NativeEnergy on April 17, 2014:

1. **Contributor Organization**:

Name	NativeEnergy, Inc.
Address	3 Main St., Suite 212
City, State	Burlington, VT 05401
Phone No.	802-861-7707

2. **Applicant Organization:**
   Applied Ecological Services, Inc. (AES)
   17921 Smith Road, PO Box 256
   Brodhead, WI 53520
   (608) 897-8641

3. **Title of Project:**
   "Agricultural Soil Carbon Demonstration with PNDSA and Shepherd's Grain in the Palouse Ecosytem"

4. **Cash Contribution Amount:**
   $300,000 as presented in the budget for the referenced project.

5. **Contribution Statement:**
   It is agreed that the donor will pay the cash contribution during the grant period as presented in the referenced proposal and on and subject to the terms and conditions set forth on the Appendix to this letter.

This letter agreement is proposed to fulfill the already agreed on scope and tasks in the contract between AES, Inc and USDA/NRCS, and as such no change in the budget from what has been approved by USDA in the awarded Conservation Innovation Grant 2011 to AES, Inc.

Approval and authorization:

Contributor Organization

by:

Jeffery Bernicke, President

NativeEnergy, Inc.

Applicant

by:

Steven Apfelbaum, Chairman/Senior Ecologist

Applied Ecological Services, Inc.
17921 Smith Road, PO Box 256
Brodhead, Wisconsin 53520

APPENDIX

1. Project Development Funding. NativeEnergy shall pay to AES $300,000, to be used by it as was contemplated for the same amount previously to have been supplied by EAM under the Project Budget. NativeEnergy shall pay the foregoing amount in increments to AES as follows:

a. Upon receipt of a copy of each invoice received by AES for Validation and/or Verification services provided by the party performing the Validation and or the first Verification; in the invoiced amount;

b. Upon delivery by NativeEnergy of each invoice to AES for Project development services provided by NativeEnergy, in the invoiced amount;

c. Upon completion of the Project Validation, 33% of the remainder; and

d. Upon completion of the first issuance of VERs in an amount indicating that the Project is expected to produce more than 100,000 VERs per year, the entirety of the remainder.

2. Notwithstanding the foregoing, NativeEnergy shall have no obligation to cause the Project to be Validated and shall be entitled to terminate this Agreement if, based on the number of acres on which Project Activity(ies) will be conducted by farmers who have signed Definitive Farmer Agreements, or for any other reason, at the time the Project Description would otherwise be submitted for Validation, NativeEnergy has reasonable grounds to believe, and believes in good faith, that the Project cannot be expected to produce at least 100,000 VERs per year. In addition, NativeEnergy shall have no obligation to make either payment otherwise required pursuant to paragraphs c. and d. of Section 4, unless:

a. AES has at the time performed all of its obligations then required to have been performed by it under this Agreement;

b. AES has secured a No-Cost Extension of Time under the Grant Agreement that it reasonably acceptable to NativeEnergy;

c. all representations and warranties of AES set forth in this Agreement are at the time true, accurate and correct at the time; and

d. the Validation process and the Validation Report, and the state of Project Development confirm NativeEnergy's belief that the Project will produce more than 100,000 VERs per year.

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
P.O. Box 2890 – Room 5220-S
Washington, DC 20013

May 8, 2014

Mr. Steven Apfelbaum
Applied Ecological Services, Inc.
17921 Smith Road
Post Office Box 256
Brodhead, Wisconsin 53520

Dear Mr. Apfelbaum:

Reference is made to NRCS grant agreement 68-3A75-11-131, between Applied Ecological Services, Inc. and the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). This serves as an acknowledgement and acceptance of the commitment by NativeEnergy, Inc. to pledge the remaining match for the "Agricultural Soil Carbon Demonstration with PNDS and Shepard's Grain in the Palouse Ecosystem" CIG project.

Also, the request contained in your correspondence dated March 14, 2014, has been reviewed by this office. In accordance with paragraph IV., e., of the General Terms and Conditions of the agreement, NRCS approves your request for a no cost extension until July 31, 2015. This correspondence is hereby being made part of the original agreement and all other terms, conditions, and provisions thereto remain in full force and effect.

Please reference the above stated NRCS grant agreement number in any future correspondence pertaining to this agreement. If I can be of further assistance, please do not hesitate to contact me at Jacqueline.roscoe@wdc.usda.gov on (202) 690-4242.

Sincerely,

JACQUELINE ROSCOE HENRY
Grants and Agreements Specialist

cc:
Ry Thompson, Project Manager, Applied Ecological Services, Inc., Brodhead, WI
Adam Chambers, Air Quality Program, NRCS, Portland, OR
Sheila Leonard, Team Leader, Acquisitions Division, NRCS, Washington, DC

The Natural Resources Conservation Service provides leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment.

An Equal Opportunity Provider and Employer

Appendix I – Semi-Annual Report #7

Applied Ecological Services, Inc. (AES)
Semi-Annual Progress Report No. 7: July 1 – December 31st, 2014
USDA-NRCS CIG-GHG Project No. 69-3A75-11-131
January 31, 2015

PROJECT DESCRIPTION / ABSTRACT

Applied Ecological Services, Inc (AES) and *Native*Energy (NE) together (AES/NE) with others are working toward a large-scale agricultural carbon restoration project that includes Shepherd's Grain members and surrounding farmers located in the loess hills of the Palouse and Columbia Plateau region. Historic farming practices across the region have resulted in the near extinction of the native grasslands, serious soil losses, and degradation of hydrological resources.

Based on a variety of models derived from years of research along with additional sampling completed in 2009, AES/NE further developed and extrapolated models to fit a scale across the entire Columbia Plateau landscape. Utilizing a protocol under development through the American Carbon Registry, AES/NE has measured, monitored, and will have validated carbon credits stemming from carbon farming agricultural practices such as no-till, direct seeding, crop rotation, and improved soil management. This project demonstrates the role of carbon farming practices in greenhouse gas policy development as well as the importance of quantitative soil carbon methods that create compliance-grade offset credits. It also provides a roadmap for aggregating landowners across large areas at low cost. Ultimately the project could provide a model for marketing and monetizing agriculturally derived carbon credits. And, this will be one of the largest land-based carbon projects to date.

Project Outcomes:

- Scale-up the project by developing a carbon farming agricultural partnership with Shepherd's Grain and neighboring landowners across the Palouse and larger Columbia Plateau eco-region. The project can be scaled due to the robust analytic and technical methodologies (GIS mapping, stratification, soil sampling, model projections, etc.).
- Aggregate landowners using a model whereby landowners collaborate across large acreages at a relatively low cost, a feat that is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. Through relationship building with landowner, AES/NE will develop, test, and refine a low-cost aggregation model. To this end, AES/NE is building on previous experience in aggregating landowners, developing standard partnership structures, and streamlining landowner interactions and engagement.
- Model a successful land-based carbon transaction even though agricultural carbon credits cannot currently be monetized in the marketplace. This project seeks to ensure that credits derived from this project are acceptable in emerging compliance markets, as well as voluntary markets like VCS and ACR. To this end, AES/NE has developed a unique partnership of farmers, project developers, carbon investors, scientists, and government officials.
- Produce data, maps and templates to inform policy and support further research. AES/NE utilizes GIS landform and geomorphic modeling and mapping to design, evaluate, and implement regional, on-the-ground baseline analysis of soil carbon levels across the Palouse and Columbia Plateau eco-region. The data and map products represent integrated information heretofore lacking in the region, but useful for agricultural producers, government agencies, scientists, university researchers, and others.

SEVENTH SEMI-ANNUAL PROGRESS REPORT

1. USDA-NRCS CIG-GHG Project Number and Contract Period

69-3A75-11-131 – August 1, 2011 to July 31, 2015 (one-year no-cost extension granted 5/8/14)

2. Project Title

Developing a Large-scale Agricultural Soil Carbon Transaction in the Palouse Region

Project Director / Principal Investigator

Steven I. Apfelbaum, Chairman of the Board/Principal Ecologist, Applied Ecological Services, Inc.

3. Date of Report / Period Covered

January 31, 2015 for Report No. 7: July 1 – December 31, 2014

4. Executive Summary

During the second half of 2014, the Project Team made good progress on the following tasks:

- Task 1 – Business Origination with Shepherd's Grain – The team continued relationship building with Shepherd's Grain producers and collaborating on converting the partnership agreements to contracts with producers.
- Task 2 – Mapping, Screening and Stratification of the Palouse – Additional work was completed on the final component of Deliverable 1 – the map of Soil Carbon Levels, which is anticipated to be complete in early February.
- Task 3 – Sampling and Analysis using the TEP Methodology of the Palouse Region – No sampling or analysis activities occurred during this project period.
- Task 4 – Analysis and Baseline Development – Ongoing discussions on project sampling, analysis and baseline development continued with NativeEnergy as the project team drafted a new ACR methodology and Project Plan for the project.
- Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers – The team spent considerable time and effort drafting a letter / legal brief to the SEC to address concerns raised around grouped projects and SEC rules.
- Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members – Additional strategy sessions were held and a presentation/outreach to no-till producers at the PNDSA meetings was completed.
- Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members – The team continues to maintain focus on meeting the administrative components of the grant and cash match partner. During this reporting period, NativeEnergy and AES developed a new ACR methodology titled "Cropland Management Greenhouse Gas Mitigation Methodology" and began drafting a Project Plan for the Palouse Soil Carbon Project.
- Task 8 – Reporting and Knowledge Dissemination –Knowledge dissemination continues through negotiation with partners, including farmers and through attendance at appropriate meetings.

5. Proposed Changes requiring Prior Approval

In accordance with the Prior Approval Requirements outlined in Section IV of CIG Contract #69-3A75-11-131, the project team proposes the following modification:

- No modifications are proposed at this time.

6. Accomplishments

Task 1 – Business Origination with Shepherd's Grain

AES and *Native*Energy have continued to build on the relationships developed with Shepherd's Grain producers and neighboring producers. Ongoing coordination with the Shepherd's Grain management team continued through the project period to provide updates on project status and project challenges faced and seek technical information related to the conservation cropping activity necessary for development of a new methodology. Much of the collaboration emphasis during the reporting period was focused on finalizing the development of the Participant Solicitation document titled "*Soil Improvements with Reduced Tillage and Improved Fertility Management in the Palouse*", included as Appendix C. This farmer information piece focuses on the project requirements necessary to meet the ACR standards for a carbon project and will form the basis for a participation contract. Primary sections of the document include:

- Project History;
- Farm Benefits;
- Eligibility Requirements (Ownership/Control, Commitment to No-Till, and Financial & Management Plan);
- Farm Responsibilities (Access to Farm, Training, and Reporting);
- Estimated Project Revenues and Costs;
- Estimated Reduced Operations and Maintenance Savings;
- About AES; and
- About NativeEnergy.

After extensive discussions with Shepherd's Grain, this document has been finalized and is being used to convert the "enrollment agreements" into carbon "transaction agreements". During 2015, this document will be shared with all previously enrolled Shepherd's Grain farmers and with others discussed in Task 6. It will be used for engaging additional farmers in the CIG project/carbon transaction.

Task 2 – Mapping, Screening and Stratification of the Palouse

Additional work was completed on the Map of Soil Carbon Levels, an outstanding deliverable that is anticipated to be provided to USDA by email in February, 2015. An early draft is included as Appendix D, and a version was used at the Pacific Northwest Direct Seeding Association meeting in January, 2015. This map has interpretive information on soil carbon accruals within each of the primary climatic zones of interest. With the submission of the final map, we believe that all items associated with deliverable 1 are complete, per Ms. Sheila Leonard's project review letter, dated February 11, 2014.

Task 3 – Sampling and Analysis using TEP Methodology of Palouse Region

No sampling or analysis activities occurred during this project period.

Task 4 – Analysis and Baseline Development

Ongoing discussions on project sampling, analysis and baseline development continued with NativeEnergy as we cooperatively developed a new ACR methodology titled "Cropland Management Greenhouse Gas Mitigation Methodology" (Appendix J/K) and began drafting a Project Plan for the Palouse Soil Carbon project.

Project team members continued work on two outstanding deliverables (deliverables 2 and 3) highlighted in the February 11, 2014 project review letter, including:

- Summary report titled "Comparative Analysis of Alternative Carbon Accrual Estimation Methods"; and
- Summary report titled "Macro-level Regional Environmental, Economic and Societal Benefits from Soil Carbon Improvement Practices in the Columbia Plateau Eco-Region of Idaho, Oregon and Washington".

The working Table of Contents for these reports are included as Appendices E and F. Additional work will be completed on both of these reports in January and February, 2015. Both outstanding deliverables will be provided to USDA by email in February, 2015.

Task 5 – Deal Packaging for Shepherd's Grain and Surrounding Farmers

After a more detailed review of the aggregation model and project development model proposed on the Palouse soil carbon project, an attorney from *Native*Energy assessed the securities and exchange issues that could arise on the project. At the request of the SEC, Tom Stoddard (*Native*Energy attorney) prepared an initial letter explaining the project relationships and transaction details for the grouped project. The initial draft was reviewed by the SEC and it was advised that additional issues be addressed. A final version of the SEC letter and legal brief was submitted in January, 2015 after an investment of significant hours researching and drafting the briefs. In addition, slightly modified versions of the letter were submitted to each of the respective states where project participants are located, including Idaho, Oregon, and Washington. Communication with GHG CIG partners, including Ducks Unlimited attorneys, was made to discuss the issues raised by the SEC and how they were handled by other projects. It was determined that other projects likely did not raise or address the SEC concerns individually. The letters were provided to Adam Chambers, USDA-NRCS, in January, 2015 to share with internal USDA attorneys. It was agreed that further discussion, if necessary, would take place with Tom Stoddard prior to interagency discussions. The initial draft and final SEC letters are included in Appendix G.

Task 6 – Aggregation and Farmer Engagement beyond Shepherd's Grain and Surrounding Members

During the week of January 19, 2015, Steve Apfelbaum (AES) and Kirsten McKnight (*Native*Energy) attended the Pacific Northwest Direct Seed Association conference to present a talk and poster. During the conference Environmental Markets breakout session, Steve presented an overview of the Palouse Soil Carbon project. The presentation is included as Appendix H and a poster was shown during the poster session (Appendix I). The Palouse Soil Carbon Project (AES/*Native*Energy) was one of the sponsors for the conference and the project had a booth in the Exhibitor space to solicit additional farmers interested in participating in the program.

Over the course of the 2.5 day conference, Steve and Kirsten spoke to dozens of farmers from the 500 present who were very interested in the program. A total of 43 growers representing nearly 150,000 acres signed an information sheet requesting more information on eligibility and next steps after the conference. In addition, several farmers suggested the project team reach out to several large landowners not present at the conference to gauge their interest in participating in the program, including Whitman College, Nez Perce Tribe, and others. Additional outreach and contractual signup will be occurring concurrently with finalization of the new ACR methodology in 2015.

During the PNDSA meeting, Steve and Kirsten had the opportunity to meet with Shepherd's Grain leadership to strategize about the next steps for collaboratively scaling up acreage in the program.

Task 7 – Marketing and Monetization of Credits from Shepherd's Grain and Surrounding Members

During this reporting period, *Native*Energy and AES developed a new ACR methodology tentatively titled "Cropland Management Greenhouse Gas Mitigation Methodology" (Appendix J) and began drafting a Project Plan for the Palouse Soil Carbon project. The methodology was submitted to ACR in mid-November and reviewed internally by ACR staff. Comments were received in late December (Appendix K) that are currently being addressed in this next draft. The primary revisions to the methodology will: 1) simplify the method and focus only on the conservation cropping (no-till) activity; 2) refer by reference to activities covered in other ACR methodologies (e.g. N_20, CH_4, manure, etc.); and 3) include all components within the methodology, rather than proposing a modular methodology (e.g. VMD0021 Soil Carbon Quantification Methodology). It appears that ACR intends to expedite the review process.

With the new methodology, we believe the Palouse Soil Carbon project can proceed with a large landscape agricultural project in the Palouse region that includes some early adopters to participate in a project focused solely on the "conservation cropping activity" (no-till agriculture) through a performance based program.

Task 8 – Reporting and Knowledge Dissemination

Ongoing communications with USDA administrative and technical contacts continued during this reporting period to ensure all administrative and budget questions and issues are addressed for the CIG grant. A few highlights of these communications are included below:

- In fall 2014 and mid-January, 2015, Steve Apfelbaum, Tom Hunt and Ry Thompson of AES had a conference call with Steve Campbell and Adam Chambers to discuss the overall project status and anticipated next steps, including the need for development of an alternative soil carbon accrual methodology through the ACR.
- Steve Campbell has provided valuable feedback and technical information during fall 2014 by email as the project team was working through several technical issues related to no-till farming, changes in no-till technology and adoption and related matters.

7. Next Steps

As shown in the Updated Project Schedule with Milestones (Appendix B), the project schedule, out of necessity, has been adjusted. During the next semi-annual report period, AES will continue to work with *Native*Energy and Shepherd's Grain on the co-development of the project. As discussed in Task 7 above, AES is finalizing development of a modified version of its Soil Carbon Quantification Methodology focused on the conservation cropping (no-till) activity with ACR during the next reporting period. In parallel, AES, *Native*Energy and Shepherd's Grain will secure participation contracts with Shepherd's Grain and neighboring producers and finalize development of the Project Plan, in preparation for a market transaction.

8. Cost Status

See ***Appendix A – SF 425 Federal Financial Reports*** for the financials for this period.

Please note: The SF425 Federal Financial Reports do not reflect any changes since mid-2013, though hundreds of hours of work and thousands of dollars in expenses have been completed since this time. The contract with NativeEnergy has specific milestones for progress that must be met prior to billing. It is anticipated that the 2015 SF 425 FFRs will reflect the influx of cash match on the project.

9. Schedule/Milestone Status

A project schedule with milestones as completed for the project is presented in ***Appendix B – Updated Project Schedule with Milestones*** and extends the project tasks through July 31, 2015.

APPENDICES

Appendix A – SF425 Federal Financial Reports for July – December 2014
Appendix B – Updated Project Schedule with Milestones
Appendix C – Palouse Soil Carbon Participant Solicitation Document
Appendix D – Map of Palouse Soil Carbon Levels
Appendix E – Comparative Analysis of Alternative Carbon Accrual Estimation Methods Summary Report
Appendix F – Macro-level Regional Environmental, Economic and Societal Benefits from Soil Carbon Improvement Practices in the Columbia Plateau Eco-Region Summary Report
Appendix G – SEC Letters/Legal Briefs regarding Certain Verified Emissions Reduction Transactions – October 2014 and January 2015
Appendix H – 2015 Pacific Northwest Direct Seed Association (PNDSA) Meeting Presentation
Appendix I – 2015 Pacific Northwest Direct Seed Association (PNDSA) Meeting Poster
Appendix J – Cropland Management Greenhouse Gas Mitigation Methodology – Initial Draft Submitted to ACR
Appendix K – Cropland Management Greenhouse Gas Mitigation Methodology – ACR Comments on Initial Draft

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page of
USDA-NRCS, Washington DC	**69-3A75-11-131**	1 of 1 pages

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	**39-1611274**		☑ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☑ Cash ☐ Accrual

8. Project/Grant Period (Month, Day, Year)		9. Reporting Period End Date (Month, Day, Year)
From: **July 1, 2014**	To: **September 30, 2014**	**September 30, 2014**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	0
b. Cash Disbursements	806,034.45
c. Cash on Hand (line a minus b)	0
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	550,000
e. Federal share of expenditures	550,000.00
f. Federal share of unliquidated obligations	0
g. Total Federal share (sum of lines e and f)	550,000.00
h. Unobligated balance of Federal funds (line d minus g)	0.00
Recipient Share:	
i. Total recipient share required	550,000
j. Recipient share of expenditures	256,034.45
k. Remaining recipient share to be provided (line i minus j)	293,965.55
Program Income:	
l. Total Federal program income earned	0
m. Program income expended in accordance with the deduction alternative	0
n. Program income expended in accordance with the addition alternative	0
o. Unexpended program income (line l minus line m or line n)	0

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number, and extension)
Ry Thompson, Ecologist/Project Manager **Applied Ecological Services, Inc.**	**(608) 897-8641 ext. 57**
	d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **10/31/14 (through 13th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

FEDERAL FINANCIAL REPORT

(Follow form instructions)

1. Federal Agency and Organizational Element to Which Report is Submitted	2. Federal Grant or Other Identifying Number Assigned by Federal Agency (To report multiple grants, use FFR Attachment)	Page of
USDA-NRCS, Washington DC	**69-3A75-11-131**	1 of 1 pages

4a. DUNS Number	4b. EIN	5. Recipient Account Number or Identifying Number (To report multiple grants, use FFR Attachment)	6. Report Type	7. Basis of Accounting
614663276	**39-1611274**		☑ Quarterly ☐ Semi-Annual ☐ Annual ☐ Final	☑ Cash ☑ Accrual

8. Project/Grant Period (Month, Day, Year)		9. Reporting Period End Date (Month, Day, Year)
From: **October 1, 2014**	To: **December 31, 2014**	**December 31, 2014**

10. **Transactions**	Cumulative
(Use lines a-c for single or multiple grant reporting)	
Federal Cash (To report multiple grants, also use FFR Attachment):	
a. Cash Receipts	**0**
b. Cash Disbursements	**806,034.45**
c. Cash on Hand (line a minus b)	**0**
(Use lines d-o for single grant reporting)	
Federal Expenditures and Unobligated Balance:	
d. Total Federal funds authorized	**550,000**
e. Federal share of expenditures	**550,000.00**
f. Federal share of unliquidated obligations	**0**
g. Total Federal share (sum of lines e and f)	**550,000.00**
h. Unobligated balance of Federal funds (line d minus g)	**0.00**
Recipient Share:	
i. Total recipient share required	**550,000**
j. Recipient share of expenditures	**256,034.45**
k. Remaining recipient share to be provided (line i minus j)	**293,965.55**
Program Income:	
l. Total Federal program income earned	**0**
m. Program income expended in accordance with the deduction alternative	**0**
n. Program income expended in accordance with the addition alternative	**0**
o. Unexpended program income (line l minus line m or line n)	**0**

11. Indirect Expense	a. Type	b. Rate	c. Period From	Period To	d. Base	e. Amount Charged	f. Federal Share
				g. Totals:	0	0	0

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official	c. Telephone (Area code, number, and extension)
Ry Thompson, Ecologist/Project Manager **Applied Ecological Services, Inc.**	**(608) 897-8641 ext. 57**
	d. Email Address ry.thompson@appliedeco.com
b. Signature of Authorized Certifying Official	e. Date Report Submitted (Month, Day, Year) **01/31/15 (through 14th quarter)**
	14. Agency use only:

Standard Form 425 - Revised 6/28/2010
OMB Approval Number: 0348-0061
Expiration Date: 10/31/2011

Paperwork Burden Statement
According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is 0348-0061. Public reporting burden for this collection of information is estimated to average 1.5 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0061), Washington, DC 20503.

	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Aug 15 - Sep 30, 2011	Sep 1 - Dec 31, 2011	Jan 1 - Mar 31, 2012	Apr 1 - Jun 30, 2012	Jul 1 - Sep 30, 2012	Oct 1 - Dec 31, 2012	Jan 1 - Mar 31, 2013	Apr 1 - Jun 30, 2013	Jul 1 - Sep 30, 2013	Oct 1 - Dec 31, 2013	Jan 1 - Mar 31, 2014	Apr 1 - Jun 30, 2014	Jul 1 - Sep 30, 2014	Oct 1 - Dec 31, 2014	Jan 1 - Mar 31, 2015	Apr 1 - July 31, 2015
Project organization and set-up																
Introductory meetings																
Partnership development with Shepherd's Grain (SG) and surrounding landowners																
Partnership agreement finalized with farmers				◆												
Development and dissemination of educational materials																
Development of live farm field activity web site																
Mapping, screening, and stratification of the Palouse																
Mapping and stratification completed			◆													
Preparation for sampling																
Sampling across Palouse region																
Laboratory analysis of samples																
Statistical analysis and baseline development																
Review of analysis by experts and technical team																
Baseline developed for carbon project								◆								
Finalize soil method validation through VCS or other body																
Methodology validated						◆										
PDD drafting and review for SG and surrounding landowners																
Formal submittal of PDD to independent validator																
PDD delivered to market																◆
Aggregation beyond SG and surrounding landowners																
Partnership agreement finalized with famers										◆				◆		
Host meetings and discussions with high potential carbon buyers																
Drafting of deal structures to monetize credits																
Carbon deal structured												◆				◆
Engage ARB or other emerging compliance markets																
USDA communications																
Semi-annual Report (Due 1/31/12, 1/31/13, 1/31/14 and 1/31/15)			◆				◆				◆				◆	
Annual report (Due 7/31/12, 7/31/13 and 7/31/14)					◆				◆				◆			
Final Report ~~(Due 10/31/14)~~ (Update: Due 10/31/15)																◆

Project Seeking Cash Partner for much of Yr 3

Soil Improvements with Reduced Tillage and Improved Fertility Management in the Palouse

INTRODUCTION TO PARTICIPATION

Applied Ecological Services, Inc. (AES) and *Native*Energy, Inc. are seeking farming landowners and farmers interested in earning significant new revenues from increasing soil carbon levels and reducing emissions. Through committing to and practicing no-till farming and improved fertilizer management, participating landowners can earn up to an additional $15.00 per acre per year and save even more in reduced fuel costs without adversely affecting yield.

Project History

AES received a Conservation Innovation Grant from the USDA-NRCS in 2011 for a 3-year project to measure and quantify soil health in the Palouse through a rigorous scientific process. The project emphasized measuring soil carbon levels. The research has added significant value to the agricultural practices by documenting the carbon accrual benefits of no-till and minimum tillage practices.

To date, AES has sampled, measured and documented carbon accruals associated with conventional tillage and with no-till from Spokane to Pullman/Moscow, to Walla Walla and The Dalles, in what is one of the very first large landscape soil carbon measurement projects in USA. We have used the laboratory analysis data from 800 three foot long soil core samples from the central and eastern-most areas of the Palouse region. That data was used to create a model of the projected accruals a farmer should be able to achieve with a conversion to no-till with improvements in soil fertility management.

Now we are looking for farmers and landowners willing to convert to no-till farming and who are motivated to further aid research on improving soil water holding capacity, soil fertility, irrigation efficiency, and crop yield and quality. With the soil carbon data and an approved soil carbon methodology, we are able to proceed with engaging farmers to generate the carbon credits necessary to fund the improved methods and further research and development.

*Native*Energy, a leading project developer and carbon credit marketer, has committed to fund the remainder of our work and help us develop the project into a producer of verified carbon credits to sell in the voluntary carbon market. *Native*Energy has over a dozen years of experience in that market, and its extensive and growing customer base includes many manufacturers of products with grains, including Clif Bar and Annie's Homegrown.

Farm Benefits

In addition to carbon credit revenues and operations cost savings (which many of you already are benefitting from), improvements in soil carbon and health reduce the risk of drought as the improved soils hold moisture better and longer, increase crop yield, and avoid quality depression.

Farmers will be able to track and monitor soil carbon reductions and compare to neighboring farms in the same program. In addition to having bragging rights about just crop yields farmers will be able to brag about carbon and soil health improvements. We look forward to helping you tell this larger story with the data we collect and the money generated through the sale of carbon credits.

From our discussions with farmers, in addition to the new revenues and cost savings with improved soil health and soil carbon levels, farmers feel good about accomplishing something special by restoring the health of soils and providing a valued legacy for the community, their land, and their family. These farmers value being able to leave the land in a better condition than it was in when they started farming. This has always been a very important reason that farmers care about their farms and work as hard as they do to improve their land.

Eligibility Requirements

Ownership/Control

To be eligible to participate, the person or entity (the "Land Control Party") that owns or otherwise controls the land being brought into no-till (the "Subject Land") must have the legal rights to control the use of the Subject Land for the next 30 years. That means that if the farming person or entity (the "Farmer") leases the Subject Land or otherwise obtained a right to use the land from a third party, then either: (i) the lease or other right of use must have a 30-year term or be renewable in the Farmer's sole discretion for successive terms totaling 30 years (and the Farmer would be the Land Control Party), or (ii) that third party must be able to demonstrate ownership or control for 30 years and must itself make the contractual commitments required for participation in the project and have in place the financial and management plans identified below (and the third party would be the Land Control Party).

As an example, if you farm leased land under a lease that required mutual agreement to renew, your lessor is the Land Control Party. In that case, your lessor would need to sign an agreement with us not to lease the land for the next 30 years except in a lease that contains the same restrictions on tillage farming as are set forth under "Commitment to No-Till" below, and you and your lessor would need to amend your lease accordingly. You would then also need to sign an agreement with us imposing those same restrictions on you for the term of your lease.

Commitment to No-Till

To be eligible to participate, the Farmer (and the Land Control Party, if different) will have to sign a binding agreement with AES and *Native*Energy to: (i) maintain the Subject Land in crop production; (ii) till or permit your lessees to till the Subject Land only in years when soil conditions necessitate tilling to avoid material yield reduction (such as unusually wet springtime); and (iii) provide 5 business days' advance written notice to AES of your intent to till or permit tillage of some or all of the Subject Land in advance, detailing the circumstances that necessitate tilling; in all cases for a period of at least the next 30 years.

Financial & Management Plan

To be eligible to participate, the Farmer (and the Land Control Party, if different) will have to adopt and follow a financial and management plan to secure and allocate the resources needed to meet the above commitment to no-till and provide a copy of the plan to the NRCS and your lender. This is a requirement of the Verified Carbon Standard for registration of the carbon credit project. We would assist you in preparing your individual farm plans that reflect this conversion to continuous no-till farming to determine whether the project is eligible and meets the farms financial and operational needs. In order to determine whether the project is feasible for a carbon project and for the Farmer, we would provide, among other resources, financial forecasts and aerial photograph maps of each farm, showing the locations where soil carbon sampling has occurred to date.

Farm Responsibilities

Access to Farm

We will need reasonable access to your farm and your farm's business records to verify your farming practices prior to your participation in the project. The Business records will need to show field-based annual cropping records, tillage records, and fertilization records. Our process will not be like an IRS audit and will not require much of your time. We simply need to confirm your eligibility and document the baseline condition of the soil carbon in your fields so that changes in soil carbon and emissions of nitrous oxide and methane (gases given off when soils are fertilized with conventional farm chemical fertilizers) levels can be calculated. Among the specific records we will need are:

- Records of your ownership or other rights to the acreage you will include in the project
- Access to NRCS maps
- Records of your annual tillage practices on that acreage
- Records of your fertilizing practices

In addition, we will need access to your farm to conduct the measurements and then over the years, to conduct follow-up monitoring and sampling activities required for the verification and issuance of carbon credits. All such access will be at reasonable times upon reasonable notice, and will not materially disturb your operations. We use a Giddings hydraulic soil probe mounted on a John Deere Gator utility vehicle to access the soil sampling points. We will share with you the results of the lab tests.

Training

We will look to you and other creative, innovative farmers, as well as the USDA and others to seek the best strategies for improving soil carbon and soil health. We will work to learn the best performing techniques, fertilizers, equipment, and know-how. Because the Palouse is a large region, we will document what we learn and share this with all farmers in this program. Sharing will likely take the form of articles written with you and other farmers in the project, with local relevant resources such as at WSU, OSU, and UI and will likely include an annual workshop or three around the region for efficient knowledge sharing.

Reporting

We will create an interactive web site for you to easily report your project activities. Once a year, you will need to log in to the web site, access your farm map, and update the activities that occurred on your fields in the preceding year, including amount and type of fertilizers applied, dates of application, type of tillage conducted with dates, crop residue management employed with dates, cover cropping and crops seeded with dates, etc. With this information, we will calculate and report to you the estimated number of carbon credits you will have generated.

Estimated Project Revenues and Costs

We estimate that a 4,000 acre farm might incur an estimated initial cost of $190,000 - $300,000 or so to purchase new no-till equipment. It is possible that project costs could be as little as $80,000 for new equipment if you can trade in or sell your conventional tillage equipment.

Estimated reduced operations and maintenance savings

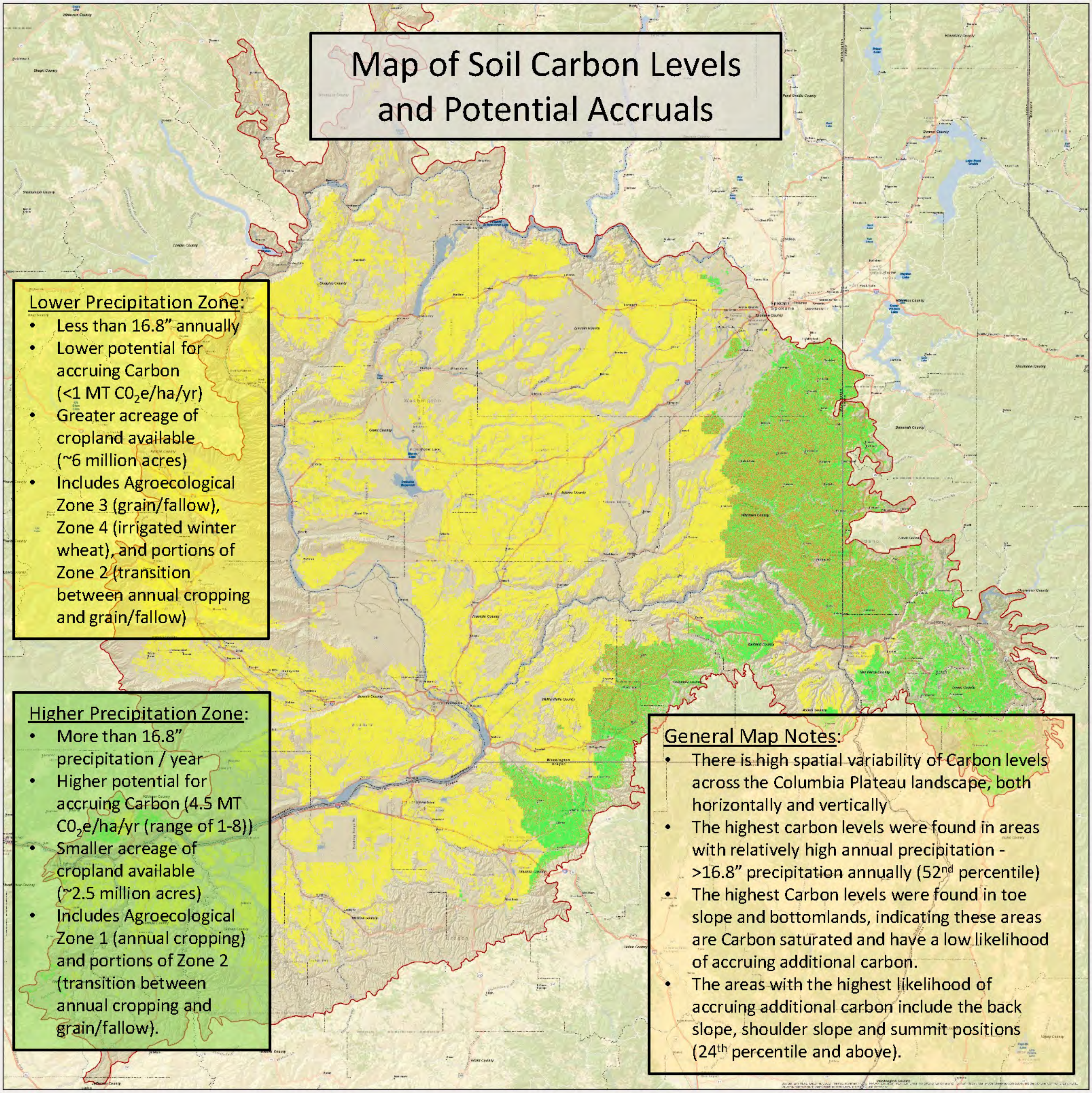
Through committing to and practicing no-till farming and improved fertilizer management, project revenues for participating landowners, a 4,000 acre farm could earn between $32,000 and $60,000 per year.

About AES

Applied Ecological Services is one of the leading ecological consulting firms in the world; we are dedicated to bringing the science of ecology to land-use decisions. AES applies science to provide practical land-use solutions that strike the most favorable balance between cultural needs, cost efficiencies and ecological sustainability. Our knowledge of ecological systems provides a solid foundation for creating balanced ecological designs and solutions that are sustainable, cost-effective and enduring. Learn more at www.appliedeco.com.

About *Native*Energy

*Native*Energy is an expert provider of carbon offsets, renewable energy credits, and carbon accounting software. With *Native*Energy's Help Build™ offsets, businesses and individuals can help finance the construction of wind, biogas, solar, and other carbon reduction projects with strong social and environmental benefits. Since 2000, *Native*Energy's customers have helped build over 50 projects that are now keeping millions of tons of greenhouse gases out of the air. All *Native*Energy carbon offsets undergo third-party validation and verification. Learn more at www.nativeenergy.com.


Map of Soil Carbon Levels and Potential Accruals
Lower Precipitation Zone:
• Less than 16.8" annually
• Lower potential for accruing Carbon (<1 MT $C0_2$e/ha/yr)
• Greater acreage of cropland available (~6 million acres)
• Includes Agroecological Zone 3 (grain/fallow), Zone 4 (irrigated winter wheat), and portions of Zone 2 (transition between annual cropping and grain/fallow)
Higher Precipitation Zone:
• More than 16.8" precipitation / year
• Higher potential for accruing Carbon (4.5 MT $C0_2$e/ha/yr (range of 1-8))
• Smaller acreage of cropland available (~2.5 million acres)
• Includes Agroecological Zone 1 (annual cropping) and portions of Zone 2 (transition between annual cropping and grain/fallow).
General Map Notes:
• There is high spatial variability of Carbon levels across the Columbia Plateau landscape, both horizontally and vertically
• The highest carbon levels were found in areas with relatively high annual precipitation - >16.8" precipitation annually (52nd percentile)
• The highest Carbon levels were found in toe slope and bottomlands, indicating these areas are Carbon saturated and have a low likelihood of accruing additional carbon.
• The areas with the highest likelihood of accruing additional carbon include the back slope, shoulder slope and summit positions (24th percentile and above).

Deliverable 2.

Comparative Analysis of Alternative Carbon Accrual Estimation Methods

Applied Ecological Services, Inc.

Applied Ecological Services, Inc.
17921 Smith Road, PO Box 256
Brodhead, WI 53520
608-897-8641

Contents

Introduction

Various methods have been used to make projections of carbon accruals associated with agricultural operations on myriad landscapes around the world. In short, these methods fall under the following broad categories:

1. Life Cycle Analysis
2. Modeling with and without calibration
3. Measurement of Baseline and Repeated Sampling

This document provides a comparison of each of these methods, but it emphasizes why we have used direct measurement in the Palouse.

Models and Modeling Approaches Currently in use for Soil Carbon Analysis

Many types of carbon projection accrual models have been created, and are regularly still being created. Additionally, existing models are constantly being refined to allow more accuracy and larger landscape applicability with improved precision.

Models generally fall into three categories: **a) Complex process-based models; b) Simplified projection models; and c) Customized models,** and each has commensurate difficultly in use, costs, and learning curves to use them. In addition, life cycle analysis has become commonplace and is being used extensively to characterize products and processes and their respective ecological impacts.

Complex Process-based Models
These models may use many data sources (e.g. climate, existing soils data sets, topography maps, growing season temperatures, insolation, plant productivity, cropping cycle process database, GHG emissions database from soils, farm equipment, water use database, etc.) applied to a land use history, such as a cropping history for a property, or a geographic region. The model then pulls from the various databases, applies the most localized or regionally specific database to a site or region and creates model runs for different time periods, different cropping scenarios, and also different scenarios of climate. Complex models are always fraught with the need for refined data and more data to refine the input ranges for each variable included in the model so that the modeling exercise considers the full range of possible outcomes.

Complex process-based models are also based on technically defined relationships. For example, the relationship between insolation, heating degree-days, available water, soil texture, soil nitrogen and phosphorus and crop plant production. Because all of these variables (and the many other variables included in complex process-based models such as CENTURY, DAYCENT, EPIC, APEX, COMET-FARM, COOL-FARM, and many others) co-vary in time and space, complex process-based models are good at smoothing over the details of localized performance that is likely occurring, and are most useful for projecting averages or bracketing the range of possible carbon accruals. Depending on the model's structure and assumptions, some models may not necessarily be accurate at accounting for site specific land history or land use change, or matching actual measured carbon accrual rates with projected rates. In order to be accurate and useful in the carbon marketplace, at least under most registry standards, these complex models need some level of site-specific calibration for projecting future change.

Complex process-based models require big investments to develop, maintain, use, and refine. For each variable, there is near constant need to upgrade the databases behind the modeling. Where complex models are most useful is in projecting the likely range of possible carbon accruals under some clearly defined scenarios. However, when one meets with landowners, in order for the complex models to be reasonably useful, detailed records of land use change, fertilizer use, tillage history (type, timing, equipment, plant coverage, antecedent conditions, etc.) all need to be documented for calibrating the complex process-based models.

Simplified Carbon Projection Models

Simplified carbon project models literally range from using an accepted carbon accrual rate for a predominant land use on a landscape and multiplying this assumed rate by an acreage and length of time for a carbon project, to the use of simple spreadsheets that attempt to bracket the expected carbon accrual rates, over some landscape and time period. In our experience, where actual time-series carbon accrual data and relationships (e.g. measured accruals, measured GHG emissions, carbon and soil erosion rates data, etc.) are available, such as from plot based research projects, especially where these plots integrate the regional climate over many years, these spreadsheet models can very quickly bracket and project a carbon accrual with equal or more localized accuracy than the complex models.

Models developed in the province of Alberta, Canada are all simplified, or overly simplified models for projecting carbon accruals and GHG emissions dynamics. For example, the Alberta no-till agricultural model (developed from several localized and small scale studies) has created a provincial baseline model for all farms, allocated into two primary regions based on annual average rainfall – the Parkland and Dry Prairie Zones. The precipitation break between these two zones was consistent with the statistically significant precipitation break observed in the Palouse dataset, approximately 16.5”. Models to date have attempted to take into account precipitation and vegetation productivity potential on landscapes. But, typically this hasn’t been accomplished with the granularity to represent heterogeneous landscapes. Much work is needed to refine the complex and simple models to work reliably for especially heterogeneous non-cultivated landscapes such as rangelands.

Using small plot studies, Alberta methodology developers developed coefficients to mathematically define how the carbon accrual rates, GHG emissions (N_20, CH_4, etc.) varied in each meteorological region or zone. Simple rolled up equations then sum the anticipated carbon accrual rates, deduct the N_20 and CH_4 emissions, to arrive at a net soil carbon accrual projection, and to determine the salable carbon credits that may be sold upon further validators inspection and approval. We selected to not use this approach because of the highly variable landforms, variable geological timing, mineral origins, depth over bedrock and water tables, and other variables found in the Palouse.

Customized Models
Many projects that we have worked on have used the STELLA modeling platform models linked to real calibration data from field sampling. For example, we have used this to understand the watershed benefits of increased carbon levels in the soil. Using STELLA, we created comprehensive watershed models that could be easily modified to adjust for changing land uses, cropping strategies, fertilizers and other key variables. The customized models also allow for calibration of each variable unlike the complex models which just give you options (toggle selections) in the canned model for most variables, and provide some flexibility in calibrating on a few variables.

Customized models can take the technical process relationships of a complex process-based model and convert those into easily changeable graphic interfaces or numerical entry points in the model, to support quick and efficient calibration for scenario testing purposes. The customized models are typically far more accurate for individual projects because the data sets used can be localized, can represent specific time periods, and can partition in the same model a full range of land uses over a landscape, through a GIS interface, such that scenarios can actually be applied to a specific landscape. In contrast, complex process-based models really don't allow for the interface with real landscapes and landforms and thus details such as slope position, aspect, depth to bedrock, depth to water table, and other antecedent conditions on the land are not easily incorporated into complex models. Custom models allow for this level of refinement.

Customized models can use comprehensive measurement data for calibration. In fact, this allows custom models to be the most accurate, or as accurate as the time and resources allow.

Life Cycle Analysis
An entire industry exists that has created standard tabular GHG emissions for most industrial and agricultural process, use of specific equipment and operations (e.g. tractors, grain mills, semi-tractors, etc.). This industry has also created generalized sequestration rates for most agricultural practices, and other strategies for sequestration of CO_2, Methane, N_2O by soils and through chemical extraction means.

Our experience with the GHG emissions and sequestration methods and generalized tabular strategies used for population life cycle analysis models is that they do not provide defensible specificity for doing landscape estimations of emissions or sequestration. The life cycle tabulations and modeling are primarily useful for doing industrial site or industrial process-related estimates of emissions and sequestration such as for a new factory, or a new production line for manufacturing. Because of the close relationship between timber production and wood product manufacturing (e.g. from paper production to durable long lived carbon stored in household furniture), the Life Cycle industry has developed highly sophisticated models and tabular data on the GHG emissions and sequestration associated with the production and use of some forest products. However, to date these data to not account for changes in soil carbon, soil methane and N_2O GHG emissions of sequestration.

This Life Cycle industry has created standard reference tables, software programs with standard reference databases that assign coefficients to each land use, each manufactured product, on the emissions, energy and materials in, and waste products discharged by the manufacturing or agricultural production process.

Life cycle analysis is not calibrated for a specific site, or region, and for each manufacturing or production process each of the different life cycle analysis processes allows for a standard analysis and comparison of the "life cycle impacts" of products. Life cycle analysis can be completed relatively quickly and uniformly to create standard work product reports that include for example projected greenhouse gas emissions (GHGs), sequestration of methane, carbon dioxide and other GHGs by soil, under different crops, and/or under different generalized tillage regimes.
Product declarations, primarily focused on a manufactured piece of equipment, are created and are now becoming market recognized documents that accompany each product, such as a new refrigerator, a new car and thus life cycle analysis attempts to translate for the consumer the "impacts" of their purchase on the earth and on their pocketbook. Labeling certifications now simplify the life cycle impacts, and more recently, even the benefit side of the equation. Most every Home Depot product now has a standard embedded energy utilization "score", a GHG emissions score, and some products now have "land and ecosystem scores" presented in an easily understood consumer communications driven certification label.

The coefficients and projection models have been evaluated for precision and relevance for only a few ecosystem services and ecosystem products (e.g. green hydropower production, certified wood products), while soil carbon accrual projections are typically normalized so that real understandings of what is likely on a farm are not possible.

Landscape scale estimates of impacts and benefits are poorly projectable with any degree of real on-the-ground accuracy from the life cycle analyses. Life cycle projections of carbon accruals are not accepted in any carbon marketplace for trades in the carbon marketplace.

Description and Analysis of Sampling-based Approaches for Carbon Accrual Projections

The most accurate models start with real, localized data, that is then used to project a range of scenarios. For the Palouse project, we chose to focus on generating a robust, scientific baseline condition assessment of the range of soil carbon levels found in the upper meter of soil depth. In addition, these measurements were used to create local regression relationships for understanding and documenting the time series changes in soil carbon accruals with no-till agriculture, compared to continuous conventional tillage and CRP, and the carbon stocks found in reference Palouse grassland natural areas. This full range of key land uses have been used to inform the possible soil carbon accrual potential is using the CRP 10-15 yr set asides as an example, and the reference natural areas as the example of long durable carbon stock relationships with the place.

The dataset, from nearly 800 full meter core samples, was used to develop and test linear relationships between time since no-till began and carbon accruals. Because all of the data were collected with the same standard method (unlike the data sets behind CENTURY, DAYCENT, etc.), and because the relationships have been developed from the regional relationships between climate, very specific soil mineralogy and textures, and a representative full range of applicable agricultural land uses, the carbon projections made from this stratified 7 million acre landscape will be a very accurate representation of the past relationships of carbon accruals. Now, this data can be used in spreadsheet models to project accruals into the future, using normal non-parametric statistical robustness testing, which is readily accepted by the carbon marketplace, by the business community who may be carbon credit purchasers, and by validators who can confirm that the statistics have been completed correctly.

The added advantage of this measurement-based modeling approach is that rather than the projections being subjected to the uncertainty of working with complex models with the many "canned database variables" (which can co-vary in nature), which will not necessarily change in ways to reflect the landscape dynamics on a complex landforms such as in the Palouse (which can fundamentally affect the accuracy of projections), our sampling and projections integrate all landscape strata so we can be more certain on the validity of the data and resulting projections. Additionally, the provision for repeated sampling in the Palouse project allows for additional calibration at the time of credit sale. For all fields included in a carbon project, re-sampling at the same sample point as the baseline sampling occurred will ensure continuous calibration and accurately demonstrating credits available for sale. Repeated sampling is a standard statistical way to detect change in variables in any science program. For the Palouse study high sample "n" allows us to statistically resample the same locations, and then additional random assigned new points on the land to generate statistically robust assessments of the changes in soil carbon over time. Repeated sampling event statistics such as repeated event ANOVA's are specifically established standard statistical routines that is routinely used in other field sampling efforts to do change detection and quantification.

Additional Methods and Recommendations

Now that the Palouse dataset is available from our project, we propose that the USDA-NRCS, AES, Colorado State University, USDA-ARS (David Huggins at WSU) and other partners work together to calibrate the complex process-based models such as DAYCENT, CENTURY, and COMET-FARM. Through this process, we can help create greater awareness and interest by giving famers access to a locally calibrated forms of COMET-FARM through our Palouse soil carbon project. While this process would need modest additional funding, it would be an important next step to bringing the complex process-based modeling projection capability to a regionally calibrated level for use in further farmer adoption of no-till (and other activities to reduce emissions and increase carbon accruals) and would further our ability to quickly move to marketplace transactions in the larger Palouse landscape.

References

Apfelbaum, Steven I., and John M. Kimble. 2007. "A Dirty Way to Fight Climate Change: A Promising Strategy: Store Carbon in the Soil." *Christian Science Monitor* (November 29).

Batjes, N. H. 1996. "Total Carbon and Nitrogen in the Soils of the World." *European Journal of Soil Science,* 47: 151–163. http://doi: 10.1111/j.1365-2389.1996.tb01386.x

Kimble, John M., Charles W. Rice, Debbie Reed, Sian Mooney, Ronald F. Follett, and Rattan Lal, eds. 2007. *Soil Carbon Management: Economic, Environmental and Societal Benefits.* Boca Raton, FL: CRC Press.

Lal, R. 2003. "Soil Erosion and the Global Carbon Budget." *Environment International* 29: 437-450.

Liebig, Mark, Alex J. Franzluebbers, and Ronald F. Follett, eds. 2012. *Managing Agricultural Greenhouse Gases: Coordinated Agricultural Research through GRACEnet to Address our Changing Climate.* NY, NY: Academic Press.

Teague, Richard, Steve Apfelbaum, Rattan Lal, Urs Kreuter, Jason Rowntree, Christian A. Davies, Russ Conser, Mark Rasmussen, Jerry Hatfield, Tong Wang, Fugui Wang, and Peter Byck. 2014. "Integrating Ruminants to Reduce Agriculture's Carbon Footprint." Technical paper.

US Department of Agriculture (USDA). 2013. *Greenhouse Gas Mitigation Options and Costs for Agricultural Land and Animal Production within the United States,* prepared by ICF International. Washington, D.C.: USDA.

Verified Carbon Standard (VCS). 2011. "VM0021: VCS Soil Carbon Quantification Methodology, v1.0." Last modified November 16, 2012. Accessed March 27, 2013. http://v-c-s.org/methodologies/VM0021.

Deliverable 3.

Macro-Level Regional
Environmental, Economic and Societal Benefits
from
Soil Carbon Improvement Practices
in the
Columbia Plateau Eco-Region
of
Idaho, Oregon and Washington

Applied Ecological Services, Inc.™

Applied Ecological Services, Inc.
17921 Smith Road, PO Box 256
Brodhead, WI 53520
608-897-8641

Contents

Executive Summary

Applied Ecological Services has undertaken the development of a large-scale project, entitled the Palouse Soil Carbon Project, based on a hypothesis that soil carbon increases at a faster rate under no-till agriculture than under traditional agricultural tillage practices. The project is an ecosystem-scale demonstration of methods of measuring carbon stocks in soil and of providing market-based incentives for farmers to undertake activities that improve soil carbon and reduce greenhouse gas (GHG) emissions from agriculture. The partners worked closely with Shepherd's Grain, a wheat producing co-operative that focuses on setting standards for sustainable practices and grain quality for farmers in order to access higher-value markets for their wheat products. Assisted by a US Department of Agriculture (USDA)/Natural Resources Conservation Service (NRCS) Conservation Innovation Grant (CIG)[1], the partners have:

- Validated a modular methodology for soil-related carbon credit projects, developed by The Earth Partners through the Verified Carbon Standard (VCS), a leading voluntary carbon standards organization (VCS 2011).
- Collected and analyzed 750 one-meter-deep soil samples from across a seven-million acre area of the Palouse region, centered in the state of Washington in the Northwestern U.S.
- Aggregated farmers under contract managing over 130,000 acres of land, predominantly in dryland (non-irrigated) wheat production.
- Created a second round of farmer aggregation efforts and received interest from another group of interested farmers managing over 150,000 acres of land.

During the sampling phase of the Palouse Soil Carbon Project, more than 750 1-meter soil cores[2] were collected in cultivated and conservation reserve fields and natural areas sites across the 7-million acre area. Sample sites were chosen within each stratum, using a stratified random approach, but they included only private fields and publicly owned sites where access had been secured. To the extent practicable, equal numbers of samples were taken in each stratum. This is one of the single largest 1-meter deep soil core data sets now available in the USA.

The Palouse Soil Carbon Project has significantly advanced the understanding of soil conditions and farm practices in the Palouse. It has provided information on a wide range of problems, issues, and opportunities related to the development of agricultural soil carbon projects in general. This has resulted in the creation of the basic structures required to undertake similar projects in other locations, including the Soil Carbon Quantification Methodology, sampling techniques, and approaches to aggregating farmers. It has also provided knowledge related to key variables, such as soil variability, which will be critical to assessing project viability. However, due to variance in agricultural landscapes, soil processes, and farming practices, each project will require a unique combination of carbon measurement and project management approaches to fit it to the specific situation. Assembling producers over large acreages at relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects. The Palouse project provided an on-the-ground

[1] http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/

[2] The aim of the study was a depth of 1 meter, though the actual results have several cores less than 1 meter due to various conditions encountered in the field. In the cultivated subset of 442 cores, 90% of the cores were ≥80cm, and 50% were ≥95cm.

opportunity to develop, test, and refine a low-cost aggregation model. Aggregation involves several issues discussed below, such as flexibility of practice, the ability of producers to opt in and out, the method for allocating benefits, and other issues. These need to be included in agreements between the farmers and the project developer. These agreements may include a master agreement that sets the standards by which specific issues, such as benefit allocation, are to be determined but which leaves the specifics of these issues to be determined in periodically reviewed sub-agreements.

Summary of Benefits

Based on this work, the partners have identified key environmental, economic and societal benefits resulting from the implementation of soil carbon improvement projects:

- Agricultural/On-Farm Benefits:
  - Improved soil structure and stability leads to reduced soil erosion, improved soil fertility, improved water infiltration and retention, improved aeration and root growth, and reduced environmental degradation
  - Reduced production costs
  - Labor cost savings (reduced labor needs, reduced labor hours, reduced labor costs)
  - Reduced energy costs
  - Reduced machinery repair and maintenance costs
  - Reduced equipment ownership costs
  - Overall cost efficiencies
  - Organic matter is a source of plant nutrients (nitrogen, phosphorus, sulfur)
  - Improved soil cation exchange (i.e., the ability to store nutrients such as potassium and calcium), which is important for plant growth
  - Improved plant production, crop yields
  - Improved soil biodiversity
  - Reduced bulk density, which improves the plant-rooting environment
  - Improved net returns/profitability in some tillage systems/some areas
  - Potential federal program payments
  - Potential marketability of sequestered tons of C

- Off-Farm/Societal:
  - Reduced wind erosion of soil reduces sedimentation, improves air quality
  - Soil organic C binds contaminants such as petroleum products, pesticides, and heavy metals, thereby reducing toxicity and minimizing leaching
  - Reduced water erosion and runoff reduces nutrient loading and thus improves water quality, improving wildlife habitat and human health impacts
  - Flood mitigation and control (reduce the magnitude and impact of floods from extreme weather events or excessive snowfall via "temporary water storage")

Context

Agriculture is the dominant form of human land management, with approximately 49 million square kilometers (33% of the world's land area) managed for annual and perennial crops and for grazing. Every form of agriculture has the potential to impact the world's soil carbon store, currently estimated at 1500Gt of C in the upper 100cm of the world's soils (Batjes 1996). If one tonne of additional carbon were sequestered per hectare per year in 10% of the world's agricultural soils, 1.8 billion tonnes of CO_2 would be removed from the atmosphere annually. And, this would be legacy carbon emissions, that to date, only the photosynthesis process has been demonstrated to effectively contribute to reducing these excessive greenhouse gases already in the atmosphere. Furthermore, agricultural soils are currently recognized as likely being a net source of greenhouse gases (GHGs), due to current management practices, although the magnitude of that effect is unclear.

Starting shortly before and during the tenure of this CIG grant, we have attempted to articulate the value of soil carbon through conventional science media and other outlets: technical papers, books, radio shows, TV shows, and various magazines and other layperson media. Several key publications to which we have contributed to are presented in the cited references section of this report. An example of coverage in the layperson media is presented in Apfelbaum and Kimble (2007).

Soil carbon (carbon held within the soil, primarily as part of soil organic matter content) is the largest terrestrial pool of carbon on earth and is important as a global carbon sink for GHGs. Yet, despite this potential to both reduce emissions from soils and to store atmospheric carbon in soils, the development of methods to incentivize and measure the effects of enhanced soil management techniques on soil carbon has lagged behind GHG measurement and management in most other sectors of the economy. This is true for a number of reasons, including:

- Soil carbon is dispersed across a variable landscape, unlike point-source combustion engine tailpipe fossil fuel and chemical emissions.
- Measurement of soil carbon requires laboratory testing, unlike forest biomass carbon pools, where measurement can be conducted in the field using well-developed techniques.
- Soil carbon has proven difficult to assess with accuracy using remote sensing, unlike trees or other above-ground ecological elements, where robust algorithms exist to assess biomass carbon pools utilizing high-resolution remote sensing imagery.
- Soil carbon models, while well designed, are handicapped by limited data availability for accurate calibration. This is particularly true with regard to deeper soil strata.
- Our knowledge about soil carbon and soil carbon processes is rapidly evolving. For instance, it has only recently been recognized that soil carbon in deeper soil layers (below 30–60cm) may also be quite dynamic.
- Agriculture is typically undertaken by individual farmers, each with his or own management methods and history, which impact the amount and trend of soil carbon on their land.
- Soil carbon is highly sensitive to soil-forming and landscape processes, and in some cases, it can vary significantly within a few tens of meters, depending on the landforms, soil processes, and land utilization history.

- Changes in soil management may have multiple effects, some of which may be positive for reducing global warming, while others are negative. For instance, changes may increase soil carbon content but also increase methane emissions.

For these reasons and others, development of agricultural soil carbon methods and improvement projects has been slow. The scale and the variability found over the landscape, as well as ever-changing land uses, have created policy, science, and marketplace confusion over how to evaluate landscape-scale investments in mitigating climate change. However, soil carbon also has some very significant characteristics that make pursuing methods and projects in this area important, including:

- Soil carbon in well-managed landscapes is low-risk. Although erosion can result in the significant movement of soil carbon and potential releases to the atmosphere, soil carbon is not vulnerable to sudden release in the way that biomass carbon is vulnerable to release from fire.
- Soil carbon enhancement is a win-win process. The majority of the soil carbon impacted by agricultural techniques is held in the form of soil organic matter. Increased soil organic matter is generally very beneficial for agriculture, enhancing water and nutrient holding capabilities. It is widely accepted that the carbon content of soil is a major factor in overall soil health.
- Soils may store carbon reliably over very long periods of time.
- Agricultural certification and climate-smart agriculture may be highly complementary, resulting in improvements in long-term agricultural sustainability.
- The history of soil carbon loss in many agricultural soils means that very significant amounts of atmospheric carbon could be sequestered in soils before these soils are ever returned to their base state.

The Palouse project was designed as a laboratory within which operational-scale solutions could be developed and tested against some of those challenges. The project examines the impact of strategies such as aggregating farms to create economies of scale, employing measurement with modeling, and developing other techniques to address many of the obstacles and challenges that have limited the ability to bring climate-smart agriculture (including non-soil carbon GHG contributors related to nitrogen and methane management) into the marketplace.

The Palouse Soil Carbon Project

The Palouse Soil Carbon Project is an ecosystem-scale demonstration of how to measure carbon stocks in soil and how to engage farmers in activities that improve soil carbon and reduce greenhouse gas emissions from agriculture. Through in-field measurements and modeling projections, the project focused on documenting the soil carbon and GHG emissions benefits of carbon friendly farming practices. The project is focused on a 7-million acre area of the Palouse region (*see maps in Figures 1 and 2*), where farmers and landowners on over 100,000 acres of dryland wheat production land are enrolled in a large-scale carbon program. Undertaken with Shepherd's Grain, a farmer-run organization that focuses on producing high-quality grain through sustainable farming practices, this project has the opportunity to be one of the largest agricultural carbon projects in the world.

Objectives of the project included:

1. Development of technical data on soil carbon measurement and projection, which can inform policy, and supporting further research into soil carbon enhancement as a method of GHG mitigation.
2. Demonstration of an efficient (cost and time) aggregation model for soil carbon. Assembling landowners over large areas at relatively low cost is perceived by the market as a major challenge in developing cost-effective land-based carbon projects.
3. Demonstration of an agricultural eco-regional carbon accounting approach through the landscape-level implementation of the VCS-verified Soil Carbon Quantification Methodology developed by The Earth Partners (VCS 2011).
4. Development of project design approaches and methods with the potential to be relevant in existing (and emerging) voluntary and compliance carbon markets.

Soil Carbon Improvement Practices: Agricultural/On-Farm Benefits

Agricultural Production and Efficiency Benefits

A national summary of soil carbon benefits to macro-level regions and at larger scales and summarized at the farm scale was created in the book, *Soil Carbon Management—Economic, Environmental and Societal Benefits* (Kimble et al. 2007). This section summarizes the key findings from that book.

An overview of the key findings is detailed in "Appendix A: Known Benefits of Soil C and Soil C Sequestration" (Kimble et al. 2007) and is summarized here as follows:

- Reduced production costs
- Labor cost savings (reduced labor needs, reduced labor hours, reduced labor costs)
- Reduced energy costs
- Reduced machinery repair and maintenance costs
- Reduced equipment ownership costs
- Overall cost efficiencies
- Improved net returns / profitability in some tillage systems / some areas
- Potential federal program payments
- Potential marketability of sequestered tons of C

Environmental Benefits

Significant on-farm and regional and potential watershed scale environmental benefits have been documented (Kimble et al. 2007) regarding the general relationships between improved Soil C and Soil C Sequestration:

- Improved soil structure and stability leads to reduced soil erosion, improved soil fertility, improved water infiltration and retention, improved aeration and root growth, and reduced environmental degradation
- Organic matter is a source of plant nutrients (nitrogen, phosphorus, sulfur)
- Improved soil cation exchange (i.e. the ability to store nutrients such as potassium and calcium), which is important for plant growth
- Improved plant production, crop yields
- Improved soil biodiversity
- Reduced bulk density, which improves the plant-rooting environment
- Improved water retention, reduced nutrient leaching, less need for fertilizers, and less need for irrigation.

The literature review in Kimble et al. (2007) is a useful synthesis of what is known under each of these benefit categories.

Soil Carbon Improvement Practices: Off-site/Societal Benefits

Air Quality Benefits

Air quality benefits from improvements in Soil C and Soil C Sequestration have been summarized to primarily result from "Reduced wind erosion of soil reduces sedimentation, improves air quality" (Kimble et al. 2007). Other publications have evaluated wind-induced erosion loss of soils, finding and documenting that erosion severity increases with decreasing soil health (Lal 2003). As Soil C decreases, the moisture holding capacity of soils declines which allows the soils to become more vulnerable to wind and water erosion. Direct entrainment of eroded soil particles as dusts, and the deterioration of prior organically bound soil nitrogen, phosphorus, carbon, become entrained with dusts and in aerosol forms and contribute to deteriorated air quality.

In this Palouse project, a conversion of farmers to multiple-pass no till, and even better, to one-pass no till, with very high levels of crop residues (>70%) is documented to reduce the erosion risk to wind and water erosion (USDA 2013). This same publication also documents the significant reduction in nitrous oxides, methane, carbon dioxide emissions also associated with no-till agriculture and crop residue management and the commensurate improvements in Soil C and Soil C sequestration that occur.

Highly significant additional air quality benefits are associated with improved erosion prevention that keeps soil organic carbon from entering waterways. Upon entering waterways, organically bound nitrogen, phosphorus, and the carbon stocks that comprised the soil organic carbon settle in deeper locations and backwaters. In these locations, at least seasonally (e.g., during heat of the summer, etc) when anaerobic conditions occur in the water column, both the organic carbon and nitrogen are microbially reduced. This liberates significant quantities of Nitrous oxides and methane. A submitted paper (Teague et al. 2014) summarized the mass balance and sources of GHG's associated directly and indirectly with erosion. This paper was drafted to provide a counterpoint to recent IPCC claims that cattle were a primary source of methane on earth. What this paper has shown is that as a source of methane, cattle (enteric emissions) pale to near insignificance when the GHG emissions associated with erosion are included in the global mass balance.

Flood Mitigation Benefits

We and others have identified the known benefits of Soil C and Soil C Sequestration for mitigating the duration, magnitude, and severity of flooding. Examples are provided (Kimble et al. 2007, Appendix A) and summarized as follows:

- Flood mitigation and control (reduce the magnitude and impact of floods from extreme weather events or excessive snowfall via "temporary water storage")

For the Palouse project, if all 7 million acres of farm land in our study area experienced an increase of soil organic carbon by 1%, this would have a profound benefit to regional flood mitigation, improved baseflows into streams, wetland, lakes, and ground water infiltration.

If, for every 1% increase in soil organic carbon, there is a water holding capacity of 60,000 gallons per acre (Kimble et al. 2007), this would suggest 4.2 x 10 to the 11th power gallons of water could potentially be held within the new organic carbon present in the revitalized soil. This is the equivalent of 1.3 million acre-feet of additional flood storage being provided in the soils. If the lag time because of the improved water holding capacity in the revitalized soils allowed 30% of this water (or ~.45 million acre-feet) to infiltrate to ground water, and if an additional 30 % ran off but if this runoff occurred over a 1 week period rather than within a 24-72 hour period, in some river basins this opportunity to slow the rate at which runoff leaves the land has been critical to desynchronize the flood peaks from contributing tributary watersheds and thus reduce the overall peak on main stem rivers. By any measure of success, reducing runoff at these magnitudes would have a highly significant flood reduction benefit, and would be the lowest cost strategy for flood damage reduction used in the world to date.

A 1% increase in soil organic carbon in the Palouse would an approximate increase in SOC from an average of 98 tons/acre to 99 tons/acre. At the cost of $2.70 per ton of sequestered carbon that is fully measured and accounted (as it has been in this Palouse CIG), this $2.70 creates a potential flood damage reduction of 60,000 gallons per acre or 8.4 x 10 to the negative 6th power dollars per acre foot. At this cost, this would suggest the total benefit of 1.3 million acre-feet of additional storage would be provided (measured, documented, verified) at a very low total cost.

For the Red River of the North in Minnesota and the Dakotas, the benefit of soil carbon improvements to create this de-synchronization and restoration of soils and vegetation at watershed scales (France 2008, Chapter 16; France 2005, 321-333). This later paper explored the opportunity to create hytograph to hydrograph temporal lags and found that in some watersheds a few minutes of lengthening of the time of concentration between the rainfall and the runoff events can reduce flood peaks significantly. This same analysis was conducted for the Red River of the North in Minnesota and the Dakotas, and found a few hours of runoff curve displacement of peaks could save tens of millions in annual flood damages to crops and infrastructure.

Water Quality Benefits

The benefits from the increased water holding capacity in the soils, reduced runoff, and flood damage reduction all individually provide significant levels of water quality improvements. Infiltration cleanses water and reduced overland runoff and erosion and subsequent water quality impacts downstream. Reduced runoff from the increased water holding capacity in the revitalized soils improves ground water infiltration and replenishes baseflow hydrologies of stream and other receiving waterbodies and also improves ground water quality. Per Kimble et al. (2007, Appendix A), these and other known document benefits of Soil C and Soil C Sequestration include:

- Soil organic C binds contaminants such as petroleum products, pesticides, and heavy metals, thereby reducing toxicity and minimizing leaching.
- Reduced water erosion and runoff reduces nutrient loading and thus improves water quality, improving wildlife habitat and human health impacts

To date, we are unaware of any comprehensive watershed-scale evaluations of the potential water quality benefits of improving Soil C and Soil C sequestration. A scattering of projects such as the NRCS, USGS and Wisconsin TNC Pecatonica River project (Pleasant Valley project) has evaluated water quality benefits associated with improved on-farm BMP to manage water quality. Some of the BMPs will directly improve Soil C and Soil C sequestration, but these improvements have not been accounted for in the SNAP modeling and other modeling used in this program. Instead of modeling down to the level of Soil C, the modeling uses generalized improvements in some key parameters such as by changing runoff coefficients for stormwater runoff by introduction of grassy waterways, or by managing dairy cow manure by containment and anaerobic digestion. Others have taken a similar approach in their assessment of GHG emissions reduction benefits associated with farm practices (USDA 2013, V, 5.10; Liebig, Franzluebbers, and Follett, 2012).

Wildlife Benefits

Locations on earth with the highest levels of soil carbon also trend to have some of the highest productivities and diversity of wildlife and other life. Because the relationship between wildlife and habitat is primarily correlated with habitat structure, habitats with a diversity of vegetation structural elements (grasses, trees, shrubs, waterbodies with aquatic and emergent vegetation) typically contain the most birds, mammals, herptiles, soil microbial flora/fauna species. The same principle generally applies to wetlands and aquatic environments where increased structure of the above and below water vegetation communities (and vegetation species, community diversity and productivity and growth responses to substrates and debris/biomass durability/retention) is closely correlated with higher diversity, productivity and use by wildlife.

Grasslands on earth, such as the North American tall grass prairie, fresh water and coastal brackish wetlands, represent several examples of landscapes with many times the tonnage of soil organic carbon over the approximate 100 tons/acre average found in agricultural lands. If "wildlife" is defined to include soil microbial life, then highest soil carbon levels in terrestrial aerobic ecosystems have the highest diversity and abundance of "wildlife" on earth. A more traditional review of wildlife benefits (Kimble et al. 2007, Appendix A) found wildlife and recreational benefits (wildlife viewing, pheasant hunting, and freshwater-based recreation and fishing) to be higher in landscapes with soils with higher levels of Soil C and Soil C Sequestration rates. The same landscape locations - grasslands and wetlands - top the list of such examples.

References

Apfelbaum, Steven I. 2005. "Stormwater Management: A Primer and Guidelines for Future Programming and Innovative Demonstration Projects." Chapter 19 in *Facilitating Watershed Management: Fostering Awareness and Stewardship,* edited by Robert L. France, 321-333. NY, NY: Rowman and Littlefield Publishers, Inc.

Apfelbaum, Steven I., and John M. Kimble. 2007. "A Dirty Way to Fight Climate Change: A Promising Strategy: Store Carbon in the Soil." *Christian Science Monitor* (November 29).

Apfelbaum, Steven I., and Neil Thomas. 2008. "Extreme Projects: Ecological Restoration Needs to Address Altered Ecosystems at Larger Spatial Scales." Chapter 16 in *Handbook of Regenerative Landscape Design*, edited by Robert L. France, 357-378. Boca Raton, FL: CRC Press.

Batjes, N. H. 1996. "Total Carbon and Nitrogen in the Soils of the World." *European Journal of Soil Science,* 47: 151–163. http://doi: 10.1111/j.1365-2389.1996.tb01386.x

Kimble, John M., Charles W. Rice, Debbie Reed, Sian Mooney, Ronald F. Follett, and Rattan Lal, eds. 2007. *Soil Carbon Management: Economic, Environmental and Societal Benefits*. Boca Raton, FL: CRC Press.

Lal, R. 2003. "Soil Erosion and the Global Carbon Budget." *Environment International* 29: 437-450.

Liebig, Mark, Alex J. Franzluebbers, and Ronald F. Follett, eds. 2012. *Managing Agricultural Greenhouse Gases: Coordinated Agricultural Research through GRACEnet to Address our Changing Climate*. NY, NY: Academic Press.

Teague, Richard, Steve Apfelbaum, Rattan Lal, Urs Kreuter, Jason Rowntree, Christian A. Davies, Russ Conser, Mark Rasmussen, Jerry Hatfield, Tong Wang, Fugui Wang, and Peter Byck. 2014. "Integrating Ruminants to Reduce Agriculture's Carbon Footprint." Technical paper.

US Department of Agriculture (USDA). 2013. *Greenhouse Gas Mitigation Options and Costs for Agricultural Land and Animal Production within the United States,* prepared by ICF International. Washington, D.C.: USDA.

Verified Carbon Standard (VCS). 2011. "VM0021: VCS Soil Carbon Quantification Methodology, v1.0." Last modified November 16, 2012. Accessed March 27, 2013. http://v-c-s.org/methodologies/VM0021.

August ___, 2014

Office of the Chief Counsel
Division of Corporate Finance
Securities and Exchange Commission
100 F Street, N.W.
Washington, DC 20549

Re: Certain NativeEnergy, Inc. Verified Emissions Reductions Transactions.

Dear Sir or Madam:

This letter is to respectfully request written confirmation that the Division of Corporate Finance (the "Division") will not recommend enforcement action to the Securities and Exchange Commission (the "Commission") if NativeEnergy enters into Project Participation and Option Agreements ("PPOAs") with crop farmers or crop farming business entities in the manner and under the circumstances described below without registration of PPOAs under the Securities Act of 1933 (the "Act").

NativeEnergy, a Delaware corporation (www.nativeenergy.com), has, since 2001, been in the business of the production and/or wholesale purchase, and wholesale and retail sale of the legal right to claim responsibility for reductions in emissions of greenhouse gases ("GHG"), and removals of atmospheric carbon dioxide through terrestrial sequestration of carbon (collectively, following third party verification of the occurrence of the reductions or removals, the reductions or removals are generally referred to as "Verified Emissions Reductions" or "VERs"). Our customers, mostly businesses, typically purchase these reductions as a means to compensate for their own unavoidable GHG emissions, to achieve their overall emissions reduction goals. The market for VERs is generally known as the "Voluntary Carbon Market."

Background

The GHG reductions and removals NativeEnergy produces or purchases, and sells, are produced in connection with an activity or discrete set of activities known generally as "VER Projects." Among the most common VER Project types in the U.S. are: (i) renewable electricity production, such as wind turbines, which reduce emissions by displacing production of electricity by fossil fuel power generators; (ii) manure digester-generators, which capture methane that would otherwise be emitted from anaerobic decomposition of stored manure, and destroy that methane through the production of renewable electricity; (iii) landfill gas (in substantial part methane) capture and destruction, usually with either a flare or through electricity production; (iv) forest conservation and/or improved forest management, which remove carbon dioxide from the atmosphere and store it in carbon in forest biomass; and (v) land-use management changes that increase soil carbon levels, such as through conversion from tillage farming to no-till farming, the practice of polyculture cover cropping otherwise fallow fields, and/or the use of biotic fertilizers in lieu of anhydrous ammonia fertilizer, among others.

In the Voluntary Carbon Market, there are numerous structures under which VER projects are developed, implemented, and operated, and under which their emissions reductions are monitored, verified, issued as VER credits on a registry, transferred among market participants and ultimately used to offset other emissions. These various structures generally involve some or all of the following kinds of market participants:

Project Owner/Operator:

This is the primary, indispensible role within any VER Project structure – the owner/operator of the equipment that creates the Project emissions reductions, or the owner of the land or timber rights who engages in activities that remove and sequester atmospheric carbon dioxide. All VER Projects are predicated on the conduct of an activity that reduces GHG emissions or increases GHG removals relative to a baseline of the emissions/removals that were occurring prior to the conduct of the project activity. *Without the conduct of that activity by the Project Owner/Operator* – the dairy farmer operating a manure digester, the school district operating a wind turbine, e.g., *there are no emissions reductions or removals to verify and sell as VERs*.

VER Project Developer:

This is also an indispensible role within any VER Project structure – the party who has the ability to: (i) assess the Project's additionality (its financial non-viability in the absence of the opportunity to receive revenues for its emissions reductions/removals); (ii) identify the baseline scenario (the emissions trajectory in the absence of the project); (iii) define the project scope and boundary (the sources and sinks of GHGs from various project or project-related emissions that must be netted against each other quantify the project's net impact); (iv) design the project monitoring plan and draft the project design document ("Project Design Document," or "PDD") meeting the validation requirements of a Standard (see Validation and Verification Standard, below); and (v) ultimately ensure that the project is designed and implemented in such a manner that: (a) a Standard-accredited independent third party (see Validation and Verification Body, below) can validate that the project as designed meets the project design requirements of the applicable Standard, a prerequisite to registration of the project with a Standard; (b) such a third party can verify the reductions and/or removals produced by the project during a given period, a prerequisite for the Standard to issue credits for such reductions/removals; and (c) marketable credits are issued on a Registry (see Registry, below) pursuant to a Standard.

A Project Owner/Operator can reduce emissions or increase removals, but the reductions/removals will have less value in the market without the integrity brought to the process through the design, development, operation and verification of the Project as a VER Project in accordance with the requirements of a Standard. Importantly, an Owner/Operator with the requisite skills and experience can be its own Project Developer, or it can hire a third party to perform Project Development services for it. Project Development service providers are generally either Marketers who have such skills and experience, or are Validation and Verification Bodies who also offer Project Development consulting services in addition to validation and verification services.[1]

Marketer:

Marketers are often an important role within VER Project structures. Most VERs are purchased by businesses for purposes of compensating for their own emissions they cannot cost-effectively avoid. Marketers' principal value in a VER Project is that they bring access to business purchasers. Most marketers have been in the Voluntary Carbon Market for years, and have established brands, reputations, networks and customer bases which they can use and or turn to and monetize the VERs. Marketers enhance liquidity for VER Projects. Often they make the initial implementation of the Project possible, by contracting in advance to purchase the VERs to be produced, giving the Project Owner/Operator confidence that the VER revenues needed to make the project economically viable will be there at a certain price. Marketers do not necessarily perform an indispensible role, however, as it is easy and common enough for an Owner/Operator or a Project Developer who purchases the Owner/Operator's VER production to find buyers through the services of a broker or to post the project VERs on an exchange such as the Carbon TradeXchange (see http://ctxglobal.com/markets/carbon/).

Aggregator:

An Aggregator, who is often a Project Developer and/or a Marketer, creates VER Projects known under the Standards as "grouped projects" or "programs of activities" – aggregations into a single VER project of several/many Owner/Operators who conduct the same kind or similar project activities that are conducive to collective validation and verification. Periodic verification is then conducted on a random sampling basis among those in the aggregate of Owner/Operators. Aggregators typically hire the VVB and compensate the Owners/Operators for the VERs they produce based on a pre-agreed method for estimating their contribution to the total aggregate volume of VERs produced in the program of activities. Under the ACR Standard, an aggregator is referred to as a "Project Proponent," and is required under the Standard to secure the agreement of the Owners/Operators to interact with the Standard on their behalf and receive, on their behalf, issuance of the ERTs representing the VERs they produce.[2]

[1] VVBs who provide Project Development consulting services to an Owner/Operator are then precluded by the Standards' conflict of interest rules from providing validation and verification services for the same project.

[2] Project Proponents are not limited to Aggregators. In a stand-alone project (as opposed to a program of activities), the Project Proponent is whichever participant in the Project (Owner/Operator, Project Developer, or Marketer) is agreed among the participants and appointed to perform the role of Project Proponent vis-à-vis the Standard. If an Owner/Operator is its own Project Developer planning to sell through the services of a broker or an exchange, the Owner-Operator would necessarily be the Project Proponent under the Standard.

Broker:

Brokers also offer liquidity, but as they do not commit to take title to VERs, they do not provide Project Owner/Operators with the same level of confidence in revenue generation that a Marketer can. Brokers are most often involved at the wholesale level, bringing together Owner/Operators and Marketers or business customers.

Validation and Verification Body ("VVB"):

While Marketers can also be Project Developers and Owner/Operators, and Owner/Operators can conduct project development and marketing for their own projects, the VVB is required by each of the Standards to be independent of the other project participants. VVBs have subject matter expertise, and must be accredited under a Standard to review the project design document, conduct site visits, review monitoring records and validate that the project, as described in the Project Design Document, is designed to meet all the requirements of the applicable Standard, and to verify to a reasonable level of assurance that the reported emissions reductions or removals actually occurred. Necessarily, then, the VVB is a third party whose services are acquired under a contract, typically with the Owner/Operator or the Project Developer, and is generally paid a fixed pre-agreed fee. In addition, as noted above, most VVB's offer Project Development services on a fee-for-service basis, and then refrain from later performing validation and/or verification services for the applicable project to avoid conflict of interest.

Validation and Verification Standard Organization ("Standard"):

These are independent organizations, such as the Climate Action Reserve ("CAR") or the American Carbon Registry ("ACR"), who have developed standards that projects must meet to be eligible to be issued Standard-branded serially numbered credits with respect to the VERs they produce.[3] For example, CAR issues VER credits called "Climate Reserve Tonnes," or "CRTs" and ACR issues VER credits called "Emission Reduction Tonnes," or "ERTs." Created, in the words of ACR, "to create confidence in the environmental and scientific integrity of carbon offsets in order to accelerate transformational emission reduction actions," these Standards organizations define criteria that projects must meet, establish methodologies

[3] It is important to note the distinction between VERs and either ERTs or CRTs. VERs are commonly considered to be a "general intangible." At their core, they are the ownership, passed by contract, of the rights necessary to substantiate a claim of responsibility for causing the underlying reduction or removal. Originally those rights are held by the person whose action proximately caused the reduction or removal, and are passed by contract ultimately to parties who place a monetary value on being able to make such a claim, and find the purchase of VERs to be more cost effective than directly creating reductions or removals on their own. ERTs and CRTs, on the other hand, are branded serial numbers. They are a tool, used by Registries to track ownership of VERs. ERTs and CRTs are issued with respect to VERs, and are transferred from account to account on the Registry following transfer of the underlying VERs from party to party. In all cases, the VER is the thing owned and transferred, and VER transfers occur and are documented between the transferee and transferor by contracts entered into and performed outside of the Registry. Only once the transferor and transferee have reported to the Registry their performance of the underlying transfer of the VERs between them, does the Registry move the serial numbers from one account to the other. As such, this letter generally refers to the purchase and sale of VERs, not ERTs or CRTs.

for project operations, monitoring, reporting and verification, and operate or contract with Registries on which projects are listed and their VER credits are transferred among account holders on the registry, and where they are "retired" following use as an emissions offset.

Importantly, with projects involving the sequestration of carbon that is susceptible to unintentional reversal (e.g., due to fire, or flooding) or intentional reversal (e.g., timber harvesting or land tillage), each of the major Standards, including ACR, requires a portion of VER credits otherwise issuable to the Project Proponent to be retained by ACR, which it places in a pool of such credits retained by it from all reversible projects registered with ACR, as a buffer pool. In the event of a reversal at any given project, the Project Proponent is required to quantify the carbon lost as carbon dioxide, and ACR cancels the corresponding number of buffer credits from the buffer pool to compensate for the reversal. Subsequently, the project must produce CO2 removals in an amount equal to the credits drawn from the buffer pool before ACR will resume crediting the project's removals with VER credits. If the reversal was intentional, such as from harvesting an otherwise preserved forest, the project typically[4] becomes ineligible for further VER crediting, and the Project Proponent is required (under a contract with ACR), to acquire ERTs from other projects and tender them to ACR to replenish the buffer pool.) As an alternative to contributing to the ACR buffer pool, or in addition, the Project Proponent can purchase and maintain qualifying insurance to ensure ACR that it has the financial resources to acquire sufficient ERTs to compensate for any reversal within its project.

Registries:

Registries, such as the Markit Environmental Registry, provide services to all participants in the Voluntary Carbon Market that provide transparency and integrity to the Market. Registries list validated projects in an electronic database, issue unique serially-numbered VER credits to Owner/Operator or its designee following verification by a VVB of the emissions reductions produced, and provide account services to market participants to record transfers of the VER credit and retirement upon end-use as an offset.

As noted, there are numerous ways to structure a VER Project and the associated VER transactions. In NativeEnergy's 14 years' experience as in the voluntary carbon market, we have been a party to or learned of structures such as the following, among others:

- A municipal landfill owner operator installs gas collection and destruction equipment and monitoring equipment, prepares the Project Design Document in accordance with the Standard, hires the VVB for validation and verification services, secures issuance of VER credits on a registry, and directly sells the VER production to a Fortune 500 end user, keeping 100% of the proceeds after paying the VVB.

[4] Given the annual decision-making in crop farming versus silviculture, crop farming project owner/operators are not disqualified for tillage events or other intentional reversals, but nevertheless would have to compensate for intentional reversals with subsequent project accruals or ERTs from the market.

- A private equity firm contracts to purchase the manure from a swine finishing operation, installs a manure digester on a leased portion of the swine operation land, digests the manure and destroys the methane in an onsite electricity generator, prepares the project design document in accordance with the Standard, hires the VVB, sells the VER production under a long-term fixed-price contract to a Marketer, who sells the VERs to dozens of business customers. The private equity firm pays the swine operation a price per gallon of manure processed in the digester.

- A forest owner contracts with a Marketer to maintain its forest in continuous forest cover, and agrees to sell all VERs produced on its land to the Marketer. The Marketer hires a firm of forestry consultants to quantify baseline standing carbon stocks and estimate future accruals, and to design a monitoring plan and draft the technical portions of the PDD. The Marketer hires the VVB, and upon issuance of the VERs and sale thereof, the Marketer pays the forest owner a floor price per VER produced plus 20% of the amount by which the Marketer's sale price exceeds the floor price. If the Marketer fails to accept and pay the forest owner for VERs produced within a year following issuance of credits therefor, the Marketer is required to pay to the forest owner the forest owner's reasonable out-of-pocket costs of effecting the sale thereof; plus the difference, if positive, of: (i) the average market price for such VERs during the year following issuance thereof; minus (ii) the market price for such VERs at the time of the Marketer's default. The marketer timely sells a portion of the VERs to its customer base at volume-based pricing and, using a broker who charges each side 3% of the sale price, locates a competing Marketer who acquires the remainder.

- A forest owner contracts with a Marketer to maintain its forest in continuous forest cover. The forest owner hires a firm of forestry consultants to quantify baseline standing carbon stocks and estimate future accruals, and to design a monitoring plan and draft the technical portions of the PDD. The Marketer hires the VVB, and upon issuance of the VERs, the Marketer distributes 70% of the VERs to the forest owner, 10% to the forestry consultancy, and keeps 20% for itself. Each party is able to sell its VERs independently, and the Marketer offers to broker the forest owner's and the consultancy's shares for the market-standard 3% brokerage fee. After contacting several brokers located by an internet search, the forest owner confirms that Marketer's brokerage fee is indeed market standard, and subsequently contracts with the Marketer to broker its VERs, as does the forestry consultancy. All three parties sell their VERs to a single buyer in a transaction arranged by Marketer.

- An Aggregator sells gravity-fed bio-sand water filters to households in rural Africa who would otherwise purify their water by burning unsustainably harvested wood. The households pay a small fee for the filters (well below cost) and sign an assignment giving title to the emissions reductions resulting from their use of the filters to the Aggregator. The Aggregator has a contract in place with a Marketer to purchase the emissions reductions, at a fixed price per VER, to fund the remaining cost of the filters and its operations and margin, paid on issuance. The Marketer hires the VVB and causes VER credits to be issued with respect to the emissions reductions annually.

The Marketer pays the Aggregator for the VERs, receives title to the VERs, and later sells the VERs to its customers and retains 100% of the proceeds.

Proposed Transactions

1. PDFA Terms

NativeEnergy has entered into a Project Development and Funding Agreement ("PDFA") with Applied Ecological Services, Inc. ("AES").[5] Under the PDFA, NativeEnergy and AES have each committed to provide the other with certain uncompensated project development services towards the development of a soil carbon sequestration project (the "Project"). In addition, NativeEnergy is committed to provide certain funding to the Project as specified milestones are met during the development phase, in exchange for the rights, as between NativeEnergy and AES, to a certain volume of VERs to be produced by the Project in each of its first 5 years of operation (the "NativeEnergy Priority VERs"). Among the milestones that are conditions to NativeEnergy's funding obligations is the ability of the parties, after commercially reasonable efforts, to secure the participation of farmers with sufficient acreage such that NativeEnergy reasonably expects the Project to produce at least 100,000 VERs per year. This can be accomplished through the participation of approximately ____% of the Early Adopters (as defined below).

The PDFA contemplates NativeEnergy and AES creating the Project as a "program of activities" in which crop farmers in the Palouse region of the Pacific Northwest convert from traditional farming to direct seeding and/or other cropland management practices capable of increasing and sustaining soil carbon levels ("Carbon Accruing Cropland Management"). The individual farmers' activities will be aggregated and validated to the American Carbon Registry Standard as a single project, with centralized administration by NativeEnergy and AEP of monitoring, verification, issuance and sale of VERs. Initially, the Project is expected to include a group of farmers that have already converted to Carbon Accruing Cropland Management (the "Early Adopters"), and to use their experience and enthusiasm to facilitate education and recruitment of farmers presently in traditional crop farming, increasing the size and scope of the Project over time.

NativeEnergy's primary roles in the Project are designing and negotiating the financial structure of the Project and the relationships with the farmers, conducting outreach to farmers soliciting their participation in the Project, preparing the non-technical aspects of the PDD, contracting with the VVB, interfacing with the American Carbon Registry, marketing the VERs, and, to the extent such marketing efforts are successful, exercising its Option (as defined below), executing the sales with respect to which it exercised the Option, and distributing the proceeds as negotiated among the project participants.

[5] AES is a leading ecological consulting firm dedicated to bringing the science of ecology to land-use decisions. With a Conservation Innovation Grant from the USDA, AES has conducted an extensive study of soil carbon levels in the Palouse region of the Pacific Northwest, with the express intention of creating a soil carbon sequestration project for the production and sale of VERs.

AES's primary roles in the Project are assisting with outreach to farmers, conducting baseline soil sampling, securing laboratory testing of soil samples, preparation of the technical portions of the PDD, creating and maintaining a web-based database (the "Database") for farmers to enter operations data and records, aggregating farmer data and conducting annual soil sampling and aerial photography for monitoring reports, and interfacing with the VVB during verification of the soil carbon accruals. In addition, AES will also assist NativeEnergy in its marketing efforts. As such, NativeEnergy and AES are each performing the roles of Project Developer, Aggregator and Marketer. Neither NativeEnergy nor AES is in the business of crop farming, and neither has any experience in or significant knowledge about traditional crop farming or in Carbon Accruing Cropland Management.

2. PPOA Terms.

The plan is to enter into Project Participation and Option Agreements with participating farmers pursuant to which the farmers will:

(i) express their good faith present intention to convert to Carbon Accruing Cropland Management;

(ii) agree, following conversion to Carbon Accruing Cropland Management, to undertake commercially reasonable efforts to engage in continuous or near-continuous Carbon Accruing Cropland Management for the 40-year duration of the Project (*importantly, the farmers insist on being able to, and will by the terms of the PPOA, retain the right to, till their fields or conduct other activities that result in soil carbon losses when climate or soil conditions require it for crop production, such as in unusually wet seasons, in their sole judgment*);

(iii) agree to upload annually to the Database farm records of seeding practices, equipment used, fertilizer application, the nature and frequency of any tillage events, and other data required for monitoring and verification of soil carbon accruals, and for determining each farmer's Pro Rata Share (as defined below);

(iv) agree to permit NativeEnergy and AES, and their designee VVB to enter onto the applicable farmer's land with reasonable notice to take soil samples and conduct verification site visits at least annually for 40 years;

(v) authorize NativeEnergy and AES to act as the Project Proponents under the ACR Standard and administer the Project;

(vi) authorize NativeEnergy to direct ACR to cause all ERTs issued with respect to soil carbon accruals resulting from their conduct of Carbon Accruing Cropland Management to be issued into an account on the Registry held by NativeEnergy as a Project Proponent, to be held for the benefit of the farmers (subject to NativeEnergy's rights under the PPOAs);

(ix) authorize and direct NativeEnergy to maintain in a dedicated subaccount each farmer's Pro Rata Share (as defined below) of such number of such ERTs as is determined by

NativeEnergy in good faith to be necessary and sufficient to insure against the risk of being required, as the Project Proponent, to tender ERTs to ACR to compensate for intentional reversals of soil carbon accruals on the Project lands, such as from a sufficient number of farmers tilling their fields during a given period to result in soil carbon losses throughout the Project lands exceeding soil carbon accruals throughout the Project lands during such period (the "Intentional Reversal Reserve");

(x) in consideration of NativeEnergy's advance funding of the cost of baseline monitoring and verification of soil carbon levels and other Project development costs: (i) assign to NativeEnergy title to their respective Pro Rata Shares of the NativeEnergy Priority VERs; and (ii) grant to NativeEnergy the option (the "Option") to purchase all remaining VERs or any portion thereof produced from their conduct of Carbon Accruing Cropland Management (including those held in the Intentional Reversal Reserve upon NativeEnergy's formulaic determination that they are no longer required to be maintained therein, but other than the NativeEnergy Priority VERs), and all associated ERTs, at the Option Price (as defined below), exercisable: (a) with respect to the VERs represented by the first ERTs to be issued[6] with respect to their conduct of Carbon Accruing Cropland Management, at any time before the date two years after such issuance; and (ii) with respect to the VERs represented by each subsequent issuance of ERTs with respect to their conduct of Carbon Accruing Cropland Management, at any time before the date one year after such issuance; where:

"Option Price" means, with respect to each farmer, such farmer's Pro Rata Share of Net Project Revenues, where:

"Pro Rata Share" is a fraction, the numerator of which is the ERTs issued to NativeEnergy by ACR with respect to estimated soil carbon accruals that occurred in a given period on the applicable farmer's land, determined based on a pre-agreed formula that accounts for the number of acres the farmer maintained in Carbon Accruing Cropland Management during such period, the number of seasons during such period that the farmer maintained such acreage in Carbon Accruing Cropland Management, the baseline soil conditions of such acreage (classified in one or more of three tiers of soil conditions), the baseline moisture conditions of such acreage (classified in one or more of three tiers of moisture conditions), the elevation of such acreage (classified in one or more of three tiers of elevation), the frequency and depth of any tillage events, and other factors, and the denominator of which is the ERTs issued to NativeEnergy with respect to the estimated soil accruals that occurred in the same period on all participating farmers' land during such period, determined based on the same formula; and

[6] Verification is planned to be conducted initially within a year of registration of the Project with ACR, and will verify Standard-eligible accruals through a fixed date on or about the date of registration of the Project. Verification is planned to be conducted at 5 year intervals thereafter. Issuance of ERTs will therefore occur in "batches" following each verification.

"Net Project Revenues" means the difference of:

(i) the gross revenues realized by NativeEnergy from the sale of VERs with respect to which NativeEnergy has exercised its Option; minus

(ii) the sum of: (a) reimbursement to NativeEnergy of all amounts paid to the VVB for verification services, and all amounts paid to ACR and the Registry as ERT issuance and transfer fees; (b) payment to AES of all amounts billed by it to the Project for its monitoring services and reimbursement to AES of all laboratory expenses paid by it; and (c) 20% of the remainder after the effect of (a) and (b), which will be shared by NativeEnergy and AES under the PDFA.

(xi) upon exercise of the Option by NativeEnergy, assign to NativeEnergy all right, title and interest in and to their Pro Rata Share of the volume of VERs and associated ERTs with respect to which NativeEnergy has exercised the Option.

Under the PPOAs, NativeEnergy will:

(i) agree to cause all necessary monitoring of soil carbon accruals to be conducted by AES and its laboratory subcontractors to enable verification and issuance of ERTs with respect to the conduct of Carbon Accruing Cropland Management by participating farmers;

(ii) agree to use commercially reasonable efforts to market and sell those VERs with respect to which it holds the Option;

(iii) acquire and sell each farmer's Pro Rata Share of the volume of VERs to be sold in connection with an exercise of the Option;

(iv) pay the Option Price to each farmer within 30 days of its sale of the corresponding VERs;

(v) promptly transfer to each farmer's account on the Registry, or an account designated by the applicable farmer, all ERTs representing VERs with respect to which NativeEnergy has not timely exercised the Option;

(vi) be liable for actual damages incurred by each farmer for any failure to make a required transfer to a farmer of ERTs representing VERs then owned by such farmer.

3. Other Information.

As discussed under Owner/Operator above, in addition to entering into the PPOA, to earn revenues from their sale of the VERs they produce, the farmers also must "conduct … an activity that reduces GHG emissions or increases GHG removals relative to a baseline of the emissions/removals that were occurring prior to the conduct of the project activity." In this case, they must conduct their crop production using Carbon Accruing Cropland Management.

Determining whether to convert from traditional crop production to Carbon Accruing Cropland Management is a significant business decision for farmers. Many will incur significant costs to replace their tillage equipment with specially designed seed drills that can accomplish seeding with minimal soil disturbance. It is estimated that an average farm of 4,000 acres would incur a net cost of $80,000 after the sale of its tillage equipment to purchase the equipment needed for Carbon Accruing Cropland Management. Some may choose to lease the necessary equipment for the first few years, to minimize the cost should they decide to revert to tillage after trying Carbon Accruing Cropland Management for a few years. Importantly, most if not all of the Early Adopters will have no new equipment costs to participate in the Project, as they have and are using the necessary equipment already. Most of the non-Early Adopters will be required to spend time and effort learning how to operate such equipment and otherwise how to conduct Carbon Accruing Cropland Management. Also, Carbon Accruing Cropland Management has been known to reduce crop yields, at least during the first few years until the yield enhancing effect of improved soil health from Carbon Accruing Cropland Management catches up to and compensates for the initial yield depressing effect of increased soil compaction from Carbon Accruing Cropland Management.

On the other hand, conducting Carbon Accruing Cropland Management has significant benefits to the farm other than the potential for VER revenues. Tillage crop production requires multiple "passes" over the fields with a heavy, high-horsepower tractor, pulling equipment with significant drag, whereas no-till direct seeding, the primary Carbon Accruing Cropland Management practice, requires only a single pass without the drag from turning the soil. As a result farmers in Carbon Accruing Cropland Management will see significant reductions in fuel costs. In fact, the realization of such fuel cost savings was the primary motivator for the Early Adopters in investing in the conversion to Carbon Accruing Cropland Management – VER revenue opportunities were not a factor.[7] In addition, Carbon Accruing Cropland Management significantly improves soil health over time and reduces soil losses through runoff, contributing to long-term farm viability. On a long-term basis, Carbon Accruing Cropland Management has been shown to increase crop yields, due to increased soil fertility.

On balance, historically, crop farmers in the Palouse appear to perceive that the costs and risks outweigh the benefits of converting to Carbon Accruing Cropland Management, as it is being conducted on only 2% to 3% of the farmed acreage in the region. Part of the reason may be due to lack of knowledge creating an unduly high perception of risk, and/or an unduly low perception of benefit. Part of it may be due to institutional bias – career crop farmers have only forty or so annual chances at a good crop, which makes them extremely reluctant to change what has worked for them in the past.

---

[7] Ordinarily, then, the Early Adopters would be ineligible under most Standards to be or participate in a Standard-eligible VER project, as the Standards require the opportunity to earn revenues from the Voluntary Carbon Market to be or have been necessary to the Project Owner's determination to implement the project. For a number of policy reasons, ACR allows Early Adopter participation when the adoption rate for the technology or activity is less than 5%, primarily as an investment in their ability to stimulate wider adoption.

Regardless, from the perspective of a VER Project Developer, the lack of significant adoption of Carbon Accruing Cropland Management is creates the opportunity, as to secure validation of a project to a Standard, the Project Developer must demonstrate that the project is "beyond business as usual" – that it faces one or more barriers to implementation, such as financial non-viability, in the absence of the opportunity to receive revenues for the VERs it produces. The Standards do not require the desire for VER revenues to be the sole reason for implementing the project – just that the VER revenue opportunity be necessary to tip the balance of costs and benefits in favor of implementation. As a project proponent of the Project, it is NativeEnergy's hope that the *combination* of the assistance of the Early Adopters in overcoming the knowledge barriers and the potential for VER revenues helping to overcome the financial barriers, will significantly increase the rate of conversion to Carbon Accruing Cropland Management, and eventually convert the Palouse region into a long-term storage site for a significant portion of the world's GHG emissions and increase the sustainability of American agriculture.

Analysis

It is our opinion that the PPOAs, when offered and entered into with the farmers in the manner described above, will not constitute "securities" as defined in Section 2(a)(1) of the Act for the reasons stated below, and accordingly registration will not be required under Section 5 thereof.

Section 2(a)(1) of the Act (15 U.S.C. §77b(a)(1)) in relevant part provides that, unless the context otherwise requires:

"[t]he term 'security' means any note, stock, treasury stock, security future, bond, debenture, evidence of indebtedness, certificate of interest or participation in any profit-sharing agreement, collateral-trust certificate, preoprganization certificate or subscription, transferable share, investment contract … or, in general, any interest or instrument commonly known as a 'security.'"

1. Stock.

It is our opinion that the PPOAs do not constitute stock. They do not bear the label "stock," and neither do they bear the characteristics typically associated with "stock" identified by the Supreme Court in Tcherepnin v Knight, 389 U.S. 332 (1967). The PPOAs are not negotiable, they are not able to be pledged or hypothecated, they do not carry voting rights, and they cannot appreciate in value. While at first glance, they might appear to carry the "right to receive dividends contingent upon an apportionment of profits," recited in Tcherepnin, at 339 as the most common feature of stock, we are of the opinion that the payments to be received by the farmers following NativeEnergy's exercise of the Option do not constitute dividends, even though they are in the first instance intended (in connection with NativeEnergy's exercise of the Option) to comprise a share of the excess of Project revenues over Project expenditures. They are not paid in proportion to ownership shares in the Project, as the farmers do not own shares of the Project. They are not paid in proportion to any "investment" the farmers might be seen as making through their purchase of the necessary equipment, as some (the Early Adopters) will make no such "investment" and can still receive payments. They are not paid in proportion to the number of acres on which they conduct Carbon Accruing Cropland Management, as acreage is only one of several variables affecting the rate of soil carbon accruals. In fact, the primary determinants of the amount of revenue any given farmer can earn are the number of acres on which the farmer conducts Carbon Accruing Cropland Management, the elevation of and moisture levels on such acreage, the slope of such acreage, the fertilizers used on such acreage, the cover cropping conducted on such acreage, the number and extent of tillage events on such acreage, which all determine the amount of soil carbon the farmer accrues, and therefor the number of VERs the farmer can sell. If a farmer accrues no soil carbon in a given period, the farmer will produce no VERs during that period and will have no opportunity to receive VER revenues. Finally, the farmers are not paid in proportion to the number of VERs they each "invest" in the Project – as is discussed below, the farmers do not "invest" VERs in the Project. They use some of them to acquire insurance against liability to ACR for intentional reversals, through contributing them to the Intentional Reversal Reserve, and they sell them to NativeEnergy if NativeEnergy exercises the Option buy them. They grant the Option in consideration of NativeEnergy providing a valuable service – undertaking the administrative work to convert their soil carbon accruals into Registry issued VER credits: VERs with respect to which ERTs are issued. If NativeEnergy does not exercise the Option, the farmers retain the VERs and associated ERTs for their own use or for sale, as Project Owners/Operators often do.

The amount any given farmer receives *per VER* can be dependent on the average price at which NativeEnergy sells the VERs produced during a given verification period, and the amounts of the costs identified in the definition of Net Project Revenues, but that alone is insufficient to render the payments dividends. While it creates the appearance of sharing in profits, and thus the appearance of dividends, the economic realities are more complex. NativeEnergy may not be positioned to fully exercise the Option, in which case, the economic reality would involve the farmers' individually or cooperatively contracting with a broker to place their VERs, or posting their VERs for sale on an exchange such as the Carbon TradeXchange (posting is free, but the seller must pay the exchange 5% of sale proceeds).

As an alternative financial structure, NativeEnergy could offer the farmers a fixed price per VER, which would eliminate the appearance of sharing in profits. But in a market as volatile as the Voluntary Carbon Market, doing so would carry significantly more financial risk for NativeEnergy, given that market pricing for VERs could drop below the fixed price offered to the farmers. As such, NativeEnergy would have to mitigate that risk by offering only a very low fixed price, which, at the margin, would be less likely to stimulate conversion to Carbon Accruing Cropland Management. To further the environmental objectives of the Project, it is critical to maximize the ultimate price received by the farmers for the VERs they produce. Structuring the Option Price based on each farmer's Pro Rata Share of Net Project Revenues is simply a mechanism to ensure that each farmer has equal priority in sales of their VERs to NativeEnergy[8] – to facilitate greater participation in the Project through the promise of fair treatment vis-à-vis other farmers.

[8] An alternative structure would be for NativeEnergy to exercise the Option farmer by farmer in the order in which farmers signed the PPOA, which would stimulate rapid near-term participation. Our goal is to stimulate long-term growth in participation, for which equal priority is a better incentive.

2. Investment Contracts.

We are also of the view that the PPOAs do not constitute "investment contracts" under the Act. As articulated by the Supreme Court in SEC v. W.J. Howey Co., 328 U.S. 293 (1946), the test of an investment contract "is whether the scheme involves an investment of money in a common enterprise with profits to come solely from the efforts of others." (*Id*., at 301.) Under this test, form is disregarded for substance and emphasis is placed on the "economic reality." (*Id*., at 298.) The Howey Court found that an investment contract, and thus a "security" within the meaning of the Act, existed where a contract for the sale of land was offered together with an optional cultivation and maintenance contract to produce oranges, due to the fact that the land purchasers lacked access to the plots and could not have obtained profits from the cultivation of the crops without the services of the promoters under the maintenance contracts.

At issue, therefore, are whether the farmers would be making an investment, whether any such investment is in a common enterprise, whether they would be doing so with an expectation of profits, and whether those profits are made by the efforts of others. For purposes of argument, we assume that there is an investment in a common enterprise with the expectation of profits. In fact, that is the Voluntary Carbon Market's reason for being: to provide financial incentives for increased engagement in activities that reduce GHG emissions or increase GHG removals. We are of the opinion, however, any such profits will not be made by the efforts of others.

We are of the view that the economic reality of NativeEnergy's and AES's offer is essentially as follows, and NativeEnergy's promotional materials will essentially convey the following message:

"If you engage in farming practices that increase soil carbon levels on the land you farm, and if you record and report your use of such practices, we will invest the resources needed to create a marketable general intangible called VERs, which represent the increases of soil carbon levels on your land that result from those farming practices. In exchange for our investment, we would require NativeEnergy to have ownership of some of your VERs and the option to purchase the remaining VERs for resale, and to be able to keep a portion of the sales proceeds, leaving the rest of the proceeds for you. In the event we can't find sufficient buyers by the time our option terminates, the VERs you produced would remain yours, to keep to substantiate your own marketing claims of carbon neutral grain production, to pass on to your grain buyers to substantiate their marketing claims of carbon neutral products, or to sell into the VER market later with the help of brokers or exchanges we can point you to.

In addition to the potential to earn revenues for the VERs you produce, engaging in these farming practices can save you money in fuel costs and labor, and over time has been shown to significantly improve soil health. We don't dictate what farming practices you engage in, and we know nothing about farming so we wouldn't even try. We encourage you to talk with other farmers to learn what has worked best for them, and to experiment and share your experiences with other farmers. You would have no liability to us if you needed to revert to prior practices – we just ask you to continue these practices if remains commercially reasonable for you to do so. But how you go about it and how much of your acreage you do it on is entirely up to you. You manage your farm. We take care of monitoring, verifying and hopefully monetizing the results, so you can remain focused on your core business of farming.

This is something you could potentially do yourself, depending on your acreage, and many businesses conduct their own VER projects on their own. You would need to hire a soil scientist and one of the accredited third party verifiers, spend a few hours on ACR's website to learn their process for getting your project validated and the VER credits issued, and take time from your farming to write up the formal project description, or hire one of many consultants to do so. The disadvantages of doing it alone are that you would incur the cost of your own validation and verification, where we can spread that cost over multiple farms, reducing the cost per VER significantly. In addition, you would be liable to the organization that issues the VERs for replacing them if you need to till and lose stored carbon that has previously been credited with VERs. In exchange for a small number of your VERs, we can take on that liability for you, and insure against that risk by putting aside some of each farmer's VERs. Any remaining risk after that pooling can be covered by a less expensive insurance policy than one covering the higher risk profile of just your farm. The disadvantage of doing it with us is that we keep a share of the VER revenues. Essentially you pay us with VERs instead of paying money to the third parties whose help you would likely need to do it on your own."

Since the Court's decision in Howey, numerous courts have chosen not to follow rigidly the "solely" from the efforts of others requirement (Howey, supra at 301) set forth in Howey. Consensus seems to have been arrived at that the more expansive formulation set out in Securities & Exch. Commn. v. Glenn W. Turner Enters., Inc., 474 F.2d 476, 482 (9th Cir. 1973), cert denied 414 U.S. 821, is more consistent with the remedial nature of the Act: where "the efforts made by those other than the investor are the undeniably significant ones, those essential managerial efforts which affect the failure or success of the enterprise." (*Id*., at 482)(See., e.g., Securities & Exch. Commn. v. Koscot Interplanetary, Inc., 497 F.2d 473 [5th Cir. 1974], Miller v. Central Chinchilla Group, Inc., 494 F.2d 414 [8th Cir. 197], Crowley v. Mongomery Ward Co., Inc. 570 F.2d 877 [10th Cir. 1978]).

Acknowledging that the purchaser "must himself exert some efforts if he is to realize a return on his initial cash outlay" (*Id*., at 482), the Turner Court noted that adhering to a strict interpretation of "solely" "could result in a mechanical, unduly restrictive view of what is and what is not an investment contract. It would be easy to evade by adding a requirement that the buyer contribute a modicum of effort." *Id*. The Turner Court took the view that the outcome in Howey should not have been different even if the buyer was to buy and plant the trees, as the "essential nature of the scheme" would still have been "buying, in exchange for money, trees and planting, a share in what he hoped would be the company's success in cultivating the trees and harvesting and marketing the crop." *Id*., at 483.

Following Turner, several courts have found the efforts of the investor insufficient to prevent characterization of the underlying transaction as a security. In Mitzner v. Cardet International, Inc. 358 F.Supp. 1262 (N.D.Ill. 1973), the court found a security to exist where the investors made the efforts to distribute products for the promoter to its customers, viewing those efforts as "a purely mechanical task" (*Id*., at 1268) and noting that the investors were not "in a position to make any meaningful or independent *business* decisions" (*Id*., emphasis in original) and that their efforts "appear to be purely *ministerial*." *Id*. (emphasis in original).

Similarly, in Miller v. Central Chinchilla Group, Inc., 494 F.2d 414 (8th Cir. 1974), the court found a security to exist where the efforts of the investors were clearly necessary to the success of the venture, where they purchased chinchillas from the promoter and raised them for resale to the promoter, for it to resell to other investors at inflated prices. The court noted that even with their efforts, "the promised profits could be achieved … only if the [promoters] secured additional investors at the inflated prices," (*Id*., at 482) and that "the plaintiffs contributions to the scheme were merely nominal, and what [they] really purchased was the [promoters'] skill at persuading others to become chinchilla raisers." *Id*. See also Koskot, supra at 487 ("investor's sole contribution … is a nominal one. Without [the promoter's efforts], an investor would invariably be powerless to realize any return on his investment.").

In some cases where the courts found a security not to exist, the courts also focused on whether the investors' efforts were "merely nominal" or something more. In Bitter v. Hoby's International, Inc., 498 F.2d 183 (9th Cir. 1974), the court noted that the efforts of the investor/franchisee were "qualitatively more substantial" than the investors in Turner, "entailing continuous operation of the restaurant, production and sale of roast beef sandwiches and related products, purchase of materials, merchandise and supplies from sources selected at his sole discretion, preparation of monthly operating statements, and employment of personnel to accomplish the foregoing" (*Id*., at 185), and therefore the restrictions imposed by the franchisor "did not render the franchisee's efforts nominal.") *Id*. See also One-O-One Enterprises, Inc. v. Caruso, 668 F.Supp. 693, 701 (D.D.C. 1987)("because defendant's efforts with respect to the provision of training, on-going advice on operations, and marketing and promotional services for plaintiffs' 25 restaurants were more than nominal, the option is not a security").

In others where a security was found not to exist, the courts hewed more closely to the wording of the Turner standard, and looked at whether the investors' efforts were essential to the success of the enterprise. See, e.g., Crowley, supra at 880, 881 (no security where "[t]hey could sell at less than the Montgomery Ward catalog prices if they were willing to accept a smaller profit margin. They could use the Montgomery Ward credit procedures, but were also free to extend credit on their own behalf. They could implement Montomery Ward advertising. They had the responsibility of hiring and firing personnel, maintaining customer relationships, and making practically all the decisions relating to the day-to-day operation of the agency," and where, therefore, "[t]he economic reality is that the contributions of the franchisees significantly and substantially affect the profits expected from the enterprise."). See also, Mr. Steak, Inc. v. River City Steak, Inc. 324 F.Supp. 640 (D.Colo. 1970) (investor's "enterprise stands or falls independently of [the promoter's] success or failure.").

Importantly, in none of these cases in which a security was found not to exist, did the court require a finding that the promoter's efforts be merely nominal. In two such cases, the promoter's efforts were clearly important. In Bitter, supra at 185, the court noted that "this is not to say that the relative profitability of the investment would not be influenced by the success of the franchisor," and held that a security did not exist because "the individual restaurant franchise operation was an integral economic entity, which could obtain supplies from sources other than the franchisor, and its success was not dependent on the success of the franchise system." *Id*., at 185.

In Cordas v. Specialty Restaurants, Inc. 470 F.Supp. 780 (D.Or. 1979), the investor had invested in a sublease to create a retail shop in a new commercial development park (the "Village") on an island in a river in Portland, Oregon. The investor did not dispute that her efforts in the conduct of her shop's business were entrepreneurial, but argued that for her shop to be successful, it was necessary for the Village as a whole to be successful – if the Village had no visitors, she would have no customers. She argued that she should have the protection of the securities laws because her small shop's impact on the park's success was merely nominal.

The Court stated that:

> "[t]he specific question I must decide is, assuming the plaintiff can establish that (1) she could not profit unless the Village as a whole was successful, and (2) her role in the Village's success was nominal, and recognizing that plaintiff's role in her own shop was entrepreneurial and managerial, can she claim the protection of the securities laws? Implicit is the question whether the Howey definition, as modified by SEC v. Turner and other cases, is concerned with the investor's impact on an enterprise or merely with the quality of the investor's participation. If the investor's impact is key, an investor may be protected even though his efforts are in some sense "entrepreneurial or managerial" as long as his impact on the enterprise is nominal. If quality of participation is the crucial factor, and investor would not be protected as long as his efforts can reasonably be characterized as entrepreneurial or managerial." *Id*., at 788.

The Court determined that the quality of the participation was the crucial factor, and held that the plaintiff had not brought herself within reach of the Howey definition of a security, noting that:

> "to hold otherwise would put the courts in the position of judging where along the continuum a manager's efforts become 'significant' in the success of a larger enterprise. The owner-manager of a small shop might have 'invested' in a shopping center within the meaning of the securities laws, while the owner of a department store had not. There may be merit to the idea that smaller merchants require protection that larger enterprises do not. However, I cannot read the federal securities laws as now written as providing a basis for such distinctions." *Id*.

We see the Courts' reasoning in these cases, and especially Cordas, as instructive in NativeEnergy's case. Regarding the farmers' efforts, the farmers' farming businesses are "integral economic entities." See Bitter, supra. Their success in producing soil carbon accruals capable of verification as VERs, along with their crops, is entirely dependent on their own "entrepreneurial and managerial" efforts. See Cordas, supra. They choose what Carbon Accruing Cropland Management practices to implement, which equipment and supplies and what employment of personnel to use in implementing them, in their sole discretion. See Bitter, supra. They choose when they need to cease and resume such practices. Unlike in Crowley, supra, NativeEnergy imposes no franchisor-type "regulations" on the farmers or the conduct of their activities, other than identifying what records they must keep and report for verification.

Regarding NativeEnergy's (and AES's) efforts, it is not the case that absent those efforts the farmers "would invariably be powerless to realize any return on his investment." See Koskot, supra. We do not argue that "the relative profitability of the investment would not be influenced by the success of" NativeEnergy's efforts, see Bitter, supra. We acknowledge that NativeEnergy's role affects the relative profitability of the investment insofar as we are able to bring "shoppers" to the VERs produced and at attractive pricing, but as in Cordas, NativeEnergy makes "no representation that investors could rely absolutely on [NativeEnergy] to turn a profit." Cordas, supra at 788.

In fact, NativeEnergy need not exercise the Option at all for the enterprise to be a success. As long as NativeEnergy, or a readily available alternative Project Developer and/or Marketer in the event of NativeEnergy's demise, causes the soil carbon accruals to be verified and issued as ERTs, the farmers will have title to and possession of a marketable or consumable general intangible of value. As noted, brokers and exchanges are readily available, and the farmers have a ready market among purchasers of their crops (wheat). NativeEnergy has built a viable business enabling businesses to pay money to be able to advertise to their customers that their operations are "carbon neutral," or that their products are "made with" renewable energy. Our experience shows that these farmers could realize premium prices for their wheat if they are able to sell it to end-product manufacturers along with substantiation for a claim that "the production of the wheat in each loaf of our bread resulting in the permanent removal of *n* pounds of carbon dioxide from the atmosphere." That premium price, along with the farmers' fuel savings and long-term soil fertility improvements, may well prove adequate even in the absence of exercise of the Option. This conclusion is supported by the fact, as we understand, that among the Early Adopters, none of whom has received a single VER representing their soil carbon accruals, none or substantially none has reverted to traditional farming practices.

It is worth examining more closely the efforts of NativeEnergy and AES that are essential to the success of the enterprise: (i) enabling and causing the verification of the soil carbon accruals and the issuance of ERTs; (i) and the distribution thereof, including the establishment and maintenance of the Intentional Reversal Reserve.

Monitoring and Verification.

As noted, each of the farmers appoints NativeEnergy as the Project Proponent and authorizes it and AES to administer the Project. While facially this appears to be a managerial function, in economic reality it is, in the words of the Mitzner Court, "a purely mechanical task." Mitzner, supra at 1268. Each of the Standards sets the rules for VER projects, among which are that any given project must follow one or more detailed protocols, or methodologies, applicable to that project type, for monitoring, reporting, quantifying and verifying emissions reductions or removals. Each parameter to be monitored is identified, as is the manner and frequency of monitoring, and the records required to be maintained. Every data point and formula for quantifying reductions or removals, is specified in the methodology. The minimum schedule for securing the conduct of verification services and the submission of verification reports is clear and inflexible. The purpose of such methodologies is to produce uniformity of process in the administration of each kind of VER project – to produce market confidence in the outcome through standardization. The methodologies' essential function is to eliminate the flexibility and individual judgment and discretion that are the fundamental components of business management. In the process of causing emissions reductions and removals to be monitored, verified and issued as registry credits, one does not make "meaningful or independent *business* decisions." *Id*. One does what one is told.

The only discretion NativeEnergy has in providing these services is in: (i) selecting more frequent verification than the schedule provided in the methodology, which for scientific reasons cannot be done with soil carbon projects, and in any case cannot affect the number of VERs produced in any given period and would not in any significant way affect the success of the enterprise; and (ii) selecting the VVB, all of whom are equally accredited, per the Standard's rules, and among whom cost differences are not material. In short, where NativeEnergy has the capacity to make business decisions, those decisions are not meaningful. As such, NativeEnergy's and AES's role in monitoring, verifying emissions reductions and removals and causing issuance of VER credits, while essential, are not "essential *managerial* efforts which affect the failure or success of the enterprise." Turner, supra at 482 (emphasis added).

Distribution of VERs, Intentional Reversal Reserve.

While determining the proper allocation to or distribution of VERs among participating farmers involves the exercise of considerable scientific knowledge on the part of AES, from and after the moment that the first farmer is offered the opportunity to participate in the project, such allocation/distribution will be in accordance with a pre-agreed, fixed formula. As with monitoring and verification, NativeEnergy will have zero discretion, and will make no business judgments in this context. Furthermore, each of the farmers will have the right to review all project records to confirm that NativeEnergy did not, in fact, exercise judgment – that it followed the formula, no more, no less.

Similarly, with the Intentional Reversal Reserve ("IRR"), NativeEnergy and AES will exercise a certain judgment in determining the percent of each farmer's VERs to set aside in the IRR, that percent will be fixed in advance and will not be subject to change without the prior written approval of each farmer, exercising his or her own judgment based in substantial part on his or her knowledge of the likelihood of the need, of the region's farmers, occasionally to engage in farming practices that cause soil carbon losses. Furthermore, to protect against the risk that the IRR proves inadequate, which could affect NativeEnergy's resources needed to position itself to exercise the Option, or to continue participating in the Project, NativeEnergy will acquire financial insurance covering that risk.

To conclude, we are of the opinion that NativeEnergy and AES are no more than service providers for the farmers, and that the services provided are not "the undeniably significant ones, those essential managerial efforts which affect the failure or success of the enterprise." *Id*. As such, we are of the opinion that the Project Participation and Option Agreements, when offered and entered into in the manner described above, will not constitute "securities" as defined in Section 2(a)(1) of the Act for the reasons stated above, and accordingly, registration will not be required under Section 5 thereof.

In view of the foregoing, we respectfully request your written assurance that the Division will not recommend any enforcement action to the Commission if NativeEnergy and AES offer the PPOA's in the manner and under the circumstances described above without registration under the Act.

NativeEnergy and AES intend to commence offering the PPOAs promptly following receipt of a favorable response from you. Accordingly, we would appreciate your response to our request as soon as possible. If, for any reason, you conclude preliminarily that you cannot respond favorably, we would hope to have the opportunity to discuss the matter with you personally prior to the preparation of your written response and, in that connection, would ask you to telephone the undersigned at (802) 861-7707 ext. 205. Thank you for your attention to this matter.

Very truly yours,

Thomas E. Stoddard
V.P. & General Counsel

January 12, 2015

Office of the Chief Counsel
Division of Corporate Finance
Securities and Exchange Commission
100 F Street, N.W.
Washington, DC 20549

Re: Certain NativeEnergy, Inc. Verified Emissions Reductions Transactions.

Dear Sir or Madam:

This letter is to respectfully request written confirmation that the Division of Corporate Finance (the "Division") will not recommend enforcement action to the Securities and Exchange Commission (the "Commission") if NativeEnergy enters into Project Participation and Option Agreements ("PPOAs") with crop farmers or crop farming business entities in the manner and under the circumstances described below without registration of PPOAs under the Securities Act of 1933 (the "1933 Act").

NativeEnergy, a Delaware corporation (www.nativeenergy.com), has, since 2001, been in the business of the production and/or wholesale purchase, and wholesale and retail sale of the legal right to claim responsibility for reductions in emissions of greenhouse gases ("GHG"), and removals of atmospheric carbon dioxide through terrestrial sequestration of carbon (collectively, following third party verification of the occurrence of the reductions or removals, the reductions or removals are generally referred to as "Verified Emissions Reductions" or "VERs"). Our customers, mostly businesses, typically purchase these reductions as a means to compensate for their own unavoidable GHG emissions, to achieve their overall emissions reduction goals. The market for VERs is generally known as the "Voluntary Carbon Market."

Background

The GHG reductions and removals NativeEnergy produces or purchases, and sells, are produced in connection with an activity or discrete set of activities known generally as "VER Projects." Among the most common VER Project types in the U.S. are: (i) renewable electricity production, such as wind turbines, which reduce emissions by displacing production of electricity by fossil fuel power generators; (ii) manure digester-generators, which capture methane that would otherwise be emitted from anaerobic decomposition of stored manure and destroy that methane through the production of renewable electricity; (iii) landfill gas (in substantial part methane) capture and destruction, usually with either a flare or through electricity production; (iv) forest conservation and/or improved forest management, which remove carbon dioxide from the atmosphere and store it in carbon in forest biomass; and (v) land-use management changes that increase soil carbon levels, such as through conversion from tillage farming to no-till farming, the practice of polyculture cover cropping otherwise fallow fields, and/or the use of biotic fertilizers in lieu of anhydrous ammonia fertilizer, among others.

In the Voluntary Carbon Market, there are numerous structures under which VER projects are developed, implemented, and operated, and under which their emissions reductions are monitored, verified, issued as VER credits on a registry, transferred among market participants and ultimately used to offset other emissions. These various structures generally involve some or all of the following kinds of market participants:

Project Owner/Operator:

This is the primary, indispensable role within any VER Project structure – the owner/operator of the equipment that creates the Project emissions reductions, or the owner of the land or timber rights who engages in activities that remove and sequester atmospheric carbon dioxide. All VER Projects are predicated on the conduct of an activity that reduces GHG emissions or increases GHG removals relative to a baseline of the emissions/removals that were occurring prior to the conduct of the project activity. *Without the conduct of that activity by the Project Owner/Operator* – the dairy farmer operating a manure digester, the school district operating a wind turbine, e.g., *there are no emissions reductions or removals to verify and sell as VERs*.

VER Project Developer:

This is also an indispensable role within any VER Project structure – the party who has the ability to: (i) assess the Project's additionality (its financial non-viability in the absence of the opportunity to receive revenues for its emissions reductions/removals); (ii) identify the baseline scenario (the emissions trajectory in the absence of the project); (iii) define the project scope and boundary (the sources and sinks of GHGs from various project or project-related emissions that must be netted against each other quantify the project's net impact); (iv) design the project monitoring plan and draft the project design document ("Project Design Document," or "PDD") meeting the validation requirements of a Standard (see Validation and Verification Standard, below); and (v) ultimately ensure that the project is designed and implemented in such a manner that: (a) a Standard-accredited independent third party (see Validation and Verification Body, below) can validate that the project as designed meets the project design requirements of the applicable Standard, a prerequisite to registration of the project with a Standard; (b) such a third party can verify the reductions and/or removals produced by the project during a given period, a prerequisite for the Standard to issue credits for such reductions/removals; and (c) marketable credits are issued on a Registry (see Registry, below) pursuant to a Standard.

A Project Owner/Operator can reduce emissions or increase removals, but the reductions/removals will have less value in the market without the integrity brought to the process through the design, development, operation and verification of the Project as a VER Project in accordance with the requirements of a Standard. Importantly, an Owner/Operator with the requisite skills and experience can be its own Project Developer, or it can hire a third party to perform Project Development services for it. Project Development service providers are generally either Marketers who have such skills and experience, or are Validation and Verification Bodies who also offer Project Development consulting services in addition to validation and verification services.[1]

Marketer:

Marketers are often an important role within VER Project structures. Most VERs are purchased by businesses for purposes of compensating for their own emissions they cannot cost-effectively avoid. Marketers' principal value in a VER Project is that they bring access to business purchasers. Most marketers have been in the Voluntary Carbon Market for years, and have established brands, reputations, networks and customer bases which they can use and or turn to and monetize the VERs. Marketers enhance liquidity for VER Projects. Often they make the initial implementation of the Project possible, by contracting in advance to purchase the VERs to be produced, giving the Project Owner/Operator confidence that the VER revenues needed to make the project economically viable will be there at a certain price. Marketers do not necessarily perform an indispensable role, however, as it is easy and common enough for an Owner/Operator or a Project Developer who purchases the Owner/Operator's VER production to find buyers through the services of a broker or to post the project VERs on an exchange such as the Carbon TradeXchange (see http://ctxglobal.com/markets/carbon/).

Aggregator:

An Aggregator, who is often a Project Developer and/or a Marketer, creates VER Projects known under the Standards as "grouped projects" or "programs of activities" – aggregations into a single VER project of several/many Owner/Operators who conduct the same kind or similar project activities that are conducive to collective validation and verification. Periodic verification is then conducted on a random sampling basis among those in the aggregate of Owner/Operators. Aggregators typically hire the VVB and compensate the Owners/Operators for the VERs they produce based on a pre-agreed method for estimating their contribution to the total aggregate volume of VERs produced in the program of activities. Under the ACR Standard, an aggregator is referred to as a "Project Proponent," and is required under the Standard to secure the agreement of the Owners/Operators to interact with the Standard on their behalf and receive, on their behalf, issuance of the ERTs representing the VERs they produce.[2]

[1] VVBs who provide Project Development consulting services to an Owner/Operator are then precluded by the Standards' conflict of interest rules from providing validation and verification services for the same project.

[2] Project Proponents are not limited to Aggregators. In a stand-alone project (as opposed to a program of activities), the Project Proponent is whichever participant in the Project (Owner/Operator, Project Developer, or Marketer) is agreed among the participants and appointed to perform the role of Project Proponent vis-à-vis the Standard. If an Owner/Operator is its own Project Developer planning to sell through the services of a broker or an exchange, the Owner-Operator would necessarily be the Project Proponent under the Standard.

Broker:

Brokers also offer liquidity, but as they do not commit to take title to VERs, they do not provide Project Owner/Operators with the same level of confidence in revenue generation that a Marketer can. Brokers are most often involved at the wholesale level, bringing together Owner/Operators and Marketers or business customers.

Validation and Verification Body ("VVB"):

While Marketers can also be Project Developers and Owner/Operators, and Owner/Operators can conduct project development and marketing for their own projects, the VVB is required by each of the Standards to be independent of the other project participants. VVBs have subject matter expertise, and must be accredited under a Standard to review the Project Design Document, conduct site visits, review monitoring records and validate that the project, as described in the Project Design Document, is designed to meet all the requirements of the applicable Standard, and to verify to a reasonable level of assurance that the reported emissions reductions or removals actually occurred. Necessarily, then, the VVB is a third party whose services are acquired under a contract, typically with the Owner/Operator or the Project Developer, and is generally paid a fixed pre-agreed fee. In addition, as noted above, most VVB's offer Project Development services on a fee-for-service basis, and then refrain from later performing validation and/or verification services for the applicable project to avoid conflict of interest.

Validation and Verification Standard Organization ("Standard"):

These are independent organizations, such as the Climate Action Reserve ("CAR") or the American Carbon Registry ("ACR"), who have developed standards that projects must meet to be eligible to be issued Standard-branded serially numbered credits with respect to the VERs they produce.[3] For example, CAR issues VER credits called "Climate Reserve Tonnes," or "CRTs" and ACR issues VER credits called "Emission Reduction Tonnes," or "ERTs." Created, in the words of ACR, "to create confidence in the environmental and scientific

[3] It is important to note the distinction between VERs and either ERTs or CRTs. VERs are commonly considered to be a "general intangible." At their core, they are the ownership, passed by contract, of the rights necessary to substantiate a claim of responsibility for causing the underlying reduction or removal. Originally those rights are held by the person whose action proximately caused the reduction or removal, and are passed by contract ultimately to parties who place a monetary value on being able to make such a claim, and find the purchase of VERs to be more cost effective than directly creating reductions or removals on their own. ERTs and CRTs, on the other hand, are branded serial numbers. They are a tool, used by Registries, to track ownership of VERs. ERTs and CRTs are issued with respect to VERs, and are transferred from account to account on the Registry following transfer of the underlying VERs from party to party. In all cases, the VER is the thing owned and transferred, and VER transfers occur and are documented between the transferee and transferor by contracts entered into and performed outside of the Registry. Only once the transferor and transferee have reported to the Registry their performance of the underlying transfer of the VERs between them, does the Registry move the serial numbers from one account to the other. As such, this letter generally refers to the purchase and sale of VERs, not ERTs or CRTs.

integrity of carbon offsets in order to accelerate transformational emission reduction actions," these Standards organizations define criteria that projects must meet, establish methodologies for project operations, monitoring, reporting and verification, and operate or contract with Registries on which projects are listed and their VER credits are transferred among account holders on the registry, and where they are "retired" following use as an emissions offset.

Importantly, with projects involving the sequestration of carbon that is susceptible to unintentional reversal (e.g., due to fire, or flooding) or intentional reversal (e.g., timber harvesting or land tillage), each of the major Standards, including ACR, requires a portion of VER credits otherwise issuable to the Project Proponent to be retained by ACR, which it places in a pool of such credits retained by it from all reversible projects registered with ACR, as a buffer pool. In the event of a reversal at any given project, the Project Proponent is required to quantify the carbon lost as carbon dioxide, and ACR cancels the corresponding number of buffer credits from the buffer pool to compensate for the reversal. Subsequently, the project must produce CO2 removals in an amount equal to the credits drawn from the buffer pool before ACR will resume crediting the project's removals with VER credits. If the reversal was intentional, such as from harvesting an otherwise preserved forest, the project typically[4] becomes ineligible for further VER crediting, and the Project Proponent is required (under a contract with ACR), to acquire ERTs from other projects and tender them to ACR to replenish the buffer pool.) As an alternative to contributing to the ACR buffer pool, or in addition, the Project Proponent can purchase and maintain qualifying insurance to ensure ACR that it has the financial resources to acquire sufficient ERTs to compensate for any reversal within its project.

<u>Registries</u>:

Registries, such as the Markit Environmental Registry, provide services to all participants in the Voluntary Carbon Market that provide transparency and integrity to the Market. Registries list validated projects in an electronic database, and on authorization from a Standard, issue unique serially-numbered VER credits (ERTs, CRTs, etc.) to Owner/Operator or its designee following verification by a VVB of the emissions reductions or removals produced, and provide account services to market participants to record transfers of the VER credit and retirement upon end-use as an offset.

As noted, there are numerous ways to structure a VER Project and the associated VER transactions. In NativeEnergy's 14 years' experience as in the Voluntary Carbon Market, we have been a party to or learned of structures such as the following, among others:

- A municipal landfill owner operator installs gas collection and destruction equipment and monitoring equipment, prepares the Project Design Document in accordance with the Standard, hires the VVB for validation and verification services, secures issuance of

---

[4] Given the annual decision-making in crop farming versus silviculture, crop farming project owner/operators are not disqualified for tillage events or other intentional reversals, but nevertheless would have to compensate for intentional reversals with subsequent project accruals or ERTs from the market.

VER credits on a registry, and directly sells the VER production to a Fortune 500 end user, keeping 100% of the proceeds after paying the VVB.

- A private equity firm contracts to purchase the manure from a swine finishing operation, installs a manure digester on a leased portion of the swine operation land, digests the manure and destroys the methane in an onsite electricity generator, prepares the project design document in accordance with the Standard, hires the VVB, sells the VER production under a long-term fixed-price contract to a Marketer, who sells the VERs to dozens of business customers. The private equity firm pays the swine operation a price per gallon of manure processed in the digester.

- A forest owner contracts with a Marketer to maintain its forest in continuous forest cover, and agrees to sell all VERs produced on its land to the Marketer. The Marketer hires a firm of forestry consultants to quantify baseline standing carbon stocks and estimate future accruals, and to design a monitoring plan and draft the technical portions of the PDD. The Marketer hires the VVB, and upon issuance of the VERs and sale thereof, the Marketer pays the forest owner a floor price per VER produced plus 20% of the amount by which the Marketer's sale price exceeds the floor price. If the Marketer fails to accept and pay the forest owner for VERs produced within a year following issuance of credits therefor, the Marketer is required to pay to the forest owner the forest owner's reasonable out-of-pocket costs of effecting the sale thereof; plus the difference, if positive, of: (i) the average market price for such VERs during the year following issuance thereof; minus (ii) the market price for such VERs at the time of the Marketer's default. The marketer timely sells a portion of the VERs to its customer base at volume-based pricing and, using a broker who charges each side 3% of the sale price, locates a competing Marketer who acquires the remainder.

- A forest owner contracts with a Marketer to maintain its forest in continuous forest cover. The forest owner hires a firm of forestry consultants to quantify baseline standing carbon stocks and estimate future accruals, and to design a monitoring plan and draft the technical portions of the PDD. The Marketer hires the VVB, and upon issuance of the VERs, the Marketer distributes 70% of the VERs to the forest owner, 10% to the forestry consultancy, and keeps 20% for itself. Each party is able to sell its VERs independently, and the Marketer offers to broker the forest owner's and the consultancy's shares for the market-standard 3% brokerage fee. After contacting several brokers located by an internet search, the forest owner confirms that Marketer's brokerage fee is indeed market standard, and subsequently contracts with the Marketer to broker its VERs, as does the forestry consultancy. All three parties sell their VERs to a single buyer in a transaction arranged by Marketer.

- An Aggregator sells gravity-fed bio-sand water filters to households in rural Africa who would otherwise purify their water by burning unsustainably harvested wood. The households pay a small fee for the filters (well below cost) and sign an assignment giving title to the emissions reductions resulting from their use of the filters to the Aggregator. The Aggregator has a contract in place with a Marketer to purchase the emissions reductions, at a fixed price per VER, to fund the remaining cost of the filters and its operations and margin, paid on issuance. The Marketer hires the VVB and causes VER credits to be issued with respect to the emissions reductions annually. The Marketer pays the Aggregator for the VERs, receives title to the VERs, and later sells the VERs to its customers and retains 100% of the proceeds.

Proposed Transactions

The "Project" discussed in this letter was initially conceived by Applied Ecological Services, Inc. ("AES") [5] and its initial development was funded under a Conservation Innovation Grant from the USDA for the specific purpose of conducting the scientific research and project development work needed to provide the foundation for a soil carbon sequestration project. AES's CIG grant was part of a multi-million dollar USDA effort in 2011 to fund innovative projects that improve agricultural practices and produce new methodologies for those practices to be eligible under carbon Standards as new VER project types, to bring the support of funding from the Voluntary Carbon Market to enable the expanded adoption of those practices. AES's award summary and the project descriptions of the other grantees can be seen here:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/cig/?&cid=stelprdb1042408.
NativeEnergy believes that some of the VER projects that will result from these grantees' efforts may be required to be structured similarly to the project discussed in this letter, to be feasible.

1. PDFA Terms

NativeEnergy has entered into a Project Development and Funding Agreement ("PDFA") with AES. Under the PDFA, NativeEnergy and AES have each committed to provide the other with certain uncompensated project development services towards the development of a soil carbon sequestration project (the "Project"). In addition, NativeEnergy is committed to provide certain funding[6] to the Project as specified milestones are met during the development phase, in exchange for the rights, as between NativeEnergy and AES, to a certain volume of VERs to be produced by the Project in each of its first 5 years of operation (the "NativeEnergy Priority VERs"). Among the milestones that are conditions to NativeEnergy's funding obligations is the ability of the parties, after commercially reasonable efforts, to secure the participation of farmers with sufficient acreage such that NativeEnergy reasonably expects the Project to produce at least 100,000 VERs in the first year. This can be accomplished through the participation of approximately 40% of the Early Adopters, under the most conservative assumptions (as defined below).

[5] AES is a leading ecological consulting firm dedicated to bringing the science of ecology to land-use decisions. With a Conservation Innovation Grant from the USDA, AES has conducted an extensive study of soil carbon levels in the Palouse region of the Pacific Northwest, with the express intention of creating a soil carbon sequestration project for the production and sale of VERs.
[6] The funding NativeEnergy is providing constitutes the cash match amount required under the USDA CIG grant that funded the initial development of the Project by AES.

The PDFA contemplates NativeEnergy and AES creating the Project as a "program of activities" in which crop farmers in the Palouse region of the Pacific Northwest convert from traditional farming to direct seeding and/or other cropland management practices capable of increasing and sustaining soil carbon levels ("Carbon Accruing Cropland Management"). The individual farmers' activities will be aggregated and validated to the American Carbon Registry Standard as a single project, with centralized administration by NativeEnergy and AEP of monitoring, verification, issuance and sale of VERs. Initially, the Project is expected to include a group of farmers that have already converted to Carbon Accruing Cropland Management (the "Early Adopters"), and to use their experience and enthusiasm to facilitate education and recruitment of farmers presently in traditional crop farming, increasing the size and scope of the Project over time.

NativeEnergy's primary roles in the Project are designing and negotiating the financial structure of the Project and the relationships with the farmers, conducting outreach to farmers soliciting their participation in the Project, preparing the non-technical aspects of the PDD, contracting with the VVB, interfacing with the American Carbon Registry, marketing the VERs, and, to the extent such marketing efforts are successful, exercising its Option (as defined below), executing the sales with respect to which it exercised the Option, and distributing the proceeds as negotiated among the project participants.

AES's primary roles in the Project are assisting with outreach to farmers, conducting baseline soil sampling, securing laboratory testing of soil samples, preparation of the technical portions of the PDD, creating and maintaining a web-based database (the "Database") for farmers to enter operations data and records, aggregating farmer data and conducting annual soil sampling and aerial photography for monitoring reports, and interfacing with the VVB during verification of the soil carbon accruals. In addition, AES will also assist NativeEnergy in its marketing efforts. As such, NativeEnergy and AES are each performing the roles of Project Developer, Aggregator and Marketer. Neither NativeEnergy nor AES is in the business of crop farming, and neither has any experience in or significant knowledge about traditional crop farming or in Carbon Accruing Cropland Management.

2. PPOA Terms.

The plan is to enter into Project Participation and Option Agreements with participating farmers pursuant to which the farmers will:

(i) express their good faith present intention to convert to Carbon Accruing Cropland Management (or, in the case of Early Adopters, to continue Carbon Accruing Cropland Management);

(ii) agree, following conversion to Carbon Accruing Cropland Management, to undertake commercially reasonable efforts to engage in continuous or near-continuous Carbon Accruing Cropland Management for the 40-year duration of the Project (*importantly, the farmers insist on being able to, and will by the terms of the PPOA, retain the right to, till their fields or conduct other activities that result in soil carbon losses when climate or soil conditions require it for crop production, such as in unusually wet seasons, in their sole judgment*);

(iii) agree to upload annually to the Database farm records of seeding practices, equipment used, fertilizer application, the nature and frequency of any tillage events, and other data required for monitoring and verification of soil carbon accruals, and for determining each farmer's Pro Rata Share (as defined below);

(iv) agree to permit NativeEnergy and AES, and their designee VVB to enter onto the applicable farmer's land with reasonable notice to take soil samples and conduct verification site visits at least annually for 40 years;

(v) authorize NativeEnergy and AES to act as the Project Proponents under the ACR Standard and administer the Project;

(vi) authorize NativeEnergy to direct ACR to cause all ERTs issued with respect to soil carbon accruals resulting from their conduct of Carbon Accruing Cropland Management to be issued into an account on the Registry held by NativeEnergy as a Project Proponent, to be held for the benefit of the farmers (subject to NativeEnergy's rights under the PPOAs);

(ix) authorize and direct NativeEnergy to maintain in a dedicated subaccount each farmer's Pro Rata Share (as defined below) of such number of such ERTs as is determined by NativeEnergy[7] in good faith to be necessary and sufficient to insure against the risk of being required, as the Project Proponent, to tender ERTs to ACR to compensate for intentional reversals of soil carbon accruals on the Project lands, such as from a sufficient number of farmers tilling their fields during a given period to result in soil carbon losses throughout the Project lands exceeding soil carbon accruals throughout the Project lands during such period (the "Intentional Reversal Reserve");

(x) in consideration of NativeEnergy's advance funding of the cost of baseline monitoring and verification of soil carbon levels and other Project development costs: (i) assign to NativeEnergy title to their respective Pro Rata Shares of the NativeEnergy Priority VERs; and (ii) grant to NativeEnergy the option (the "Option") to purchase all remaining VERs or any portion thereof produced from their conduct of Carbon Accruing Cropland Management (including those held in the Intentional Reversal Reserve upon NativeEnergy's formulaic determination that they are no longer required to be maintained therein, but other than the NativeEnergy Priority VERs), and all associated ERTs, at the Option Price (as defined below), exercisable: (a) with respect to the VERs represented by the first ERTs to be issued[8] as a result of their conduct of Carbon Accruing Cropland Management, at any time before the date two years after such issuance; and (b) with respect to the VERs represented by each subsequent issuance of ERTs with respect to their conduct of Carbon Accruing Cropland Management, at any time before the date one year after such issuance; where:

[7] This determination will be made prior to farmers enrolling in the Project, and will remain fixed at the pre-determined percent unless the farmers consent to a modification.

[8] Verification is planned to be conducted initially within a year of registration of the Project with ACR, and will verify Standard-eligible accruals through a fixed date on or about the date of registration of the Project. Verification is planned to be conducted at 5 year intervals thereafter. Issuance of ERTs will therefore occur in "batches" following each verification.

"Option Price" means, with respect to each farmer, such farmer's Pro Rata Share of Net Project Revenues, where:

"Pro Rata Share" is a fraction, the numerator of which is the ERTs issued to NativeEnergy by ACR with respect to estimated soil carbon accruals that occurred in a given period on the applicable farmer's land, determined based on pre-agreed formulae that account for the number of acres the farmer maintained in Carbon Accruing Cropland Management during such period, the number of seasons during such period that the farmer maintained such acreage in Carbon Accruing Cropland Management, the baseline soil conditions of such acreage (classified in one or more of three tiers of soil conditions), the baseline moisture conditions of such acreage (classified in one or more of three tiers of moisture conditions), the elevation of such acreage (classified in one or more of three tiers of elevation), the frequency and depth of any tillage events, and other factors, and the denominator of which is the ERTs issued to NativeEnergy with respect to the estimated soil accruals that occurred in the same period on all participating farmers' land during such period, determined based on the same formula; and

"Net Project Revenues" means the difference of:

(i) the gross revenues realized by NativeEnergy from the sale of VERs with respect to which NativeEnergy has exercised its Option; minus

(ii) the sum of: (a) reimbursement to NativeEnergy of all amounts paid to the VVB for verification services, and all amounts paid to ACR and the Registry as ERT issuance and transfer fees; (b) payment to AES of all amounts billed by it to the Project for its monitoring services and reimbursement to AES of all laboratory expenses paid by it; and (c) 20% of the remainder after the effect of (a) and (b), which will be shared by NativeEnergy and AES under the PDFA.

(xi) upon exercise of the Option by NativeEnergy, assign to NativeEnergy all right, title and interest in and to their Pro Rata Share of the volume of VERs and associated ERTs with respect to which NativeEnergy has exercised the Option.

Importantly, at no time prior to the issuance of ERTs associated with VERs produced by the farmers is any payment made by any farmer to NativeEnergy or AES. The only payments made by the farmers are payments made to purchase or lease any direct seeding equipment or other equipment they decide, in their sole discretion, that they need to conduct Carbon Accruing Cropland Management, as discussed below. The farmers buy or lease this equipment from suppliers of their choosing, none of which has any affiliation or other relationship with NativeEnergy or AES, and the farmers acquire and retain 100% of the fair market value of the equipment they purchase or the lease they enter into.[9]

[9] As noted, following issuance of ERTs, the farmers contribute VERs to the Intentional Reversal Reserve, they contribute their Pro Rata Share of the NativeEnergy Priority VERs, and they contribute

Under the PPOAs, NativeEnergy will:

(i) agree to cause all necessary monitoring of soil carbon accruals to be conducted by AES and its laboratory subcontractors to enable verification and issuance of ERTs with respect to the conduct of Carbon Accruing Cropland Management by participating farmers;

(ii) agree to use commercially reasonable efforts to market and sell those VERs with respect to which it holds the Option;

(iii) acquire and sell each farmer's Pro Rata Share of the volume of VERs to be sold in connection with an exercise of the Option;

(iv) pay the Option Price to each farmer within 30 days of its sale of the corresponding VERs;

(v) promptly transfer to each farmer's account on the Registry, or an account designated by the applicable farmer, all ERTs representing VERs with respect to which NativeEnergy has not timely exercised the Option;

(vi) be liable for actual damages incurred by each farmer for any failure to make a required transfer to a farmer of ERTs representing VERs then owned by such farmer.

3. Other Information.

As discussed under Owner/Operator above, in addition to entering into the PPOA, to earn revenues from their sale of the VERs they produce, the farmers also must "conduct … an activity that reduces GHG emissions or increases GHG removals relative to a baseline of the emissions/removals that were occurring prior to the conduct of the project activity." In this case, they must conduct their crop production using Carbon Accruing Cropland Management.

Determining whether to convert from traditional crop production to Carbon Accruing Cropland Management is a significant business decision for farmers. Many will incur significant costs to replace their tillage equipment with specially designed seed drills that can accomplish seeding with minimal soil disturbance. It is estimated that an average farm of 4,000 acres would incur a net cost of $80,000 after the sale of its tillage equipment to purchase the equipment needed for Carbon Accruing Cropland Management. Some may choose to lease the necessary equipment for the first few years, to minimize the cost should they decide to revert to tillage after trying Carbon Accruing Cropland Management for a few years. Importantly, most if not all of the Early Adopters will have no new equipment costs to participate in the Project, as they have and are using the necessary equipment already. Most of the non-Early

---

the amounts described in clause (ii) of the definition of Net Project Revenues. We are of the view that none of those contributions constitutes an "investment" in the Project, as each is paid as compensation for a service: reversal risk insurance, project development and verification services, and sales commissions, respectively.

Adopters will be required to spend time and effort learning how to operate such equipment and otherwise how to conduct Carbon Accruing Cropland Management. Also, Carbon Accruing Cropland Management has been known to reduce crop yields, at least during the first few years until the yield enhancing effect of improved soil health from Carbon Accruing Cropland Management catches up to and compensates for the initial yield depressing effect of increased soil compaction from Carbon Accruing Cropland Management.

On the other hand, conducting Carbon Accruing Cropland Management has significant benefits to the farm other than the potential for VER revenues. Tillage crop production requires multiple "passes" over the fields with a heavy, high-horsepower tractor, pulling equipment with significant drag, whereas no-till direct seeding, the primary Carbon Accruing Cropland Management practice, requires only a single pass without the drag from turning the soil. As a result, farmers in Carbon Accruing Cropland Management will see significant reductions in fuel costs. In fact, the realization of such fuel cost savings was the primary motivator for the Early Adopters in investing in the conversion to Carbon Accruing Cropland Management – VER revenue opportunities were not a factor.[10] In addition, Carbon Accruing Cropland Management significantly improves soil health over time and reduces soil losses through runoff, contributing to long-term farm viability. On a long-term basis, Carbon Accruing Cropland Management has been shown to increase crop yields, due to increased soil fertility.

On balance, historically, crop farmers in the Palouse appear to perceive that the costs and risks outweigh the benefits of converting to Carbon Accruing Cropland Management, as it is being conducted on only 2% to 3% of the farmed acreage in the region. Part of the reason may be due to lack of knowledge creating an unduly high perception of risk, and/or an unduly low perception of benefit. Part of it may be due to institutional bias – career crop farmers have only forty or so annual chances at a good crop, which makes them extremely reluctant to change what has worked for them in the past.

Regardless, from the perspective of a VER Project Developer, the lack of significant adoption of Carbon Accruing Cropland Management is creates the opportunity, as to secure validation of a project to a Standard, the Project Developer must demonstrate that the project is "beyond business as usual" – that it faces one or more barriers to implementation, such as financial non-viability or educational or technical barriers, in the absence of the opportunity to receive revenues for the VERs it produces. The Standards do not require the desire for VER revenues to be the sole reason for implementing the project – just that the VER revenue opportunity be necessary to tip the balance of costs and benefits in favor of implementation. As a project proponent of the Project, it is NativeEnergy's hope that the *combination* of the assistance of the Early Adopters in overcoming the knowledge barriers and the potential for VER revenues helping to overcome the financial barriers, will significantly increase the rate of conversion to Carbon Accruing Cropland Management, and eventually convert the Palouse

[10] Ordinarily, then, the Early Adopters would be ineligible under most Standards to be or participate in a Standard-eligible VER project, as the Standards require the opportunity to earn revenues from the Voluntary Carbon Market to be or have been necessary to the Project Owner's determination to implement the project. For a number of policy reasons, ACR allows Early Adopter participation when the adoption rate for the technology or activity is less than 5%, primarily as an investment in their ability to stimulate wider adoption.

region into a long-term storage site for a significant portion of the world's GHG emissions and increase the sustainability of American agriculture.

Analysis

It is our opinion that the PPOAs, when offered and entered into with the farmers in the manner described above, will not constitute "securities" as defined in Section 2(a)(1) of the 1933 Act and/or Section 3(a)(10) of the Securities Exchange Act of 1934 (the "1934 Act") for the reasons stated below, and accordingly registration will not be required under either such Act.

Section 2(a)(1) of the Act (15 U.S.C. §77b(a)(1)) in relevant part provides that, unless the context otherwise requires:

"[t]he term 'security' means any note, stock, treasury stock, security future, bond, debenture, evidence of indebtedness, certificate of interest or participation in any profit-sharing agreement, collateral-trust certificate, preorganization certificate or subscription, transferable share, investment contract … or, in general, any interest or instrument commonly known as a 'security.'"

Section 3(a)(10) of the 1934 Act (15 U.S.C. §78c(a)(10)) provides a virtually identical definition of "security."

1. Stock.

It is our opinion that the PPOAs do not constitute stock. They do not bear the label "stock," and neither do they bear the characteristics typically associated with "stock" identified by the Supreme Court in Tcherepnin v Knight, 389 U.S. 332 (1967). The PPOAs are not negotiable, they are not able to be pledged or hypothecated, they do not carry voting rights, and they cannot appreciate in value. While at first glance, they might appear to carry the "right to receive dividends contingent upon an apportionment of profits," recited in Tcherepnin, at 339, as the most common feature of stock, we are of the opinion that the payments to be received by the farmers following NativeEnergy's exercise of the Option do not constitute dividends, even though they are in the first instance intended (in connection with NativeEnergy's exercise of the Option) to comprise a share of the excess of Project revenues over Project expenditures. They are not paid in proportion to ownership shares in the Project, as the farmers do not own shares of the Project. They are not paid in proportion to any "investment" the farmers might be seen as making through their purchase of the necessary equipment, as some (the Early Adopters) will make no such "investment" and can still receive payments. They are not paid in proportion to the number of acres on which they conduct Carbon Accruing Cropland Management, as acreage is only one of several variables affecting the rate of soil carbon accruals. In fact, the primary determinants of the amount of revenue any given farmer can earn are the number of acres on which the farmer conducts Carbon Accruing Cropland Management, the elevation of and moisture levels on such acreage, the slope of such acreage, the fertilizers used on such acreage, the cover cropping conducted on such acreage, the number and extent of tillage events on such acreage, which all determine the amount of soil carbon the farmer accrues, and therefor the number of VERs the farmer can sell. If a farmer accrues no soil carbon in a given period, the farmer will produce no VERs during that period and will have no opportunity to receive VER revenues. Finally, the farmers are not paid in proportion to the number of VERs they each "invest" in the Project – as is discussed below, the farmers do not "invest" VERs in the Project. They use some of them to acquire insurance against liability to ACR for intentional reversals, through contributing them to the Intentional Reversal Reserve, and they sell them to NativeEnergy if NativeEnergy exercises the Option buy them. They grant the Option in consideration of NativeEnergy providing a valuable service – undertaking the administrative work to convert their soil carbon accruals into Registry issued VER credits: VERs with respect to which ERTs are issued. If NativeEnergy does not exercise the Option, the farmers retain the VERs and associated ERTs for their own use or for sale, as Project Owners/Operators often do.

The amount any given farmer receives *per VER* can be dependent on the average price at which NativeEnergy sells the VERs produced during a given verification period, and the amounts of the costs identified in the definition of Net Project Revenues, but that alone is insufficient to render the payments dividends. While it creates the appearance of sharing in profits, and thus the appearance of dividends, the economic realities are more complex. NativeEnergy may not be positioned to fully exercise the Option, in which case, the economic reality would involve the farmers' individually or cooperatively contracting with a broker to place their VERs, or posting their VERs for sale on an exchange such as the Carbon TradeXchange (posting is free, but the seller must pay the exchange 5% of sale proceeds), or selling their grain at a premium with carbon reduction claims associated with their retirement of their VERs.

As an alternative financial structure, NativeEnergy could offer the farmers a fixed price per VER, which would eliminate the appearance of sharing in profits. But in a market as volatile as the Voluntary Carbon Market, doing so would carry significantly more financial risk for NativeEnergy, given that market pricing for VERs could drop below the fixed price offered to the farmers. As such, NativeEnergy would have to mitigate that risk by offering only a very low fixed price, which, at the margin, would be less likely to stimulate conversion to Carbon Accruing Cropland Management. To further the environmental objectives of the Project, it is important to maximize the ultimate price received by the farmers for the VERs they produce. Structuring the Option Price based on each farmer's Pro Rata Share of Net Project Revenues is simply a mechanism to ensure that each farmer has equal priority in any sales of their VERs to NativeEnergy[11] – to facilitate greater participation in the Project through the promise of fair treatment vis-à-vis other farmers.

2. Investment Contracts.

We are also of the view that the PPOAs do not constitute "investment contracts" under the Act. As articulated by the Supreme Court in SEC v. W.J. Howey Co., 328 U.S. 293 (1946), the test of an investment contract "is whether the scheme involves an investment of

[11] An alternative structure would be for NativeEnergy to exercise the Option farmer by farmer in the order in which farmers signed the PPOA, which would stimulate rapid near-term participation. Our goal is to stimulate long-term growth in participation, for which equal priority is a better incentive.

money in a common enterprise with profits to come solely from the efforts of others." (*Id*., at 301.) Under this test, form is disregarded for substance and emphasis is placed on the "economic reality." (*Id*., at 298.) The Howey Court found that an investment contract, and thus a "security" within the meaning of the Act, existed where a contract for the sale of land was offered together with an optional cultivation and maintenance contract to produce oranges, due to the fact that the land purchasers lacked access to the plots and could not have obtained profits from the cultivation of the crops without the services of the promoters under the maintenance contracts.

At issue, therefore, are whether the farmers would be making an investment, whether any such investment is in a common enterprise, whether they would be doing so with an expectation of profits, and whether those profits are made by the efforts of others. For purposes of argument, we assume that there is an investment in a common enterprise with the expectation of profits. In fact, that is the Voluntary Carbon Market's reason for being: to provide financial incentives for increased engagement in activities that reduce GHG emissions or increase GHG removals. We are of the opinion, however, any such profits will not be made by the efforts of others.

We are of the view that the economic reality of NativeEnergy's and AES's offer is essentially as follows, and NativeEnergy's promotional materials will essentially convey the following message:

"If you engage in farming practices that increase soil carbon levels on the land you farm, and if you record and report your use of such practices, we will invest the resources needed to create a marketable general intangible called VERs, which represent the increases of soil carbon levels on your land that result from those farming practices. In exchange for our investment, we would require NativeEnergy to have ownership of some of your VERs and the option to purchase the remaining VERs for resale, and to be able to keep a portion of the sales proceeds, leaving the rest of the proceeds for you. In the event we can't find sufficient buyers by the time our option terminates, the VERs you produced would remain yours, to keep to substantiate your own marketing claims of carbon neutral grain production, to pass on to your grain buyers to substantiate their marketing claims of carbon neutral products, or to sell into the VER market later with the help of brokers or exchanges we can point you to.

In addition to the potential to earn revenues for the VERs you produce, engaging in these farming practices can save you money in fuel costs and labor, and over time has been shown to significantly improve soil health. We don't dictate what farming practices you engage in, and we know nothing about farming so we wouldn't even try. We encourage you to talk with other farmers to learn what has worked best for them, and to experiment and share your experiences with other farmers. You would have no liability to us if you needed to revert to prior practices – we just ask you to continue these practices if remains commercially reasonable for you to do so. But how you go about it and how much of your acreage you do it on is entirely up to you. You manage your farm. We take care of monitoring, verifying and hopefully monetizing the results, so you can remain focused on your core business of farming.

This is something you could potentially do yourself, depending on your acreage, and many businesses conduct their own VER projects on their own. You would need to hire a soil scientist and one of the accredited third party verifiers, spend time on ACR's website to learn their process for getting your project validated and the VER credits issued, and take time from your farming to write up the formal project description, or hire one of many available consultants to do so. The disadvantages of doing it alone are that you would incur the cost of your own validation and verification, where we can spread that cost over multiple farms, reducing the cost per VER significantly. In addition, you would be liable to the organization that issues the VERs for replacing them if you need to till and lose stored carbon that has previously been credited with VERs. In exchange for a small number of your VERs, we can take on that liability for you, and insure against that risk by putting aside some of each farmer's VERs. Any remaining risk after that pooling can be covered by a less expensive insurance policy than one covering the higher risk profile of just your farm. The disadvantage of doing it with us is that we keep a share of the VER revenues. Essentially you pay us with VERs instead of paying money to the third parties whose help you would likely need to do it on your own."

Since the Court's decision in Howey, numerous courts have chosen not to follow rigidly the "solely" from the efforts of others requirement (Howey, *supra* at 301) set forth in Howey. Consensus seems to have been arrived at that the more expansive formulation set out in Securities & Exch. Commn. v. Glenn W. Turner Enters., Inc., 474 F.2d 476, 482 (9th Cir. 1973), cert denied 414 U.S. 821, is more consistent with the remedial nature of the Act: where "the efforts made by those other than the investor are the undeniably significant ones, those essential managerial efforts which affect the failure or success of the enterprise." (*Id*., at 482)(See., e.g., Securities & Exch. Commn. v. Koscot Interplanetary, Inc., 497 F.2d 473 [5th Cir. 1974], Miller v. Central Chinchilla Group, Inc., 494 F.2d 414 [8th Cir. 197], Crowley v. Mongomery Ward Co., Inc. 570 F.2d 877 [10th Cir. 1978]).

Acknowledging that the purchaser "must himself exert some efforts if he is to realize a return on his initial cash outlay" (*Id*., at 482), the Turner Court noted that adhering to a strict interpretation of "solely" "could result in a mechanical, unduly restrictive view of what is and what is not an investment contract. It would be easy to evade by adding a requirement that the buyer contribute a modicum of effort." *Id*. The Turner Court took the view that the outcome in Howey should not have been different even if the buyer was to buy and plant the trees, as the "essential nature of the scheme" would still have been "buying, in exchange for money, trees and planting, a share in what he hoped would be the company's success in cultivating the trees and harvesting and marketing the crop." *Id*., at 483.

Following Turner, several courts have found the efforts of the investor insufficient to prevent characterization of the underlying transaction as a security. In Mitzner v. Cardet International, Inc. 358 F.Supp. 1262 (N.D.Ill. 1973), the court found a security to exist where the investors made the efforts to distribute products for the promoter to its customers, viewing those efforts as "a purely mechanical task" (*Id*., at 1268) and noting that the investors were not "in a position to make any meaningful or independent *business* decisions" (*Id*., emphasis in original) and that their efforts "appear to be purely *ministerial*." *Id*. (emphasis in original).

Similarly, in Miller v. Central Chinchilla Group, Inc., 494 F.2d 414 (8th Cir. 1974), discussed further below, the court refused to rule out the existence of a security where the efforts of the investors were clearly necessary to the success of the venture, where they purchased chinchillas from the promoter and raised them for resale to the promoter, for it to resell to other investors at inflated prices. The court noted that even with their efforts, "the promised profits could be achieved … only if the [promoters] secured additional investors at the inflated prices," (*Id*., at 482) and that "the plaintiffs contributions to the scheme were merely nominal, and what [they] really purchased was the [promoters'] skill at persuading others to become chinchilla raisers." *Id*. See also Koskot, at 487 ("investor's sole contribution … is a nominal one. Without [the promoter's efforts], an investor would invariably be powerless to realize any return on his investment.").

In some cases where the courts found a security not to exist, the courts also focused on whether the investors' efforts were "merely nominal" or something more. In Bitter v. Hoby's International, Inc., 498 F.2d 183 (9th Cir. 1974), the court noted that the efforts of the investor/franchisee were "qualitatively more substantial" than the investors in Turner, "entailing continuous operation of the restaurant, production and sale of roast beef sandwiches and related products, purchase of materials, merchandise and supplies from sources selected at his sole discretion, preparation of monthly operating statements, and employment of personnel to accomplish the foregoing" (*Id*., at 185), and therefore the restrictions imposed by the franchisor "did not render the franchisee's efforts nominal.") *Id*. See also One-O-One Enterprises, Inc. v. Caruso, 668 F.Supp. 693, 701 (D.D.C. 1987)("because defendant's efforts with respect to the provision of training, on-going advice on operations, and marketing and promotional services for plaintiffs' 25 restaurants were more than nominal, the option is not a security").

In others where a security was found not to exist, the courts hewed more closely to the wording of the Turner standard, and looked at whether the investors' efforts were essential to the success of the enterprise. See, e.g., Crowley, *supra* at 880, 881 (no security where "[t]hey could sell at less than the Montgomery Ward catalog prices if they were willing to accept a smaller profit margin. They could use the Montgomery Ward credit procedures, but were also free to extend credit on their own behalf. They could implement Montomery Ward advertising. They had the responsibility of hiring and firing personnel, maintaining customer relationships, and making practically all the decisions relating to the day-to-day operation of the agency," and where, therefore, "[t]he economic reality is that the contributions of the franchisees significantly and substantially affect the profits expected from the enterprise."). See also, Mr. Steak, Inc. v. River City Steak, Inc. 324 F.Supp. 640 (D.Colo. 1970) (investor's "enterprise stands or falls independently of [the promoter's] success or failure.").

Importantly, in none of these cases in which a security was found not to exist, did the court require a finding that the promoter's efforts be merely nominal. In two such cases, the promoter's efforts were clearly important. In Bitter, *supra* at 185, the court noted that "this is not to say that the relative profitability of the investment would not be influenced by the success of the franchisor," and held that a security did not exist because "the individual restaurant franchise operation was an integral economic entity, which could obtain supplies from sources other than the franchisor, and its success was not dependent on the success of the franchise system." *Id*., at 185.

In Cordas v. Specialty Restaurants, Inc. 470 F.Supp. 780 (D.Or. 1979), the investor had invested in a sublease to create a retail shop in a new commercial development park (the "Village") on an island in a river in Portland, Oregon. The investor did not dispute that her efforts in the conduct of her shop's business were entrepreneurial, but argued that for her shop to be successful, it was necessary for the Village as a whole to be successful – if the Village had no visitors, she would have no customers. She argued that she should have the protection of the securities laws because her small shop's impact on the park's success was merely nominal.

The Court stated that:

> "[t]he specific question I must decide is, assuming the plaintiff can establish that (1) she could not profit unless the Village as a whole was successful, and (2) her role in the Village's success was nominal, and recognizing that plaintiff's role in her own shop was entrepreneurial and managerial, can she claim the protection of the securities laws? Implicit is the question whether the Howey definition, as modified by SEC v. Turner and other cases, is concerned with the investor's impact on an enterprise or merely with the quality of the investor's participation. If the investor's impact is key, an investor may be protected even though his efforts are in some sense "entrepreneurial or managerial" as long as his impact on the enterprise is nominal. If quality of participation is the crucial factor, and investor would not be protected as long as his efforts can reasonably be characterized as entrepreneurial or managerial." *Id*., at 788.

The Court determined that the quality of the participation was the crucial factor, and held that the plaintiff had not brought herself within reach of the Howey definition of a security, noting that:

> "to hold otherwise would put the courts in the position of judging where along the continuum a manager's efforts become 'significant' in the success of a larger enterprise. The owner-manager of a small shop might have 'invested' in a shopping center within the meaning of the securities laws, while the owner of a department store had not. There may be merit to the idea that smaller merchants require protection that larger enterprises do not. However, I cannot read the federal securities laws as now written as providing a basis for such distinctions." *Id*.

To summarize these cases, from Turner we know that a security can be found where the promoters' efforts are the essential managerial efforts which affect the failure or success of the enterprise, at least where the investors' efforts can be described as nominal. Turner, at 482. From Koscot, and implicitly from Turner, we know that the investors' efforts are effectively nominal if, without the promoters' efforts, the investor would invariably be powerless to realize any return on his investment. Koscot, at 487. From Mitzner, we know that if the investors' efforts are purely mechanical or ministerial, they are nominal, but can rise above nominal status if the investors make meaningful or independent business decisions. Mitzner, at 1268. From Bitter, One-O-One and Mr. Steak, we know that making independent business decisions in the running of a franchise does indeed preclude finding a security to exist, as long as restrictions imposed by the franchisor don't effectively render the franchisee's efforts nominal. See, e.g., Bitter at 185. From Bitter, we know that if the investors' efforts are more than nominal, the scheme can fail the efforts of others prong even if the promoters' efforts influenced the relative profitability of the enterprise. *Id*. From Cordas, we know that no security exists if the investor's efforts are entrepreneurial and managerial, even if the promoters' success is also necessary to the investor's success. Cordas, at 788. But from Miller, we know that if the investor's only path to profitability is through the success of the promoter, the third prong is met even if the efforts of the investor are necessary and arguably managerial.[12] Miller, at 482.

From these cases, it appears that the transactions contemplated under the PPOAs would fail the third prong of the Howey/Turner test if it can be shown that: (i) the farmers' efforts are entrepreneurial and managerial or if they make meaningful or independent business decisions; and (ii) those efforts are not rendered nominal by virtue of NativeEnergy imposing onerous restrictions on their otherwise independent judgment or by virtue of the farmers being powerless to realize any return on their investment absent NativeEnergy's and AES's efforts; even if it also appears that NativeEnergy's and AES's efforts affect the relative profitability of the enterprise, or, in some circumstances, are even necessary to the success of the enterprise.

Are the farmers' efforts entrepreneurial or managerial and do they make independent business decisions, or are they purely mechanical or ministerial?

The farmers' farming businesses are "integral economic entities." See Bitter, at 185. While for argument we accede that a common enterprise exists in the Project for purposes of the securities laws, it is important to note that the farmers' farming businesses are at a minimum, a necessary component of the enterprise. Unless the farmers farm in ways that accrue soil carbon, the enterprise fails completely. As such, crop production is integral to the enterprise.

The farmers' success in producing crops while also producing soil carbon accruals capable of verification as VERs, is entirely dependent on their own "entrepreneurial and managerial" efforts. See Cordas, at 788. They choose what Carbon Accruing Cropland Management practices to implement, which equipment and supplies and what employment of personnel to use in implementing them, in their sole discretion. See Bitter, at 185. They choose what acreage to employ them on or not, and when they need to cease and resume such practices on any given acreage, based on their judgment about soil, climate and weather conditions, as their primary goal, as discussed further below, is to produce their crops. If they cease or suspend such practices, they produce no soil carbon accruals, or reduced levels thereof, and can earn no profits or only reduced profits from the sale of VERs. In short, the

---

12 The apparent conflict between Cordas and Miller can presumably be resolved by looking at the context. Miller was a pyramid scheme on its face, starting with overpriced property and ending with overpriced property. Cordas was a legitimate shop, independently run, in a legitimate commercial development whose success would bring customers to the shop.

levels of soil carbon accrued is entirely a function of how they go about producing their crops. To posit crop production as anything other than entrepreneurial and managerial, in our view, defies reason.

Does NativeEnergy or AES impose onerous "regulations" on the farmers?

No. Unlike in Crowley, *supra*, NativeEnergy imposes no franchisor-type "regulations" on the farmers or the conduct of their activities. Our only substantive requirements regarding the farmers' efforts, as detailed above, are access to the land, commercially reasonable effort to maintain Carbon Accruing Cropland Management, and certain reporting of records they otherwise maintain in the ordinary course of their businesses.

Are the farmers, absent the efforts of NativeEnergy and AES, powerless to realize any return on their investment?

To answer this question, it may be helpful to look more closely at the Miller case, keeping two important facts in mind. First, a wheat farmer in the Palouse can generally expect to produce about $1,000 per acre per year in wheat production. See http://crosscut.com/2012/07/25/agriculture/109723/pacific-northwest-wheat-crop-prices-drought-idaho/. Second, producing that wheat using Carbon Accruing Cropland Management as part of the Project is projected to sequester 1.8 metric tonnes of carbon dioxide equivalent ("CO2e") of carbon in the soil per acre per year. VER credits traded in the Voluntary Carbon Market at an average of $4.90 per metric tonne of CO2e in 2013, which would provide approximately $9 per acre per year in potential additional revenue to the farmer. See figure 3 at http://www.forest-trends.org/documents/files/doc_4501.pdf. Increasing the farmers' gross revenue by ~1% through VER sales would of course increase net revenues by a significantly larger percent, but participation in the Project will not by any means make a farmer rich quickly.

Several alleged facts distinguish the Miller case from NativeEnergy's case. First, the Miller plaintiffs alleged that the defendants sold them chinchillas "at prices many times in excess of their true market value." Miller, at 415. In NativeEnergy's case, the Early Adopters have no up-front cost to participate in the Project, and none of the farmers will purchase anything at all from NativeEnergy or AES up-front. As noted, farmers newly converting to Carbon Accruing Cropland Management will purchase direct seeding and other equipment from third parties with whom neither NativeEnergy nor AES has any relationship, presumably at fair market value. All of the farmers will be required to tender VERs to NativeEnergy in exchange for services rendered. However, unlike in Miller, where presumably no market existed for overpriced chinchillas other than the promoter's repurchase commitment, the farmers have the opportunity to compare the cost of NativeEnergy's and AES's services to the costs of other such service providers. A simple google search of "carbon offset project developer" reveals a considerable number of NativeEnergy's competitors. As such, NativeEnergy is compelled to offer reasonable, market-based terms to the farmers.

Second, the Miller plaintiffs alleged that the promoters persuaded them to invest by representing that the efforts required of them would be very minimal, which the court interpreted as the defendants' admission that the plaintiffs' efforts were nominal. *Id*., at 417. By contrast, neither NativeEnergy nor AES will make any such representation. Our goal is to leverage the experience of those farmers who have already converted successfully to Carbon Accruing Cropland Management to help tillage farmers understand, in advance, *exactly* what efforts will be required of them to grow their crops successfully in ways that accrue soil carbon. As noted, farmers are generally risk-averse when it comes to changing their farming practices, and without that clear understanding, created in them by their farming peers, they simply will not make the change.

Third, the Miller plaintiffs alleged that, despite their efforts, profits under the scheme could *only* be had if the promoters secured additional investors at inflated prices. In examining the relative efforts of the farmers and NativeEnergy/AES in the "success of the enterprise," see Turner, at 482, it is important to understand what exactly a reasonable grain farmer will view as "success." For the Early Adopters, "success" has been *entirely* comprised of producing their crops profitably using Carbon Accruing Cropland Management. VERs were not involved and therefore not a factor in their decisions to convert. Most if not all of the Early Adopters view their conversion to Carbon Accruing Cropland Management as having nevertheless been successful: We understand that among the Early Adopters, none of whom has received and sold a single VER representing their soil carbon accruals, *none or substantially none has reverted to traditional tillage farming practices on an ongoing basis*, which strongly implies that they view their investment as having been successful.

Most of the Early Adopters are suppliers to Shepherd's Grain, which markets its products in part based on the sustainable agricultural practices of its growers, whom Shepherd's Grain promotes at this link: http://www.shepherdsgrain.com/home/our-growers/. Uniformly, the growers' testimonials are positive regarding their success, and the benefits they derive from what we refer to as Carbon Accruing Cropland Management, and they refer to as "direct seeding." None mentions increased revenues from sales of VERs as a benefit. Representative testimonials that emphasize what these farmers see as success are as follows:

> "Direct seeding is the best thing that has been done to our land since it was broke out of native prairie sod. It has basically stopped our wind, water and tillage erosion. It is slowly building organic matter, and all the beneficial organisms, worms etc. in the soil that has [sic] been destroyed by tillage over the past 100 plus years. It will give our three children, and the generations to come, better soil than what I started with … It is truly a win-win situation for humans and the environment. See http://www.shepherdsgrain.com/home/our-growers/rod-and-susan-dewald/.
>
> "As trusted stewards of this great land, we must be responsible with our natural resources. Direct seeding reduces soil, wind, and water erosion as well as improves overall soil tilth, among many other benefits. Also, and just as important, as input costs consistently increase and commodity markets continue to be extremely volatile, it becomes much more important to run our family farms as

the businesses that they are. Direct seeding makes it easier to apply cutting edge technologies that help *reduce overall costs and help us to be more profitable producers*." See http://www.shepherdsgrain.com/home/our-growers/jason-and-tara-huntley/ (emphasis added).

"Direct seeding has been an important tool in maintaining moisture levels in the soil, preventing soil erosion and overall creating a healthier soil with added life. Direct seeding enables us to *grow a premium product with the environmental benefits*." http://www.shepherdsgrain.com/home/our-growers/mark-lindstedt-kevin-and-naomi-lindstedt/ (emphasis added).

"As always, repetition over the ground costs time and money. Direct seeding serves as an efficiency tool that aids in reducing the amount of tillage and trips across the soil. These time and cost savings can have a direct impact on our farms overall profitability. In addition to the cost savings and efficiencies gained, direct seeding will help us preserve the soil, our most valued natural resource in this business, which helps ensure the sustainability of agricultural production for future generations." See http://www.shepherdsgrain.com/home/our-growers/ed-and-blake-wolf/.

NativeEnergy has no reason to doubt the veracity of these testimonials. And as can be gleaned from them, success for these Early Adopters is producing crops both profitably and sustainably. The goal of the Project is to convert more crop farmers in the Palouse to sustainable farming. VER revenues are simply one added incentive to convince more farmers to convert. Yes, the conversion requires an investment on their part in different farming equipment and in gaining knowledge and experience, and in taking on a risk of reduced yield, but we believe that most farmers will view the investment as an investment *in their farm*.

We believe that the experience of the Early Adopters will also be the experience of new participants in the Project. As such, these farmers will perceive the threshold of "success" in their conversion to Carbon Accruing Cropland Management to be crossed when they successfully produce their crops profitably while improving soil health and reducing erosion. Producing an extra $9 per acre year from VERs is helpful, especially along with the cost savings realized from not tilling, but preserving the $1,000 per acre year from growing the crops will be the key measure of success for the farmers. Further, as crop production using Carbon Accruing Cropland Management is an absolutely necessary component of the common enterprise, the enterprise can be seen as the endeavor to produce $1,009 dollars per acre year. In that light, it seems obvious that the farmers' efforts in producing ~99% of the enterprise's income are the "undeniably significant ones." Turner, at 482.

Once that success threshold is crossed – and it is crossed only by and through the entrepreneurial and managerial efforts of the farmers – then, even if NativeEnergy or a competitor fails in causing verification and issuance of VER credits to occur, significant claims can be made by the farmers, such as "this grain is produced with farming methods that have been shown to increase soil carbon levels, helping to reduce impacts on the climate," or, in the Lindstedts' words, "[we] grow a premium product with the environmental benefits."

Lindstedt Testimonial, *supra*. NativeEnergy has built a viable business enabling businesses to pay money to be able to advertise to their customers that their operations are "carbon neutral," or that their products are "made with" renewable energy. Our experience shows that these farmers could realize premium prices for their grains and/or increase customer loyalty if they are able to sell it to end-product manufacturers along with substantiation environmental claims. In short, more success than the initial threshold crossing can be had by the farmers on their own.

If NativeEnergy is successful in causing the sampling, monitoring, verification and issuance of VER credits, but fails to exercise the Option, it will nevertheless add value by providing substantiation for a moderately stronger claim that "the production of the wheat in each loaf of our bread resulting in the permanent removal of *n* pounds of carbon dioxide from the atmosphere." But NativeEnergy will also have provided the farmers title to and possession of a marketable or consumable general intangible of value. As noted, brokers and exchanges are readily available, and the farmers have a ready market among purchasers of their crops (wheat).

To the extent that NativeEnergy exercises the Option, NativeEnergy provides further value by relieving the farmers of the burden of locating readily available alternatives for selling their VERs, should they choose to do so. But verifying the accruals, securing issuance of ERTs, and exercising the Option are all just ways to make the enterprise *more* successful, not successful or unsuccessful. And under Turner, the significant efforts are those that affect the "*failure or* success of the enterprise." Turner, at 482. In any case, we believe that NativeEnergy's and AES's efforts are far from so essential to the enterprise that our failure to produce VER credits and/or VER revenues would leave the farmers in a situation even remotely analogous to holding herds of overpriced chinchillas. A better analogy would be the baseline situation the Cordas plaintiff would be in after a failed effort on the part of the developer to advertise the plaintiff's and other shop-owners' wares to bring more visitors to the Village than might otherwise come.

NativeEnergy and AES's Services

If SEC staff are not yet convinced that the efforts of the farmers are the undeniably significant efforts that affect the failure or success of the enterprise, it may be helpful to examine NativeEnergy's and AES's efforts more closely. Following the logic the Court in S.E.C. v. Life Partners, Inc., 87 F.3d 536 (D.C. Cir. 1996), in which the court focused on the distinction between pre-purchase functions and post-purchase functions of the promoter, we will look at NativeEnergy's and AES's functions prior to the farmers' enrollment in the Project and after (with the assumption that the time of enrollment is the time at which the new farmers purchase their new equipment). As in Life Partners, "[b]ecause post-purchase entrepreneurial activities are the 'efforts of others' most obviously relevant to the question whether a promoter is selling a 'security,' we turn first to the distinction between those post-[enrollment] functions that are entrepreneurial and those that are ministerial; thereafter, we consider the relevance of pre-[enrollment] entrepreneurial services." *Id*., at 545.

Post-Enrollment Services

In Life Partners, the context involved the sale of viatical settlements – the sale of the right to the proceeds of life insurance policies held by third parties, generally with statistically short life expectancies, as a profit opportunity for the investor and the promoter, and the opportunity for the original policy holder to access a portion of the value of those proceeds during life. The Court primarily examined three features of the scheme: (i) ownership of record of the policies, which it found insignificant as nothing the promoter could do as owner could affect the rate of return to the investor; (ii) the post-purchase services performed, among which were "holding the policy, monitoring the insured's health, paying premiums, converting a group policy into an individual policy where required, filing the death claim, collecting and distributing the death benefit (if requested)" (*id*., at 546), and the court implicitly agreed with the promoter's position that these were merely "clerical and routine in nature, not managerial or entrepreneurial, and therefore unimportant to the source of investor expectations," and noted that "in sum, anyone including the investor himself could supply these services," (*id*.), and that the sole determinant of the investors' return was the length of time the applicable insured survived; and (iii) the service of making a secondary market for sale of the policies by the promoter, which the court disregarded as comprising entrepreneurial efforts of others because, inter alia, "there is no evidence that [the promoter's] potential assistance adds value to the investment contract; an investor could, for all that appears, get the same help with resale (if any is needed) through any one of the many firms that sell viatical settlements." *Id*.

Comparing the assessment of post-purchase functions in Life Partners to NativeEnergy's and AES's case, first, up until the time of NativeEnergy's exercise of its Option, if any, the farmers are the record owners of their VERs and the associated ERTs (other than those contributed to the ACR Buffer and the Intentional Reversal Reserve for insurance purposes), just as the Life Partners investors were the record owners of the policies (in Version III). Second, while not the sole determinant of the farmers' return, the farmers farming practices, an entrepreneurial activity over which they have sole control, are the sole determinant of the volume of crops and VERs they produce. Third, just as the Life Partners promoter held the polices, NativeEnergy holds the group contract with ACR; just as the promoter monitored the insured's health, AES monitors the soil's carbon accrual and overall health; just as the promoter paid the premiums and filed the death claims, NativeEnergy pays the verifier and files the verification report; and just as the promoter collected and distributed the death benefits, NativeEnergy collects the ERTs and distributes them into the farmers' subaccounts on the ACR Registry; just as the promoter made itself available to resell the policies, NativeEnergy stands ready to market and sell the VERs, to the extent it exercises the Option; and while that added liquidity adds value, just as the Life Partners investor could get the same help with resale through any one of the many firms that sell viatical settlements, the farmers can get the same help with resale through any one of the many marketers, brokers and exchanges that facilitate or perform VER sales. In short, we see little difference between the post-purchase services provided in Life Partners and those provided by NativeEnergy and AES, at least in form.

We believe that NativeEnergy's and AES's post-enrollment services, other than marketing the VERs, are "clerical and routine in nature, not managerial or entrepreneurial" in substance as well as in form. Life Partners, *supra* at 546. These services are comprised of:

(i) enabling and causing the verification of the soil carbon accruals and the issuance of ERTs; (i) and the distribution thereof, including the establishment and maintenance of the Intentional Reversal Reserve.

As noted, each of the farmers appoints NativeEnergy as the Project Proponent and authorizes it and AES to administer the Project. While facially this appears to be a managerial function, in economic reality it is, in the words of the Mitzner Court, "a purely mechanical task." Mitzner, *supra* at 1268. Each of the Standards sets the rules for VER projects, among which are that any given project must follow one or more detailed protocols, or methodologies, applicable to that project type, for monitoring, reporting, quantifying and verifying emissions reductions or removals. Each parameter to be monitored is identified, as is the manner and frequency of monitoring, and the records required to be maintained. Every data point and formula for quantifying reductions or removals, is specified in the methodology. The minimum schedule for securing the conduct of verification services and the submission of verification reports is clear and inflexible. The purpose of such methodologies is to produce uniformity of process in the administration of each kind of VER project – to produce market confidence in the outcome through standardization. The methodologies' essential function is to *eliminate* the flexibility and individual judgment and discretion that are the fundamental components of business management. In the process of causing emissions reductions and removals to be monitored, verified and issued as registry credits, one does not make "meaningful or independent *business* decisions." *Id*. One does what one is told to do by the Standard.

The only discretion NativeEnergy has in providing these services is in: (i) selecting more frequent verification than the schedule provided in the methodology, which for scientific reasons cannot be done with soil carbon projects, and in any case cannot affect the number of VERs produced in any given period and would not in any significant way affect the success of the enterprise; and (ii) selecting the VVB, all of whom are equally accredited, per the Standard's rules, and among whom cost differences are not material. In short, where NativeEnergy has the capacity to make business decisions, those decisions are not meaningful. As such, NativeEnergy's and AES's role in monitoring, verifying emissions reductions and removals and causing issuance of VER credits, while essential to producing the incremental ~$9 per acre year, are not "essential *managerial* efforts which affect the failure or success of the enterprise." Turner, at 482 (emphasis added).

While determining the proper allocation to or distribution of VERs among participating farmers involves the exercise of considerable scientific knowledge on the part of AES, making that determination is a pre-enrollment service, discussed below. From and after the moment that the first farmer is offered the opportunity to participate in the project, such allocation/distribution will be in accordance with pre-agreed, fixed formulae. As with monitoring and verification, NativeEnergy will have zero discretion, and will make no business judgments in this context. Furthermore, each of the farmers will have the right to review all project records to confirm that NativeEnergy did not, in fact, exercise judgment – that it followed the formulae, no more, no less.

Similarly, with the Intentional Reversal Reserve ("IRR"), NativeEnergy and AES will exercise a certain judgment in determining the percent of each farmer's VERs to set aside in the IRR, but as a pre-enrollment service. That percent will be fixed in advance and will not be subject to change without the prior written approval of each farmer, exercising his or her own judgment based in substantial part on his or her knowledge of the likelihood of the need, of the region's farmers, occasionally to engage in farming practices that cause soil carbon losses. Furthermore, to protect against the risk that the IRR proves inadequate, which could affect NativeEnergy's resources needed to position itself to exercise the Option, or to continue participating in the Project, NativeEnergy plans to acquire financial insurance covering that risk.

Finally, regarding the marketing of the VER credits, while entrepreneurial, this service is not essential, as the farmers retain title to the VER credits and have readily available alternative opportunities to sell them or use them themselves. Furthermore, NativeEnergy will make no express or implied guarantee that it will exercise the Option. As such, reasonable (and naturally risk averse) farmers will likely make their investment decision based on the assumption that the Option will not be exercised. We do not argue that "the relative profitability of the investment would not be influenced by the success of" NativeEnergy's efforts, see Bitter, at 185. We acknowledge that NativeEnergy's role affects the relative profitability of the investment insofar as we are able to bring "shoppers" to the VERs produced and at attractive pricing, but as in Cordas, NativeEnergy makes "no representation that investors could rely absolutely on [NativeEnergy] to turn a profit." Cordas, at 788.

Pre-Enrollment Services

The pre-enrollment services performed by NativeEnergy and AES are: conducting the underlying scientific research, drafting the ACR Methodology, structuring the grouped project and drafting the Project Design Document, developing the pro-rata sharing formulae and the Intentional Reversal Reserve allocations, and preparing outreach materials. Each of these is a completed task at the moment the first farmer is engaged. For all but the outreach materials, their effect on the success of the enterprise is fixed – they make the enterprise possible as a VER project, no more, no less. While the quality and appeal of the outreach materials may have some effect on the number of farmers who participate, which affects the required size of the Intentional Reversal Reserve and thus its cost in VERs to the farmers, the impact of the outreach materials will be modest. Overwhelmingly, the driver of farmer participation will be the efforts of farmers themselves, initially the Early Adopters, in convincing tillage farmers that they can farm successfully using Carbon Accruing Cropland Management.

In assessing pre-purchase functions, the Life Partners court looked to the Ninth Circuit's decision in Noa v. Key Futures, Inc., 638 F.2d 77 (1980) (per curiam) and the Tenth Circuit's decision in McCown v. Heidler, 527 F.2d 204(1975), and noted that both "regarded the promoter's pre-purchase efforts as insignificant to the question whether the investments--in silver bars and parcels of land, respectively--were securities." Life Partners, at 547. Stating its own "doubt that pre-purchase services should ever count for much," *Id*., the Life Partners court determined that in the case before it, it need only decide that "pre-purchase services cannot by themselves suffice to make the profits of an investment arise predominantly from the efforts of others, and that ministerial functions should receive a good deal less weight than entrepreneurial activities." It is our position that NativeEnergy's and AES's post-purchase functions are ministerial, easily replaced, or both. Thus, any entrepreneurial or managerial character of our pre-project functions cannot, in accord with Life Partners, Noa and McCown, stand alone to render the PPOA's investment contracts.

To conclude, we are of the opinion that NativeEnergy and AES are no more than service providers for the farmers, and that the services provided are not "the undeniably significant ones, those essential managerial efforts which affect the failure or success of the enterprise" *Id*., and that the success of each farmer is first and foremost under his, her or its management and control. As such, we are of the opinion that the PPOA's, when offered and entered into in the manner described above, will not constitute "securities" as defined in Section 2(a)(1) of the Act for the reasons stated above, and accordingly, registration will not be required under Section 5 thereof.

In view of the foregoing, we respectfully request your written assurance that the Division will not recommend any enforcement action to the Commission if NativeEnergy and AES offer the PPOA's in the manner and under the circumstances described above without registration under the Act.

NativeEnergy and AES intend to commence offering the PPOAs promptly following receipt of a favorable response from you. Accordingly, we would appreciate your response to our request as soon as possible. If, for any reason, you conclude preliminarily that you cannot respond favorably, we would hope to have the opportunity to discuss the matter with you personally prior to the preparation of your written response and, in that connection, would ask you to telephone the undersigned at (802) 861-7707 ext. 205. Thank you for your attention to this matter.

Very truly yours,

2015 Conference Agenda

CROPPING CONCEPTS
FEEDING FARMER INNOVATIONS
JAN 20 - 22 2015
PNW OILSEED & DIRECT SEED CONFERENCE
THREE RIVERS CONVENTION CENTER
Kennewick, WA

css.wsu.edu/biofuels/ www.directseed.org/events

Tuesday, January 20
Focus: Production Innovation & Strategies

8:00 – 10:00	**Registration and Exhibit Hall Open** **Coffee Service**	
9:00 – 10:00	**TRCC Boardroom - Washington Oilseeds Commission Annual Meeting**	
10:00 – 10:15	**Conference Welcome**	Bill Pan, WSU and PNDSA Representative
10:15 – 10:30	**Cropping Systems in the PNW**	Frank Young, USDA-ARS
10:30 – 11:15	**Keynote – Innovations in Agriculture and Components of a Successful Cropping System**	Neil Harker, Agriculture & Agri-Food Canada
11:15 – 11:45	**Keynote – High Residue Farming in Irrigated Cropping Systems**	Andy McGuire, WSU Extension
11:45 - 12:15	**Lunch**	
12:15 – 1:15	**Oilseed & Direct Seed Producer Panel** **- Innovative Production Strategies** (Facilitator: Bill Pan)	Douglas Poole, Mansfield, WA Andy Juris, Bickleton, WA Eric Odberg, Genesee, ID Drew Leitch, Nezperce, ID Bill Jepsen, Heppner, OR
1:15- 1:45	**Break with Exhibitors & Networking**	
1:45 – 2:45	**Breakout Session I** **Direct Seed Topics:** **Room E:** Organic soil amendments that are maximizing moisture and yields (Facilitator: Rob Dewald)	Thad Schutt, Royal Organics

	Room G: Sharpening your skills with Precision Ag tools, data management, and production decisions (Facilitator: Eric Odberg)	Ryan Kuster, Ag Enterprise
	Room H: Conservation approach to high-disturbance crops to build OM and reduce fumigants within a wheat, canola, potato rotation (Facilitator: Andy McGuire)	Dale Gies, Moses Lake, WA Irrigated Producer
	Oilseed Topics: **Room A:** Canola 101 – Getting Started and Revisiting the Basics (Facilitator: Dave Huggins)	Jim Davis, UI and Beau Blachly, Croplan by Winfield
	Room C: Variety Performance & Research – University Perspective (Facilitator: Don Wysocki)	Mike Stamm, Kansas State University; Frank Young, USDA-ARS; Jack Brown, UI
	Room D: Flax, Camelina, Mustard, and other oilseeds (Facilitator: Tai McClellan)	Tomas Endicott, Willamette Biomass Processors; John McElheran, Maupin, OR; Gaylin Davies, McKay Seed; Scot Hulbert, WSU
2:45 – 3:30	**Q&A with Breakout Session, Break, and Networking with Exhibitors**	
3:30 – 4:30	**Breakout Sessions II** **Direct Seed Topics:** **Room E:** Environmental market development study and a new opportunity for direct seed farmers using carbon and environmental markets (Facilitator: Rick Jones)	Ron Schultz – Washington Conservation Commission; Stephen Apfelbaum, Native Energy
	Room G: Collecting and deciphering precision ag data to improve your production decisions topics include protein and yield monitors, FarmWorks, SMS AgLeader, Variable Rate Fertilizer. (Facilitator: Wayne Thompson)	Herb March, Crouse Creek Ranch, Milton-Freewater, OR; Dan Long, USDA-ARS Oregon
	Room H: Stripper Header Results – Increasing moisture, lowering soil temp, and building OM and soil structure (Facilitator: David Brewer)	Lauren Young, WSU and Producers, Eric Thorn, and Andy Juris
	Oilseed Topics: **Room A:** Winter Survival – Survival of the Fittest? (Facilitator: Scot Hulbert)	Bill Pan, WSU; Curtis Hennings, Ritzville; Jim Davis, UI; Mike Stamm, KSU
	Room C: Water Management in Dryland and Irrigated Systems (Facilitator: Dennis Roe)	Megan Reese, WSU; Bill Schillinger, WSU; Kurt Melville, Enterprise, OR
	Room D: Managing Chem Fallow for Oilseeds (Facilitator: Dale Whaley)	Frank Young, USDA-ARS and Douglas Poole, Mansfield

4:30 – 6:00	**Reception with Poster Presentations by Authors & Exhibitors** No-Host Bar & Music by Blue Mt Spanish Sound	
6:15 – 7:00	**Dinner - Major Sponsor presentations** (Facilitator: Kristy Borrelli)	Bayer CropScience, Pacific Coast Canola and The Scoular Co.
7:00 – 8:30	**Precision Ag Panel – Unmanned Aerial Vehicles and Satellite Imagery**	Robert Blair, Producer, Kendrick ID; Brad Ward, Advanced Aviation Solutions; and John Sulik, USDA-ARS, Pendleton, OR.
8:30 – 9:30	**Beer and Bull Sessions** High Residue/Irrigated Direct Seeding Flex Cropping UAV Prescription Mapping and VR Application Farm Bill–Income vs. Price Program Innovative Equipment Modifications–Does It Pay? Winter or Spring Canola? Pros & Cons of Each	

Wednesday, January 21
Focus: Soil Health and Quality

8:00 – 8:15	**Welcome and Intro – Soil Research: The New Frontier**	Jim Moyer, WSU-ARC
8:15 – 9:00	**Keynote: Crop Productivity is Rooted in Healthy Soil**	Jill Clapperton, Rhizoterra
9:00 – 10:00	**Soil Health and Quality panel discussion** (Facilitator: Chad Kruger)	Dave Huggins, UDSA-ARS - soil testing Bill Pan, WSU - sub-soil quality Stephen Machado, OSU - soil health and cropping systems Jodi Johnson-Maynard, UI - earthworms and soil health
10:00 – 10:30	**Break with Exhibitors**	
10:30 – 11:30	**Breakout Sessions III** **Direct Seed Topics:**	
	Room E: Rattail Fescue and Russian Thistle management (Facilitator: Mark Richter)	Drew Lyon, WSU Joan Campbell, UI
	Room G: Analysis Tool for real-time monitoring of Water Quality, Soil Quality, and Plant Nutrition (Facilitator: Ty Meyer)	Jill Clapperton, Rhizoterra

	Room H: Can cover crops replace summer fallow? Moisture Removal Rates in Cover Crops vs. Fallow Study, in 5 low to high rainfall farms (Facilitator: Mike Stubbs)	Wayne Thompson, WSU Extension Mary Dye, Pomeroy, WA
	Oilseed Topics: **Room A:** Nutrient and Soil pH Management Strategies (Facilitator: Don Wysocki)	Don Wysocki, OSU; Markus Braaten, Agri-Trend; Paul Carter, WSU Extension
	Room C: Canola Variety Selection & Research – Industry Perspective (Facilitator: Jim Davis)	Bayer, Croplan, Monsanto, Rubisco, Star Specialty Seed
	Room D: What IS Canola Doing to the Soil? (Facilitator: Jim Harsh)	Tai McClellan Maaz, Taylor Beard, WSU; Jeremy Hansen, WSU
11:30 – 11:45	**Q&A and Return to General Session**	
12:00 – 12:30	**Lunch and Visit**	
12:30 - 1:30	**Keynote – Ice Age Geology: A Common Thread for Pacific Northwest Agriculture**	Nick Zentner, Central Washington University geologist (Introduction: Jeff Schibel)
1:30 – 2:30	**Keynote Panel – An Overview of Cover Cropping in the U.S. and PNW – Opportunities & Challenges** (Facilitator: Rich Koenig)	Rob Myers, NCR-SARE Regional Director of Extension Programs (Missouri); Lindsey du Toit, WSU vegetable seed pathologist
2:30 – 3:15	**Break and Exhibitors**	
3:15 – 4:15	**Breakout Session IV** **Direct Seed Topics:** **Room E:** Rotational N Uptake Efficiency, What are we Missing with Single Season Estimates (Facilitator: Aaron Esser)	Aaron Esser, WSU Extension Tai McClellan Maaz, WSU
	Room G: Cover Crop Study Reporting on Results (Facilitator: Doug Finkelnburg)	Doug Finkelnburg, UI Extension; Ken Hart, UI Extension; and Drew Leitch, Nezperce, ID producer
	Room H: How do I know if my soil is healthy? Evaluating soil health and understanding the interactions between micro-organisms and the plant. (Facilitator: Douglas Poole)	Marlon Winger, ID State Agronomist, USDA-NRCS
	Oilseed Topics: **Room A:** Insect and Disease Management for Oilseed Crops (Facilitator: Kurt Schroeder)	Dale Whaley, WSU Extension; Tim Paulitz, USDA-ARS; Jim Davis, UI

	Room C: 2014 – The Year Your Neighbor was Right…But is Opportunity Knocking?	PNW Producer Panel – Curtis Hennings, Ritzville; Andy Juris, Bickleton; Denver Black, Mansfield
	Room D: Forage, Grazing and Feed – It's Not Just the Seed! (Facilitator: Michael Neff)	Don Llewellyn, WSU Extension; Randy Emtman; Keith Weerts, Garfield
4:15 – 5:30	**Reception with Poster Presentations by Authors & Exhibitors, Demos & Diagnostics** No-Host Bar and Music by Blue Mountain Spanish Sound	
5:30 – 6:30	**Dinner Banquet & Award Ceremony** (Facilitator: Rick Jones)	
6:30 – 7:30	**Keynote Panel – Maximizing Retention of Moisture in Low-Rainfall Regions & technologies to help soil retain moisture**	Markus Braaten and Elston Solberg, AgriTrend
7:30 – 8:30	**Beer and Bull Sessions** Cover Crops Maximizing Moisture Soil Health CRP Takeout – Success with Winter Canola Herbicide Resistance – Is It Avoidable? The Willamette Valley canola saga Fertilizer Timing – What's the Best for Canola? Seeding Winter Canola Early…or Not?	

Thursday, January 22
Focus: Marketing & Economics

8:00 – 8:10	**Welcome and Thoughts on Innovation**	John McNabb, PNDSA President
8:10 – 9:10	**Keynote Panel- The Economic Environment for Biodiesel: Plant Location Decisions and Feedstock Dynamics, *and* PNW…The Gateway to Asia**	Randy Fortenbery, WSU Economist Bud Riedner, General Manager, McCoy Grain Terminal LLC
9:15 – 10:15	**Breakout Session V** **Direct Seed Topics:**	
	Room E: Analyzing machinery costs within a crop enterprise budget: A cost comparison of conventional and direct seed production methods (Facilitator: Tim Spratling)	Kate Painter, UI and producer, TBD
	Room G: Farmed Smart Certification: Update and working session for interested producers self-evaluating their operations – Panel (Facilitator: Dan Harwood)	Kay Meyer, Executive Director PNDSA Chad Atkins, Department of Ecology Ty Meyer, Spokane CD

	Room H: What's New for you in the Farm Bill - Panel (Facilitator: Kristy Borrelli)	Rod Hamilton, UDSA Farm Service Agency Bonda Habets, USDA NRCS Jonquil, USDA RMA
	Oilseed Topics: **Room A:** Crop Insurance – Navigating Policies and Adjustments for Oilseed Crops (Facilitator: Karen Sowers)	Jason Ludeman, Crop Insurance Solutions
	Room C: Agronomy & Economy of Rotations with Oilseeds (Facilitator: Frank Young)	Vicki McCracken, WSU economist Wade Troutman, Bridgeport Mark Greene, Cloverland
	Room D: Marketing Strategies – The Big and Little Pictures (Facilitator: Taylor Beard)	Mike Conklin, The Scoular Co. Heath Barnes, Whitgro; Steve Riggers, Nezperce, ID
10:30 – 11:30	**Break with Exhibitors** **Annual Meetings**	**Room A:** Roundtable with WSU-WOCS faculty and graduate students **Room C:** Idaho Oilseed Commission Annual Meeting **Room E:** PNDSA Annual Meeting
11:45 - 12:15	**Lunch and Visit**	
12:15 – 1:15	**Closing Session – *Transgenic Crops – The Methods, Pros & Cons of GMOs and Biotechnology***	Michael Neff, WSU molecular geneticist (Introduction: Scot Hulbert)

Thank you to the 2015 Sponsors and Exhibitors

Major Sponsors

Dinner | Lunch | Plenary | Lanyard Sponsors

Keynote Speaker Sponsors

Coffee | Afternoon Refreshment Sponsors

Breakout Session Sponsors

Advertising Sponsors

EXHIBITORS

Ag Enterprise Supply
Ag Trucks and Equipment
AgPro Manufacturing
AgriTrend Consulting
Agro Culture Liquid Fertilizer
ATI Solutions LLC
Barr-Tech
BASF
Bayer CropScience
Black Rock AgriPrises
Central Machinery Sales (Case IH)
Crop Protection Services
Croplan by Winfield
Cross Slot
Evergreen Implement (John Deere)
Exactrix Global Systems
FMC Corp
Idaho Oilseeds Commission
Kile Machine & Mfg, Inc
McGregor
McKay Seed
Monsanto BioAg
Native Energy
North Pine Ag Equipment (Horsch)
Northwest Farm Credit Services
Odessa Trading Co/AgTech Services
Pacific Coast Canola
Peripheral Vision
Pillar Lasers
Pioneer West
PNDSA
RDO Equipment (Pasco JD dealer)
REAACH
Royal Organics
Rubisco Seeds
Scoular Grain
Seed2Oil
Skone Irrigation
Spectrum Crop Development
Spokane Conservation District
Spray Center
SS Equipment, New Holland
St. John Hardware & Implement (Case)
Star Specialty Seed
Visit Tri-Cities
Washington Oilseeds Commission
Washington State University Ext.
Western Ag
Western Farmer Stockman
Western States Equipment - CAT

CROPPING CONCEPTS
FEEDING FARMER INNOVATIONS

PNW OILSEED & DIRECT SEED CONFERENCE

Palouse Soil Carbon Project Now Enrolling New Farmers

APPLIED ECOLOGICAL SERVICES, INC.
NATIVEENERGY, INC.

WASHINGTON STATE UNIVERSITY EXTENSION

PACIFIC NORTHWEST direct seed ASSOCIATION

Background

Began with a Shepherd's Grain soil carbon initiative

Applied Ecological Services and NativeEnergy with partner Palouse farmers are now commercializing another soil carbon project in the Palouse region

Shepherd's Grain partnership with over 30 producers over past two years implementing on-the-ground science

One of the largest land-based carbon projects in the US receiving significant attention and funding from USDA-NRCS, policy makers, and carbon investors

About Us

NativeEnergy

- **Pioneer Carbon project developer** and carbon credit seller – driving the market for 14 years
- **Focused on delivering carbon revenue to Shepherds Grain and PNDSA enrolled farmers**.

Applied Ecological Services (AES)

- Science team is focused on **measuring soil carbon**
- **Work on thousands of land and soil improvement projects**.

CROPPING CONCEPTS
FEEDING FARMER INNOVATIONS

Primary Benefits of the Program

PNW OILSEED & DIRECT SEED CONFERENCE

LANDOWNERS CAN:

1. **Receive a new revenue stream** from improved soil carbon levels, and/or offer low/no carbon grain

2. **Receive measurements of your soil carbon**

3. **Help innovate to increase soil carbon** and improve soil health

Soil sampling, Whitman County

WASHINGTON STATE UNIVERSITY EXTENSION

PACIFIC NORTHWEST direct seed ASSOCIATION

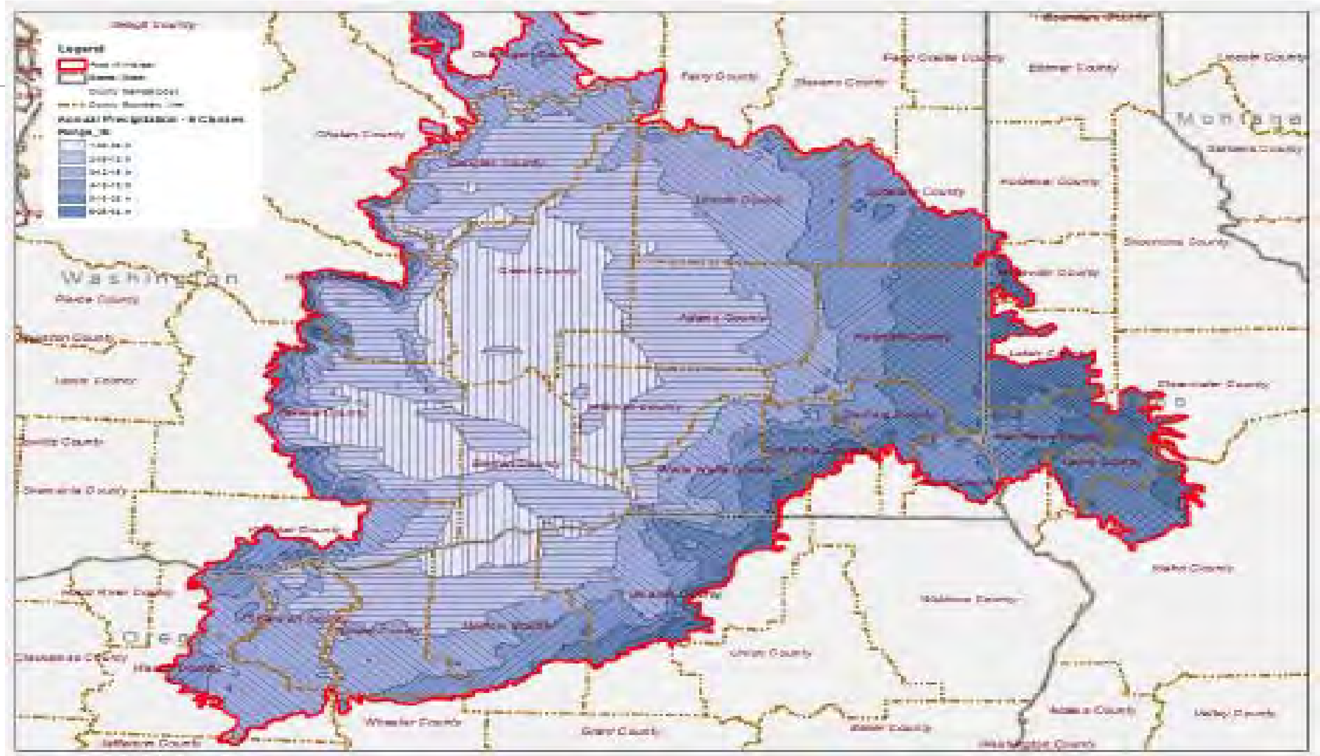
APPROVED STANDARD

Soil Carbon Methodology

- Addresses a marketplace requirements.
- Create new revenues from direct seeding that increase soil carbon.

Module	Description
MODULE 1	APPLICABILITY
MODULE 2	ADDITIONALITY
MODULE 3	BOUNDARIES
MODULE 4	STRATIFICATION
MODULE 5	SOIL CARBON
MODULE 6	LIVING PLANT BIOMASS
MODULE 7	PROJECTION OF FUTURE CONDITIONS
MODULE 8	WOODY BIOMASS HARVESTING AND UTILIZATION
MODULE 9	LONG LIVED WOOD PRODUCTS
MODULE 10	ESTIMATION OF DOMESTIC ANIMAL POPULATIONS
MODULE 11	EMISSIONS FROM DOMESTIC ANIMALS
MODULE 12	EMISSIONS OF NON-CO2 GHG'S FROM SOILS
MODULE 13	SUMMATION OF GHG POOLS, REMOVALS AND EMISSIONS
MODULE 14	EMISSIONS OF GHG'S FROM POWER EQUIPMENT
MODULE 15	DISPLACEMENT LEAKAGE
MODULE 16	MONITORING PLAN
MODULE 17	NON-CO2 EMISSIONS FROM BURNING
MODULE 18	ESTIMATION OF LITTER POOLS
MODULE 19	ESTIMATION OF DEAD WOOD POOLS
MODULE 20	MARKET LEAKAGE

How Did We Measure Palouse Soil Carbon



Over 7 million acres Included in Measurements

CROPPING CONCEPTS
FEEDING FARMER INNOVATIONS

Sampling

PNW OILSEED & DIRECT SEED CONFERENCE

WASHINGTON STATE UNIVERSITY EXTENSION

PACIFIC NORTHWEST direct seed ASSOCIATION

Analysis

Number of Cores and Samples Collected
608 sampled locations +
102 total duplicates
710 cores total, 2062 lab samples (~3/core)

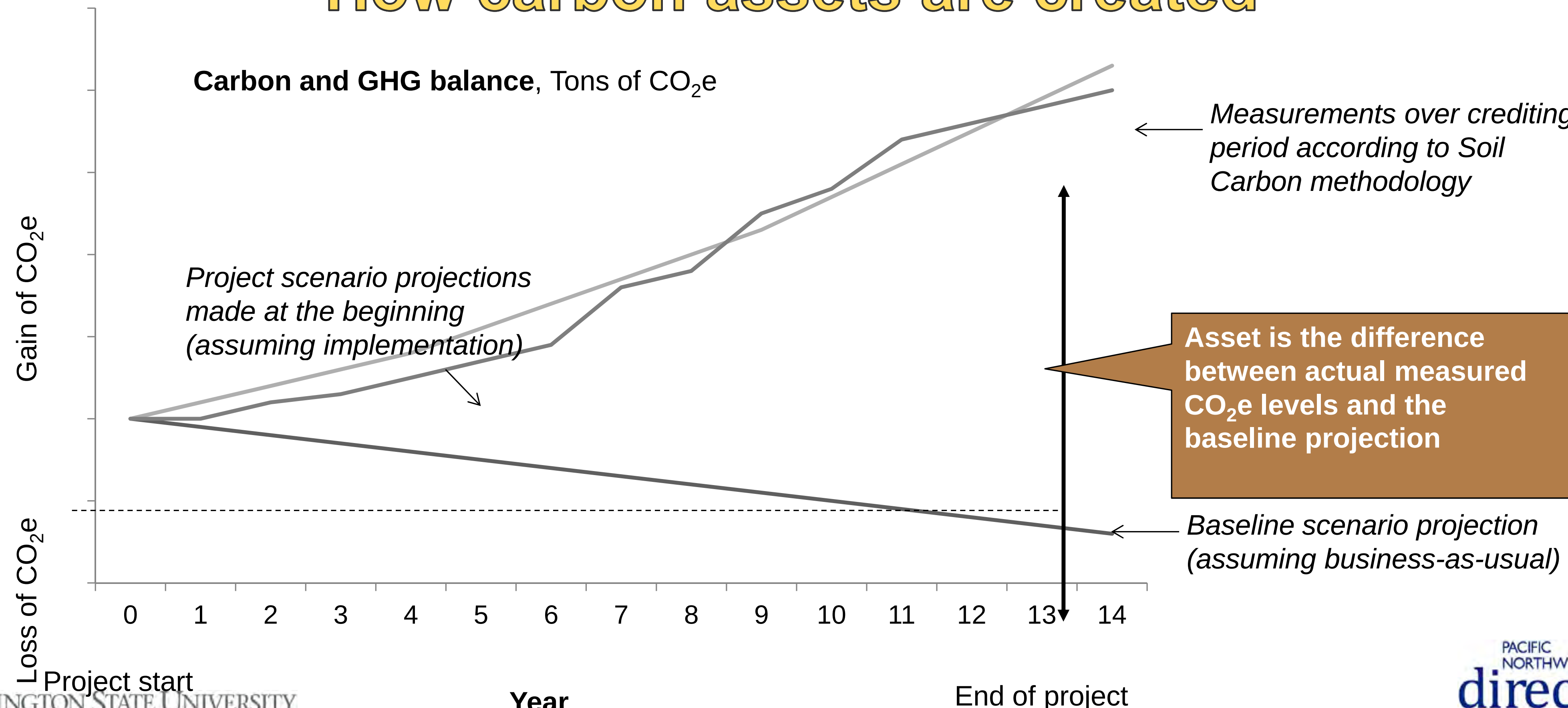
Samples by type

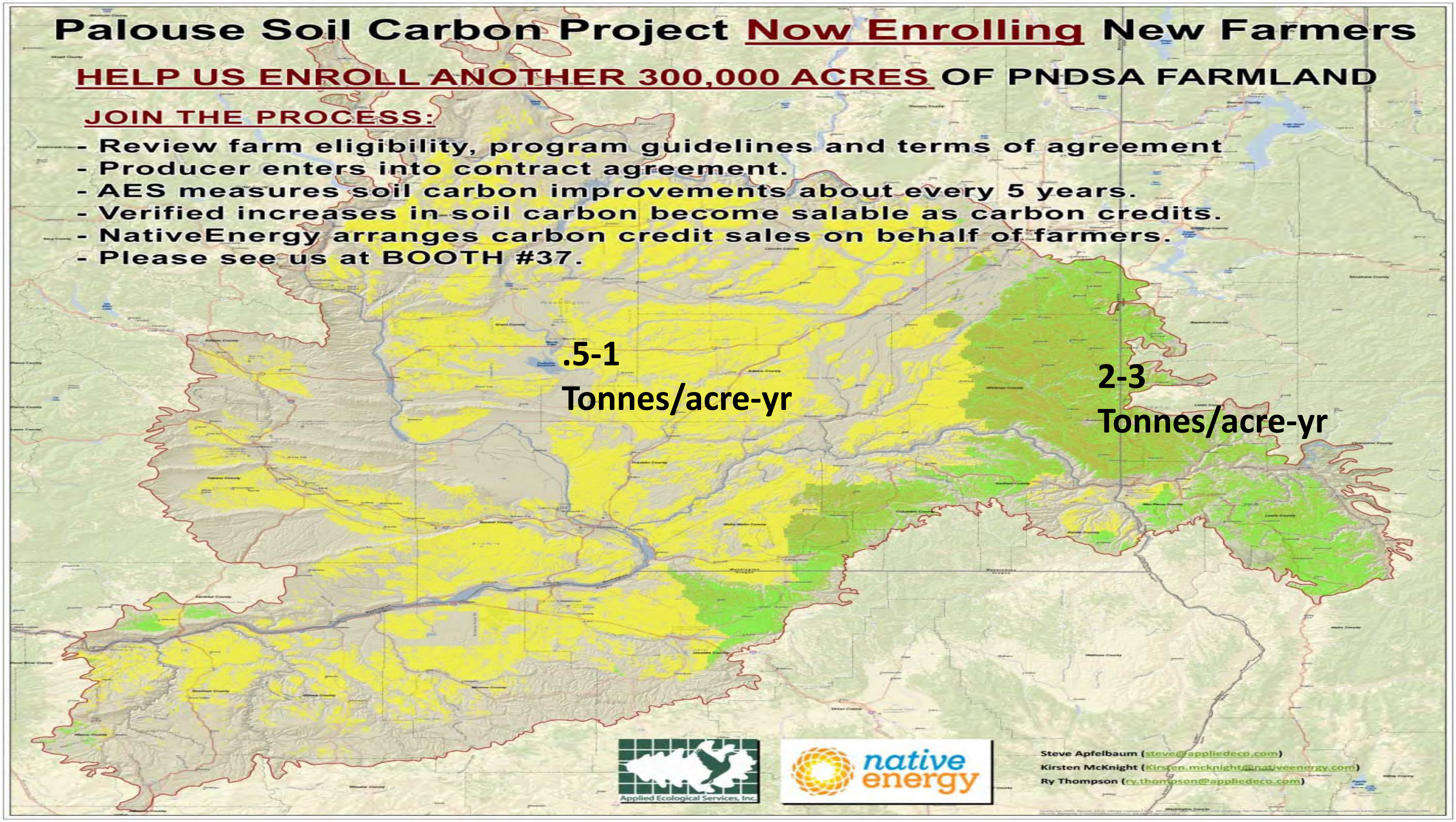
H1 – Conventional	(81 samples)
H2 – 1-5 yrs No-till	(73 samples)
H3 – 6-12 yrs No-till	(100 samples)
H4 – 13-20 yrs No-till	(84 samples)
H5 – 21+ yrs No-till	(52 samples)
H6 – CRP	(101 samples)
H7 – Misc/Irrigated	(8 samples)
H9 – Reference Area	(109 samples)

Then further allocated by several strata categories: slope position, aspect, precipitation zone, etc.

Soils Lab Analysis
- Core description & splitting by horizon
- Course Fragments
- Bulk Density
- % Organic Carbon
- % Inorganic Carbon
- % Total Carbon

How carbon assets are created




Palouse Soil Carbon Project Now Enrolling New Farmers
HELP US ENROLL ANOTHER 300,000 ACRES OF PNDSA FARMLAND
JOIN THE PROCESS:
- Review farm eligibility, program guidelines and terms of agreement
- Producer enters into contract agreement.
- AES measures soil carbon improvements about every 5 years.
- Verified increases in soil carbon become salable as carbon credits.
- NativeEnergy arranges carbon credit sales on behalf of farmers.
- Please see us at BOOTH #37.
.5-1
Tonnes/acre-yr
2-3
Tonnes/acre-yr
Applied Ecological Services, Inc.
native energy
Steve Apfelbaum (steve@appliedeco.com)
Kirsten McKnight (Kirsten.mcknight@nativeenergy.com)
Ry Thompson (ry.thompson@appliedeco.com)

How the program works

- Review farm eligibility, program guidelines, and terms of agreement
  - Long-term commitment to allow soil testing
  - Direct seeding/No-till unless commercially unreasonable that year
- Producer enters into contract agreement.
- Soil carbon re-measured~ 5 years and carbon accruals are independently verified.
- Verified increases in soil carbon levels become salable carbon credits.
- NativeEnergy arranges carbon credit sales on behalf of farmers

Producers "bank" their carbon

How to get started

1. PLEASE ----COME TO OUR BOOTH #37.
2. Provide contact information to learn more.
3. We contact you on next steps.

HELP ENROLL **300,000 ACRES** AT PNDSA Conference

For more information

Steve Apfelbaum (steve@appliedeco.com)

Kirsten McKnight (Kirsten.mcknight@nativeenergy.com)

Ry Thompson (ry.thompson@appliedeco.com)

Poster Number	Communicating Author	Authors	Title
01	Clark Seavert	Clark Seavert, Jenna Way, Susan Capalbo, and Laurie Houston, Oregon State University, Department of Applied Economics.	Economic, Financial and Environmental Decision Tools For Farmers, Ranchers and Land Managers
02	Jenny R. Connolly	Jenny R. Connolly and , Vicki A. McCracken, Washington State University and Kathleen M. Painter , University of Idaho	Does it make economic sense to grow canola in my rotation? Enterprise budget tools for assessing costs, returns, and rotational impacts of canola in Eastern Washington
03	Kate Painter	Hilary Donlon Davis, Kathleen Painter University of Idaho, Dennis Roe, Washington State University	A comparison of machinery costs for direct seeding: Results of a longitudinal survey of wheat producers in the Inland Pacific Northwest
04	Georgine Yorgey	Georgine Yorgey and Sylvia Kantor, Washington State University, Seattle, WA, Kathleen Painter, Hilary Donlon, Kristy Borrelli, and Leigh Bernacchi, University of Idaho, Moscow, ID, Dennis Roe, Washington State University, Pullman, WA, Chad Kruger, Washington State	Farmer to Farmer: Multi-media case studies to build adaptive capacity among cereal-based farmers in the Pacific Northwest
05	Aron Boettcher	Aron Boettcher, Hayley Peters-Contesse, Mandy Wuest, & Dan Long, USDA-ARS, Pendleton	Water Budget Analysis of Cereal-Oilseed Cropping Systems
06	John McCallum	John McCallum and Dan Long, USDA-ARS, Pendleton, OR	Detecting Variance of Oil Concentration in Canola
07	Bill Schillinger	Bill Schillinger and John Jacobsen, Washington State University, Lind, Tim Paulitz, USDA-ARS, Pullman, Jeff Schibel, Irrigated canola grower,	Management of Fresh Wheat Stubble for Irrigated Winter Canola Production
08	Frank Young	Frank Young, USDA-ARS, Pullman WA, Dale Whaley, Ian Burke, Dennis Roe, Washington State University, Pullman WA	Feral rye (Secale cereale L.) control in winter canola (Brassica napus) in the Pacific Northwest
09	Laban Molsee	Frank Young and Larry McGrew, USDA-ARS, Pullman WA, Dale Whaley, William Pan, Lauren Young, Dennis Roe, Laban Molsee and Karen Sowers, Washington State University, Pullman WA	A Summarization of Past, Current, and Future Winter Canola Research in the PNW
10	Isaac Madsen	Isaac Madsen, William Pan, and Ron Bolton, Washington State University, Pullman	Canola and Wheat Seedling Root and Root Hair Behavior in the Presence of Deep-Banded Urea
11	Megan Reese	Megan Reese and Bill Pan, Washington State University, Pullman, Bill Schillinger, Washington State University, Lind Dryland Research	Winter Canola Water Use in Low Rainfall Areas of Eastern Washington and Planting Date Effects
12	Karen Sowers	Karen Sowers, Bill Pan and Dennis Roe, Washington State University, Pullman, WA	The Impact of Research and Extension on Oilseed Production in Washington State.
13	Michael Stamm	Michael Stamm, Yared Assefa, and Kraig Roozeboom, Kansas State University, Manhattan	Winter Canola Yield and Survival as a Function of Environment, Genetics, and Management
14	Tai McClellan Maaz	Tai McClellan Maaz, Taylor L. Beard, William L. Pan Washington State University, Crop and Soil Sciences	Uptake Efficiency and Partitioning of Soil and Fertilizer N Sources by Canola, Wheat, and Pea
15	Taylor Beard	T.L. Beard, T. McClellan Maaz, and W.L. Pan, Washington State University, Pullman, WA	The Effects of Silicon and Fiber Composition from Canola and Wheat Residue on Soil Quality
16	Don Wysocki	Don Wysocki and Alan Wernsing, Oregon State University, Pendleton	Yield, Oil Content and Water Use of Summer-Planted Winter Canola in Semiarid Oregon
17	Bradley Pakish	Bradley Pakish, Jim B. Davis, Megan Wingerson and Jack Brown, University of Idaho, Moscow, ID	Twenty Years of Canola Variety Performance in the Pacific Northwest.
18	Katie Reed	Katie Reed, Jack Brown, Jim B. Davis, Megan Wingerson, and Bradley Pakish , University of Idaho	Optimal Agronomic Conditions for Spring and Winter Canola Production in Northern Idaho
19	Katie Reed	Katie Reed, Jack Brown, Jim B. Davis, Megan Wingerson, and Bradley Pakish , University of Idaho	Regional Canola Grower Survey
20	Megan Wingerson	Megan Wingerson, Jim B. Davis and Jack Brown, University of Idaho, Moscow, ID	Environmental Effects on Oil Quality of High Oleic-Low Linoleneic (HOLL) and Low Linoleneic (LLIN) Spring Canola
21	Pedee Ewing	Pedee Ewing, Jack Brown, Jim Davis, and Megan Wingerson, University of Idaho	Oilseed Production Feasibility in the Pacific Northwest
22	Sage McClintick-Friddle	Sage McClintick-Friddle, Jim B. Davis, Megan Wingerson, Jack Brown, and Bradley Pakish. University of Idaho	Investigating Cover Crops in Dry land Pacific Northwest Winter Wheat Rotations.

23	Jim Davis	Jim B. Davis, Bradley Pakish, Megan Wingerson, and Jack Brown University of Idaho, Moscow, Idaho and Alan Wernsing and Don Wysocki, Oregon State University, Pendleton, Oregon	Results of the 2014 Pacific Northwest Canola and Mustard Trials
24	Valcho Jeliazkov	Henry Y. Sintim1, Valtcho D. Jeliazkov1, 2, and Augustine K. Obour, 1University of Wyoming, Department of Plant Sciences, and Sheridan Research & Extension Center, WY; 2Oregon State University, Columbia Basin Agricultural Research Center, OR; 3Kansas State University, Agricultural Research Center- Hays, KS	Camelina (Camelina sativa Crantz) response to soil moisture variability and harvest time
25	Muhammad Bilal Chatth	Muhammad Bilal Chattha and Muhammad Nasir Subhani, University of the Punjab, Lahore Muhammad Umer Chattha, University of Agriculture, Faisalabad, Pakistan	Improving germinability and vigor enhancement of Sunflower (Hellianthus annus L.) Hybrid seed under low temperature through seed priming
26	Tomas Endicott	Tomas Endicott, Willamette Biomass Processors, Inc., Rickreall, Oregon	Oilseed Flax as a Dryland Broadleaf Rotation in the Pacific Northwest
27	Dick Smiley	Richard Smiley, Oregon State University, Pendleton and Moro	Multiplication Rates of Root-lesion Nematodes on Selected PNW
28	Dick Smiley	Richard Smiley, Oregon State University, Pendleton and Moro	Rangeland (CRP) Grasses and Legumes as Hosts for Root-lesion Nematodes
29	Dick Smiley	Richard Smiley, Oregon State University, Pendleton and Moro	Weeds as Hosts for Root-lesion Nematodes
30	Dick Smiley	Abolfazl Hajihassani, Islamic Azad University, Arak, Iran,Richard W. Smiley, Oregon State University, Pendleton and Moro	Effects of Root-lesion Nematode plus Fusarium Crown Rot on Winter Wheat
31	Dick Smiley	Juliet Marshall, University of Idaho, Idaho Falls and Aberdeen, Richard Smiley, Oregon State University, Pendleton and Moro	Spring Barley Resistance and Tolerance to Cereal Cyst Nematode (CCN)
32	Dick Smiley	Juliet Marshall, University of Idaho, Idaho Falls and Aberdeen, Richard Smiley, Oregon State University, Pendleton and Moro	Spring Wheat Resistance and Tolerance to Cereal Cyst Nematode (CCN)
33	Dick Smiley	Richard Smiley, Oregon State University, Pendleton and Moro	Nematodes: It is Important to Identify Species as well as to Determine
34	Dick Smiley	Richard Smiley & Stephen Machado, Oregon State University, Pendleton and Moro, OR	Effects of Cropping Systems on Root-invading Fungi and Nematodes
35	Harsimran Kaur	1Harsimran Kaur, 2Dave Huggins, 1Rick Rupp, 3John Abatzoglou, 4Claudio Stockle, 1John Reganold, 1Dept. Crop and Soil Sciences, Washington State University ,2USDA-ARS, Pullman, Washington 3Dept. of Geography, University of Idaho, Dept. of Biological Systems Engineering, Washington State University	Bioclimatic Predictors of Dry-land Agro-ecological Classes and Projected Shifts under Climate Change
36	Jason Morrow	Jason Morrow, Lynne Carpenter-Boggs, John Reganold, Washington State University, Pullman, Stephen Machado, Oregon State University, CBARC, Jodi Johnson-Maynard, University of Idaho, Moscow, Hal Collins, USDA-ARS, Prosser, Hero Gollany, USDA-ARS, Pendleton, Dave Huggins, USDA-ARS, Pullma	Climate, Management, and Surface Soil C and N Properties and Processes: A Soil Health Perspective
37	Kendall Kahl	Kendall Kahl, Jodi Johnson-Maynard, Ian Leslie, Department of Plant, Soil and Entomological Sciences, University of Idaho, Moscow, ID	Influence of organic, reduced-tillage crop rotations on earthworms and other indicators of soil quality
38	Kirsten McKnight	Ry Thompson and Steve Apfelbaum, Applied Ecological Services, Inc., Br	Palouse Soil Carbon Just About Open for Business
39	Gary Wegner	Gary Wegner, Columbia River Carbonates, Woodland, WA	Wheat Roots Response to Low pH Soils
40	Carol McFarland	Carol McFarland, David R. Huggins, Kurt L. Schroeder, J. Joey Blackburn, L. Carpenter-Boggs, Rich Koenig, Timothy C. Paulitz	Remediation of stratified soil acidity through surface application of lime in no-till cropping systems
41	Paul G. Carter	Paul G. Carter , WSU Extension Regional Extension Educator, Dayton, WA and Terry Bruegman WACD Columbia Conservation District, Dayton, WA	Soil pH Survey Lime Project
42	Rachel Unger	Rachel Unger, Ian Burke, Mark Swanson, and Lynne Carpenter-Boggs, Washington State University, Pullman, WA, Dave Huggins, USDA-ARS, Pullman, WA	Field-Scale Cropping System N Use Efficiency after 10 Years of Continuous No-tillage
43	Rajan Ghimir	Rajan Ghimire, Stephen Machado and Prakriti Bista, Oregon State University, Columbia Basin Agricultural Research Center, Pendleton,	Soil Organic Carbon and Soil pH in the Pendleton Tillage-Fertility Long-Term Experiment

POSTER 38

Palouse Soil Carbon Just About Open for Business

Ry Thompson and Steve Apfelbaum, Applied Ecological Services, Inc., Brodhead, WI
Tom Stoddard and Kirsten McKnight, NativeEnergy, Inc., Burlington, VT

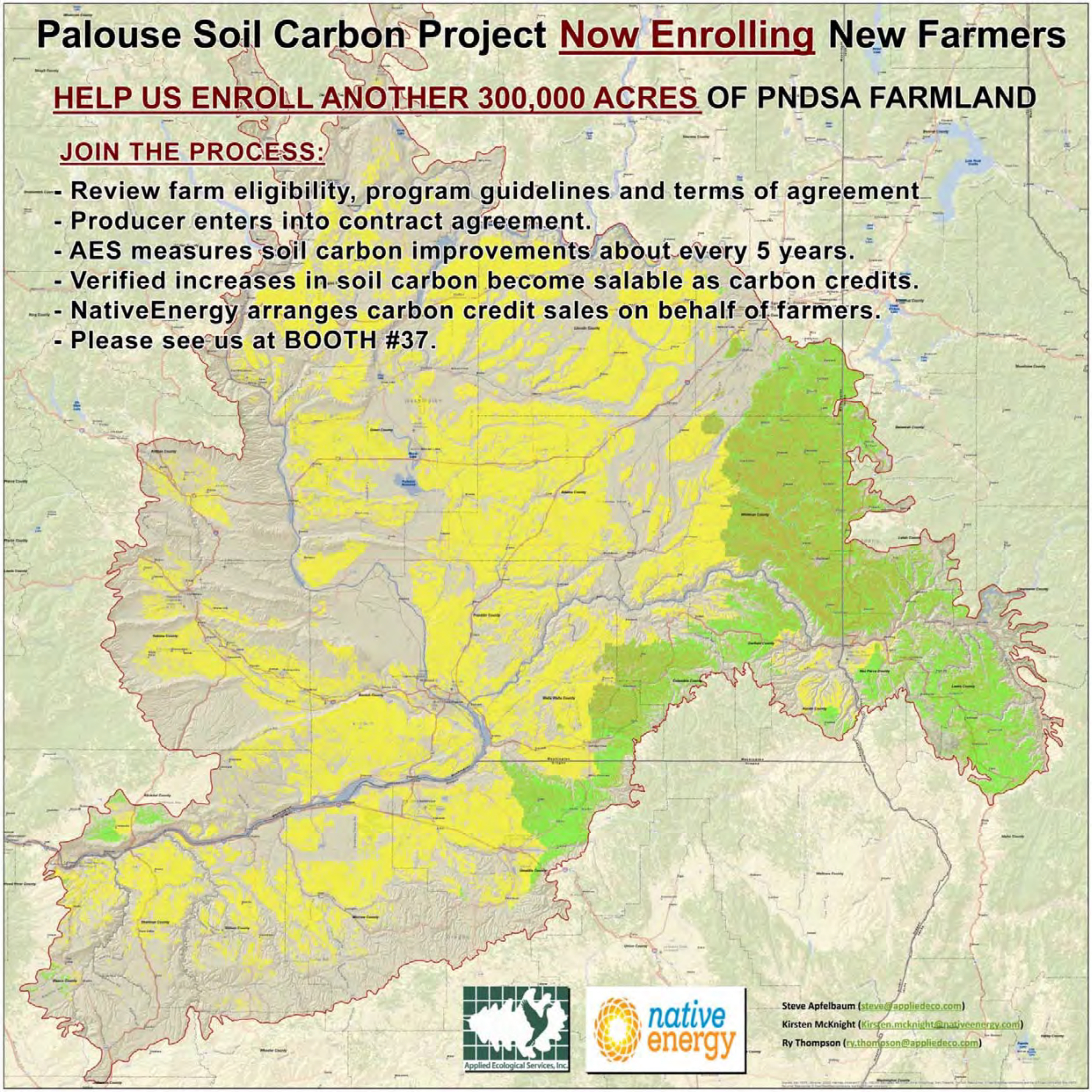
Applied Ecological Services received a USDA-NRCS Conservation Innovation Grant to develop, with Shepherd's Grain, a large-scale agricultural carbon project in the Palouse region in 2011. This POSTER is a follow up to the presentation by AES and Shepherds Grain at the 2013 annual PNDSA meeting. Since 2013, the team measured soil carbon stocks associated with no-till agriculture practices and developed a carbon accrual quantification methodology. Along with NativeEnergy, a carbon developer and retailer, we are now prepared to engage producers to participate and claim carbon credits from their management practices, specifically direct seeding. In progress to bring the project to the carbon market, NativeEnergy and AES are working to get the methodology and project structure approved by carbon standards. Our latest effort is focused on adapting an existing land-use methodology from the American Carbon Registry to fit the Palouse program. We are looking for no-till producers or producers willing to convert to no-till farming who are motivated to further aid research on improving soil water holding capacity, soil fertility, irrigation efficiency, and crop yield and quality. This POSTER will display the carbon accrual research, outline the costs and benefits for participating producers, and explain the carbon market requirements and opportunity.

POSTER 39

Wheat Roots Response to Low pH Soils

Gary Wegner, Columbia River Carbonates, Woodland, WA

Low pH soils are a serious problem in the Inland Northwest. One of the best ways to understand the impact of low pH soil is to access growth and development of wheat plants in areas where low pH status has been verified. Visually, accessing wheat roots is quick and simple process, but can provide valuable information. Low pH soils can have a dramatic effect on wheat performance. The poster shares visual references that should help in understanding the significance of low soil pH "


Palouse Soil Carbon Project Now Enrolling New Farmers
HELP US ENROLL ANOTHER 300,000 ACRES OF PNDSA FARMLAND
JOIN THE PROCESS:
- Review farm eligibility, program guidelines and terms of agreement
- Producer enters into contract agreement.
- AES measures soil carbon improvements about every 5 years.
- Verified increases in soil carbon become salable as carbon credits.
- NativeEnergy arranges carbon credit sales on behalf of farmers.
- Please see us at BOOTH #37.
Applied Ecological Services, Inc.
native energy
Steve Apfelbaum (steve@appliedeco.com)
Kirsten McKnight (Kirsten.mcknight@nativeenergy.com)
Ry Thompson (ry.thompson@appliedeco.com)

CROPLAND MANAGEMENT
GREENHOUSE GAS MITIGATION METHODOLOGY

MODULE NAME:
METHODOLOGY FRAMEWORK

MODULE CODE:
FRAMEWORK-CLM

Output Parameter(s)
Parameter Name: *ERT_CLM_t*
Parameter Description: Number of ERTs generated from cropland management activity at time t (t CO_2e)

Key Input Data:
E_ENT Net enteric emissions, t CO_2-e.
E_MAN Net manure emissions, t CO_2e.
E_FERT Net fertilizer emissions, tCO_2-e.
E_FF Net fossil fuel emissions, t CO_2-e.
S_BIO Net biotic sequestration/emission, t CO_2-e.
Buffer% Buffer withholding percentage, %.
E_LK Net emissions due to leakage, t CO_2-e

Purpose

- To provide the overall structure and functionality of this modular Cropland Management (CLM) GHG methodology
- To provide applicability conditions for the methodology overall
- To provide guidance under which conditions to use the other modules
- To provide guidance for defining the project boundary (geographic boundary, temporal
- boundary, and GHG sources, sinks and reservoirs included/excluded from accounting)
- To provide requirements for demonstrating additionality
- To calculate ERTs using the output parameters of the other modules
- To specify rules regarding aggregation and Programs of Activities

Applicability Conditions

- The methodology is applicable to any CLM project activity implemented on a crop farming operation.
- The FRAMEWORK module shall be used regardless of the magnitude of emissions or removals estimated *ex ante*.
- In the baseline scenario and/or as of the project Start Date, project lands may not constitute 'forest' per applicable definitions[1]; or if project lands have sufficient forest cover to constitute 'forest,' trees present in the baseline may not be felled in site preparation or during project implementation.

[1] See *ACR Forest Carbon Project Standard* for applicable forest definition.

- In the project scenario, project lands must be managed for crop production. The methodology is not intended for activities taking cropland out of production, due to leakage concerns.
- CLM activities in which crops are grown all or part of the year on public lands may only receive credit for enhanced biotic sequestration if the Project Proponent provides documentation from the responsible public agency that the agency cedes offset ownership to the Project Proponent. In addition, projects claiming credit for biotic sequestration on public lands must make their non-permanence buffer contribution in non-project ERTs.
- Recognizing that some cropland is leased rather than owned, the Project Proponent need not necessarily demonstrate land ownership, but must demonstrate offset title and effective control over the monitoring of the GHG sources and sinks from which the credited reductions/removal enhancements originate, for the duration of the specified Minimum Project Term. This applicability condition may be met by providing a letter from the landowner granting offset title to the Project Proponent and guaranteeing access to the land for soil sampling.
- If project activities lead to a decrease greater than 3% in product output, relative to the baseline case, the potential for activity shifting and market-effects leakage emissions must be accounted for using the VCS VMD0032 and VM0033 modules.
- Projects on organic soils are eligible unless excluded by the models used in the relevant module.
- Change by the Project Proponent to the drainage conditions on project lands are not permitted in any instance in which such changes would significantly increase emissions of greenhouse gases.
- Aggregated projects and Programs of Activities (PoAs) must comply with the definitions in 3.0 and the rules in Annex A.

1.0 Goal

The goal of this methodology is to create a comprehensive and flexible accounting framework for a broad range of cropland baseline management practices and GHG mitigation activities. The methodology focuses on five primary GHG sources, sinks and reservoirs (SSRs): enteric methane, manure methane, nitrous oxide from fertilizer use, fossil fuel emissions, and biotic sequestration in above- and below-ground biomass and soils. Cropland management (CLM) activities will affect one or more of these SSRs.

Any CLM activity that affects these sources and pools, whether it involves conversion to direct seeding farming, rotational cropping, fertilizer management, or a range of other mitigation practices, is eligible under this methodology as long as it meets the applicability conditions of the relevant modules and all applicable requirements of the *ACR Standard*.

The methodology is designed to ensure the complete, consistent, transparent, accurate and conservative quantification of GHG emission reductions associated with a CLM project. The methodology also aims to provide flexible and cost-effective accounting methods where it can be shown that anticipated impacts on a particular SSR are small; see section 2.1.

2.0 Methodology Structure

This CLM Methodology adopts a modular structure to streamline methodology development and use. Considering the broad range of potential baseline management practices and GHG mitigation activities in the crop farming sector, rather than creating stand-alone methodologies specific to each baseline and mitigation activity, the modular structure allows Project Proponents (crop producers or the project developers/aggregators representing them) to select the modules relevant to their particular baseline and project activities.

FRAMEWORK-CLM constitutes, together with the modules and tools it calls upon, a complete baseline and monitoring methodology. The reference to FRAMEWORK-CLM and the modules used to construct the project-specific methodology shall be given in the ACR GHG Project Plan.

2.1 Graduated Approach to GHG Accounting

The tool T-XANTE, contained within the A-MICROSCALE module, allows Project Proponents to select an accounting approach corresponding in complexity and data requirements to the magnitude of the estimated GHG impacts associated with a particular SSR. In MICROSCALE, simplified accounting tools are provided that estimate net GHG impacts in each SSR based on readily available data inputs.

For SSRs where the project activity is expected to cause 'micro' impacts (less than 5,000 tCO_2-e per year), the simplified accounting tools provided in A-MICROSCALE are all that is required to account for emission reductions/removal enhancements in that SSR.

For SSRs where the project activity is expected to cause 'small' impacts (more than 5,000 but less than 60,000 tCO_2-e per year, *and* direct emissions less than 60,000 t CO_2-e annually), projects in the continental United States may use A-SMALLSCALE, which employs the whole farm calculation model COMET 2.0, to calculate biotic, fertilizer and fossil fuel emissions. However the A-ENTERIC and A-MANURE modules must be used when estimated reductions in enteric and manure methane are greater than 5,000 t CO_2-e annually, since enteric and manure emissions are not accounted in COMET 2.0.

For projects in the continental United States, for SSRs where the project activity is expected to cause impacts greater than 60,000 tCO_2-e per year, the modules used in the VCS VM0021 Soil Carbon Quantification Methodology (VMD0018 – VMD0035) that are applicable thereunder to the specific practices engaged in or the large-scale modules A-FERTILIZER, and A-BIOTIC must be used.

For projects outside the continental United States, for SSRs where the project activity is expected to cause impacts greater than 5,000 tCO_2-e per year, the modules used in the VCS VM0021 Soil Carbon Quantification Methodology that are applicable thereunder to the specific practices engaged in or the large-scale modules A-FERTILIZER, and A-BIOTIC must be used.

For fossil fuel emissions, for all projects in the continental United States A-SMALLSCALE shall be used; for all other locations A-MICROSCALE shall be used.

2.2 Modules Provided and Conditions for Use

Accounting modules:

- A-MICROSCALE: an Excel spreadsheet-based tool calculating baseline and project emissions from CLM activities inside or outside the United States, using IPCC emission factors and other methods. Used for all emission sources and carbon pools when estimated emission reductions from focal sources are less than 5,000 t CO_2-e annually. AMICROSCALE is also used for calculation of fossil fuel emissions for all projects outside the continental United States.

- A-SMALLSCALE: estimates emissions and net emission reductions from CLM activities in the continental United States, when reductions from biotic sequestration, fossil fuel and fertilizer are more than 5,000 t CO_2-e annually but less than 60,000 t CO_2e annually *and* direct emissions from these sources are less than 60,000 t CO_2-e annually. For reductions in enteric and manure methane greater than 5,000 t CO_2-e annually, the AENTERIC and A-MANURE modules must be used.

- A-ENTERIC: estimates baseline and project emissions and net emission reductions from enteric fermentation as part of GLLM activities. Used for GLLM activities inside or outside the United States when estimated emission reductions from focal sources are greater than 5,000 t CO_2-e annually.

- A-MANURE: estimates baseline and project emissions and net emission reductions from manure as part of GLLM activities. Used for GLLM activities inside or outside the United States when estimated emission reductions from focal sources are greater than 5,000 t CO_2-e annually.

- A-FERTILIZER: estimates baseline and project emissions and net emission reductions from fertilizer use as part of CLM activities. Used for projects in the continental United States when estimated emission reductions from focal sources are greater than 60,000 tCO_2-e annually, and for projects outside the continental United States when estimated emission reductions from focal sources are greater than 5,000 t CO_2-e annually.

- A-BIOTIC: estimates sequestration and net emission reductions from soils and plants as part of CLM activities. Available for projects in the continental United States when estimated emission reductions from focal sources are greater than 60,000 t CO_2-e annually, and for projects outside the continental United States when estimated emission reductions from focal sources are greater than 5,000 t CO_2-e annually.

- VCS VM0021 Soil Carbon Quantification Methodology: estimates sequestration and net emission reductions from soils and plants as part of CLM activities. Available for projects in the continental United States when estimated emission reductions from focal sources are greater than 60,000 t CO_2-e annually, and for projects outside the continental

United States when estimated emission reductions from focal sources are greater than 5,000 t CO_2-e annually.

Leakage modules:

- VCS VMD0032 and VMD0033: provide procedures to calculate activity-shifting and market-effects leakage emissions where significant.

Tools:

- T-XANTE: an Excel spreadsheet-based *ex ante* estimation tool that estimates net emission reductions for enteric, manure, biotic, fertilizer and fossil fuel emissions from readily available data inputs. The tool is designed to streamline project development by allowing users to make an up-front estimate of impacts on each SSR and use simplified accounting methods for 'micro' (<5,000 t CO_2-e annually) and 'small' (more than 5,000 t CO_2-e annually but less than 60,000 t CO_2-e annually) GHG impacts.

- T-RISK: ACR-approved risk assessment tool per the *ACR Forest Carbon Project Standard.* Used in A-BIOTIC, A-SMALLSCALE and A- MICROSCALE to mitigate the risk of reversals in biotic sequestration by calculating a required contribution of ERTs to the ACR non-permanence buffer pool.

3.0 Definitions

Where not explicitly defined in this document, current *ACR Standard* definitions apply.

Aggregate: the grouping of multiple project instances, fields, producers or facilities into a single project activity registered on ACR. An Aggregate must be coordinated by a Project Proponent (public or private entity) serving as the aggregator. The GHG Project Plan will define the overall project boundary and baseline conditions encompassing all project instances, fields, producers or facilities. An Aggregate will have a single Start Date and Crediting Period.

Cohort: a new group of Project Participants, meeting all eligibility, project boundary, baseline and additionality criteria of an already established Program of Activities (PoA).

Cohort Description: a document provided to ACR and the Validation/Verification Body (VVB) at the time of addition of a Cohort to the PoA, summarizing all necessary information on the Cohort. Each Cohort Description becomes an addendum to the greenhouse gas (GHG) Project Plan for the PoA.

Module: a component of a methodology that can be applied on its own to perform a specific task.

Project Participant: an individual producer participating in an Aggregate, or in a Cohort of a PoA.

Project Proponent: per the *ACR Standard,* "an individual or entity that undertakes, develops, and/or owns a project. This may include the project investor, designer, and/or owner of the lands/facilities on which project activities are conducted. The Project Proponent and landowner/facility owner may be different entities." As used in this methodology, the Project Proponent may be a crop producer, a carbon project developer representing the producer, a carbon project aggregator representing multiple Project Participants in an Aggregate, or a carbon project aggregator representing multiple Cohorts of Project Participants in a PoA.

Program of Activities (PoA): a project in which successive Cohorts of fields, producers or facilities are added incrementally to a project over time. A PoA must be coordinated by a Project Proponent (public or private entity) serving as the aggregator. In order to register a PoA the Project Proponent must use an approved baseline and monitoring methodology that defines the appropriate boundary, avoids double-counting, accounts for leakage, and ensures that the emission reductions are real, measurable, verifiable, and additional to any that would occur in the absence of the project activity.[2]

Tool: a guideline or procedure for performing an analysis or to help use or select a module or methodology.

4.0 Project Boundaries

The following boundaries shall be defined:

a) The geographic boundaries relevant to the project activity;
b) The temporal boundaries;
c) The greenhouse gas SSRs included in and excluded from accounting for the baseline and project scenarios.

4.1 Geographic Boundary

Project Proponents shall clearly define the geographic boundaries of the project so as to facilitate accurate measuring, monitoring, accounting, and verifying of the project's emissions reductions and removals.

The geographic boundary shall include all facilities and lands where project activities are undertaken, in both the baseline and project scenarios. The geographic boundary may not be defined so as to exclude lands or facilities where emission increases attributable to the project activity may occur. The geographic boundary must be justified to ACR and the VVB.

The CLM project activity may contain more than one discrete area of land. When describing physical project boundaries, the following information shall be provided per discrete area:

- Name of the project area (e.g., field number, facility, etc);
- Unique ID for each discrete parcel of land or facility;
- Map(s) of the area (preferably in digital format);
- Total land area and number of facilities.

[2] Adapted from Clean Development Mechanism Rulebook at http://cdmrulebook.org/452.

The CLM project activity may also span several commercial entities. The geographic boundary shall be defined to include all entities over which the Project Proponent has effective control of offsets produced and monitoring access. Note that the GHG boundary, however, may be broader, requiring the project proponent to consider GHG emissions attributable to "upstream" activities such as fossil fuel and fertilizer use (see section 4.3).

Defining the geographic boundary of the CLM project activity may require creating analytical units that correspond more to crop production than specific areas of land, e.g. in the case where crops are grown on different lands at different times of the year or different parts of the season. The Project Proponent must justify to ACR and the VVB the logic of the geographic boundary definition based on how crop production included in the Project is managed across the year and over the seasons.

See Annex A for guidance on specifying the geographic boundary in Aggregates and Programs of Activities.

4.2 Temporal Boundaries

Start Date is the date on which CLM project activities began. This will need to be defined in the GHG Project Plan such that there is a discrete identifiable date when the project scenario began to diverge from baseline management. This methodology does not define Start Dates for all potential activities, but leaves to the Project Proponent to define the Start Date unambiguously in the GHG Project Plan.

A PoA will have multiple different Start Dates: a Start Date for the PoA overall, and Start Dates for each new Cohort. The Start Date of a Crediting Period for a Cohort shall be the date of its inclusion in the registered PoA or any date thereafter. See Annex A.

Crediting Period is the finite length of time during which the project's GHG Project Plan is valid, and during which a project can generate offsets for registration on ACR against its baseline.[3] For CLM project activities the Crediting Period shall be 10 years; except that for CLM activities impacting biotic sequestration only, or for the biotic sequestration component of CLM activities impacting multiple SSRs, the Crediting Period shall be 40 years.

A PoA will have multiple different Crediting Periods: a Crediting Period for the first Cohort (the Cohort included in the GHG Project Plan at the time of establishment of the PoA), and Crediting Periods for each new Cohort. See Annex A.

Per the ACR Standard, Crediting Periods may be renewed without limitation. Renewing the Crediting Period requires re-assessing the project baseline, every 10 years (or every 40 years for CLM activities impacting biotic sequestration only, or for the biotic sequestration component of CLM activities impacting multiple SSRs), unless a reversal triggers an earlier baseline revision.

---

[3] See *ACR Standard.*

Minimum Project Term is the minimum length of time for which a Project Proponent commits to project continuance, monitoring and verification. For projects claiming credit for biotic sequestration in above- and below-ground biomass carbon and soils, a project term of 40 years is required.[4]

Projects claiming reduced emissions that are irreversible – e.g. reduced enteric, manure, fertilizer, and fossil fuel emissions – have no Minimum Project Term requirement. Thus the 40-year requirement only applies to projects seeking credit for enhanced biotic sequestration.

See Annex A for guidance on specifying the Temporal Boundaries in Aggregates and Programs of Activities.

4.3 GHG Boundary

CLM project activities may affect enteric emissions (primarily CH_4), manure emissions (CO_2, CH_4 and N_2O), fertilizer emissions (N_2O), fossil fuel emissions (CO_2, with trace emissions of CH_4 and N_2O), and CO_2 sequestration in above- and below-ground biomass and soils.

Emission sources. The project shall account for any significant increases in emissions of CO_2, CH_4 and N_2O relative to the baseline that are reasonably attributable to the project activity. The GHG emission sources included in or excluded from the project boundary are shown in Table 1.

Table 1. Sources of emissions and associated greenhouse gases in CLM project activities

Sources	Gas	Included/Excluded	Justification / Explanation of choice
Enteric emissions from dairy and beef cattle	CO2	Excluded	Potential emissions are negligibly small
	CH4	Included	Primary GHG affected by the project activity
	N2O	Excluded	Potential emissions are negligibly small
Manure emissions from dairy and beef cattle	CO2	Included	Primary GHG affected by the project activity
	CH4	Included	Primary GHG affected by the project activity
	N2O	Included	Primary GHG affected by the project activity
Combustion of fossil fuels	CO2	Included	Must be included if fossil fuel emissions are significantly higher (greater than *de minimis* as defined in ACR Standard) in the project case.
	CH4	Excluded	Potential emissions are negligibly small
	N2O	Excluded	Potential emissions are negligibly small
Emissions from land application of organic and synthetic fertilizers	CO2	Excluded	Potential emissions are negligibly small
	CH4	Excluded	Potential emissions are negligibly small
	N2O	Included	Primary GHG affected by the project activity

Table 1 with the selection of sources and the appropriate justification shall be presented in the GHG Project Plan.

All emissions associated with feed production, such as fertilizer use, drying of Distillers Dry

[4] See ACR *Forest Carbon Project Standard*.

Grains (DDGs), feed processing etc. must be included in the GHG boundary and accounted for in both baseline and project, unless the Project Proponent can demonstrate these emissions are *de minimis* as defined in the *ACR Standard*.

Emission increases related to feed production (greater emissions from feed production in the project than in the baseline scenario) must be accounted and deducted as project emissions. This includes emissions caused by shifting from feed grown on a Project Proponent or Project Participant's own lands, to greater reliance on imported feed.

Emission decreases related to feed production (lower emissions from feed production in the project than in the baseline scenario) may be credited to the project if the feed is grown on lands owned or controlled by the Project Proponent or Project Participant. For example, shifting from grains grown on own lands to greater pasturing of livestock, reducing the amount of grain produced, may result in a decrease in fertilizer and fossil fuel emissions on project lands that is creditable.

Emission decreases related to feed production (lower emissions from feed production in the project than in the baseline scenario), when feed is not grown on lands owned or controlled by the Project Proponent or Project Participant, will only be credited to the project if the Project Proponent can demonstrate to ACR and the VVB that the producers of feed, fertilizer etc. will not claim credit to the same emission reductions (which would constitute double counting). For example, decreases in fertilizer use by the feed producer when a project imports less feed, or decreases in natural gas use when a project uses less DDGs, will be credited to the project but only if the above condition is met.

Carbon pools. The project shall account for any significant decreases in carbon stock in the project scenario and any significant increases in carbon stock in the baseline scenario, and may account for decreases in the baseline scenario and increases in the project scenario. The carbon pools included in or excluded from the project boundary are shown in Table 2.

Table 2. Carbon pools in CLM project activities

Carbon pools	Included / Excluded	Justification / Explanation of choice
Aboveground	Included / Excluded	Must be included if *ex ante* estimate of baseline C stocks exceed with-project C stocks. May be included if with-project C stocks exceed baseline and the Project Proponent wishes to claim credit.
Belowground	Included / Excluded	Must be included if *ex ante* estimate of baseline C stocks exceed with-project C stocks. May be included if with-project C stocks exceed baseline and the Project Proponent wishes to claim credit.
Dead wood	Excluded	Changes in the dead wood pool are expected to be negligibly small over the Crediting Period.
Harvested wood products	Included / Excluded	Must be included if *ex ante* estimate of baseline C stocks exceed with-project C stocks. May be included if with-project C stocks exceed baseline and the Project Proponent wishes to claim credit.
Litter	Excluded	Changes in the dead wood pool are expected to be negligibly small over the Crediting Period.
Soil organic carbon	Included / Excluded	Must be included if *ex ante* estimate of baseline C stocks exceed with-project C stocks. May be included if with-project C stocks exceed baseline and the Project Proponent wishes to claim credit.

Table 2 with the selection of carbon pools and the appropriate justification shall be presented in the GHG Project Plan.

5.0 Demonstration of Additionality

CLM project activities must yield GHG emission reductions or removal enhancements that exceed any GHG reductions or removals required by law or regulation, and exceed any GHG reductions or removals that would otherwise occur in a conservative business-as-usual scenario.

To demonstrate additionality, ACR requires all project activities to 1) be surplus to applicable enforced regulations and either 2a) pass a performance standard test, or 2b) demonstrate that the activity is not common practice and faces at least one implementation barrier (financial, technological or institutional), making it less attractive than the business-as-usual scenario.

5.1 Start Date

If the project Start Date is more than two years before submission of the GHG Project Plan, the Project Proponent shall provide evidence that GHG mitigation was considered in the decision to proceed with the project activity. Evidence shall be based on (preferably official, legal and/or other corporate) documentation that was available to third parties at, or prior to, the Start Date.

5.2 Regulatory Surplus

The regulatory surplus test involves existing laws, regulations, statutes, legal rulings, or other regulatory frameworks that directly or indirectly affect GHG emissions associated with a project action or its baseline candidates, and which require technical, performance, or management actions.

The Project Proponent shall conduct a review of applicable regulations (e.g. air quality, water quality, water discharge, nutrient management, endangered species and protection, etc.), mandates, legal rulings, consent decrees etc. that affect the project facilities or lands. The Project Proponent must demonstrate in the GHG Project Plan that the proposed project activity is not required by any existing applicable and enforced mandate. In determining whether an action is surplus to regulations, the Project Proponent should not consider voluntary agreements without an enforcement mechanism, proposed laws or regulations, optional guidelines, or general government policies.

Projects that are deemed regulatory surplus are considered surplus for the duration of the Crediting Period. If laws or regulations change during the Crediting Period, this may make the project ineligible for renewal.

5.3 Practices Deemed Additional

ACR conceptually supports the approach that certain practices, which can be shown to have a very low common practice adoption rate, may be included on a "positive list" of practices deemed additional. These practices, implemented in the specified regions, are eligible for crediting provided they meet the Regulatory Surplus test, without requiring a project-specific demonstration of implementation barriers or common practice adoption rates as specified in 5.4.

Project Proponents may submit data to ACR indicating a particular practice within a specified region has an adoption rate lower than 5%. ACR will evaluate the submitted data and supporting documentation and consider adding the activity to the positive list of practices deemed additional. Adoption rate data will need to be re-evaluated at every baseline renewal.

5.4 Three-Prong Test

For practices not included in 5.3, Project Proponents shall demonstrate additionality in the GHG Project Plan using the ACR "three-prong" test (regulatory surplus, not common practice, and faces at least one implementation barrier) as supported by application of an ACR-approved additionality tool.[5] Such tools will help the Project Proponent to identify credible alternative land use scenarios, evaluate the attractiveness of all identified scenarios, and demonstrate that the project scenario is not the most economically or financially attractive of the identified scenarios, or faces higher barriers than those faced by another identified land use scenario, and is not common practice in the sector and geographic region.

5.5 Early Adopters[6]

---

[5] Such as the "ACR Tool for Determining REDD Project Baseline and Additionality" at http://americancarbonregistry.org/carbon-accounting/tools-templates, or the CDM Tool for the Demonstration and Assessment of Additionality at http://cdm.unfccc.int/methodologies/PAmethodologies/tools/

[6] This section based on *Voluntary Emission Reductions in Rice Management Systems*, a GHG methodology prepared by Terra Global Capital LLC, Environmental Defense Fund, California Rice Commission, and Applied Geosolutions LLC. July 2012.

Some existing GHG methodologies do not allow producers who have implemented an eligible project activity in recent years ("early adopters") to participate in the program, even if that practice is at a very low adoption rate in the industry. If the baseline is set by the recent historical management on a producer's own livestock operations or fields, an early adopter will have no difference between baseline and project scenarios and therefore no credits will be generated.

These mechanics are justified by the notion that producers who are already implementing a project activity will not change their practice when they participate in a carbon project, and there would be no environmental improvement if such producers could participate. However, since many agricultural/livestock management decisions are made year-to-year, the argument of no environmental improvement does not necessarily hold, and disqualifying early adopters may even create a perverse incentive for them to discontinue low-emission practices for one or more years in order to be able to re-start those practices and claim carbon credits. It also fails to reward early action, and is often seen by others in the industry as a reason not to adopt the practices either (since those who are seen as the "industry leaders" cannot benefit).

Here eligible early adopters are allowed up to ten years to participate in the program. If their participation has not succeeded in bringing new producers into the program after ten years, as measured by the rate of adoption of the alternative practice, then the early adopters cannot renew their Crediting Period and continue in the program. The early adopter provision invests in the early adopters' ability to promote increasing levels of participation by non-early-adopters.

Early adopters of activities that have limited baseline adoption are allowed to use a "common practice baseline" rather than the baseline on their own livestock operations or fields. The limited adoption rate is tested using a simple threshold level: every project that plans to implement a practice that can be demonstrated to have an adoption rate less than or equal to 5% in the industry and relevant geographic region is deemed additional and can use a baseline that is based on the common practice of the producers that have not adopted the practice ("common practice baseline").[7] At the end of the 10-year Crediting Period, if the baseline adoption rate is still less than 5%, or has increased by less than a factor of 25%, the Crediting Period may not be renewed. If after 10 years, the baseline adoption rate is greater than 5%, or has increased by a factor of 25% or more, the Crediting Period may be renewed. This limitation on Crediting Period renewal is based on the view that if after 10 years the practice remains at <5% adoption, or has not achieved at least a 25% increase, there must be some other barrier to adoption, and the reason for allowing early adopters in the program (to prime the system and demonstrate that a set of management practices can be successfully used) becomes less persuasive.

The additionality of activities for which the baseline adoption rate exceeds 5% must be tested on a project-specific basis using the approach in 5.4. Only a project-based baseline is allowed for such activities. The project's Crediting Period for such practices may be renewed only until the baseline adoption reaches 50%. This to ensure that a baseline is set based on common practice that represents the practice of a majority of the producers.

---

[7] The 5% threshold is identical to the VCS' level of activity penetration of 5% in the Standardized Methods Requirements document.

- **Minimum data requirements for determining adoption rate**. The baseline adoption rate must be quantified in the reference region the project is located in. The Project Proponent shall define the project's reference region, justifiable to ACR and the VVB. During validation of a GHG Project Plan or renewal of the Crediting Period for an existing project, the average of all publically available baseline adoption rates (including those published in validated GHG Project Plans) during a 5-year historical period shall be used.

- **Procedures to determine baseline adoption rate**. There are two options to determine the baseline adoption rate of a specific practice:
  - **Survey data**. The baseline adoption must be determined using a statistically valid survey of producers within the reference region where the project is located. The average of all available survey data must be used to calculate the baseline adoption rate (including those published in validated GHG Project Plans). For initial validation, 1 data point in the past 5 years suffices to quantify the baseline adoption rate. However, upon renewal of a project's Crediting Period, the baseline adoption rate must be based on the average of at least 2 time points in the 5 years preceding the Crediting Period.
  - **Expert opinion**. If 3 independent experts assert that the baseline adoption rate of a given practice is less than 2% of the acres within the reference region, no survey is required, and projects using the practice may use a common practice baseline. The independent experts must have at least 10 years of relevant experience and must be associated with an academic institution, government institution, or must be a full-time professional crop farming advisor with experience in the reference region. The credentials of the independent experts shall be evaluated during validation of a GHG Project Plan by the VVB.

- **Renewal of the Crediting Period**. At initial validation, practices for which the adoption rate is less than or equal to 5% within the reference region where the project is located are eligible to use a baseline that is based on common practice. At every renewal of the Crediting Period, Project Proponents shall demonstrate that the adoption rate is greater than 5% in the reference region where the project area is located, or is at least increased by a factor of XX. If the adoption rate remains below 5% at the time of Crediting Period renewal for an early adopter, or has not increased by a factor of XX, renewal is not allowed. Maximally 10 years are thus allowed to demonstrate that the early adopters' incentive is causing an eligible practice to be adopted by others.

- **How to set the values for critical variables for common-practice baselines**. All data used to set the critical variables of a common practice baseline shall be based on actual management data from at least 5 operations on which the common practice management is done (i.e. non-early-adopters) and shall be reviewed by at least 3 independent peer reviewers such as farm advisors, extension agents or academic scientists.

6.0 Mitigation of Risk of Reversals in Biotic Sequestration

Projects seeking credit for enhanced biotic sequestration are subject to risks of both unintentional and intentional reversals. These risks must be assessed as detailed in the ACR *Forest Carbon Project Standard*.

Project Proponents shall conduct a risk assessment using the latest ACR-approved tool,[8] provided that in the case of Programs of Activities involving conversion to direct seeding/no-till crop production practices capable of increasing soil carbon accruals, the Project Proponent shall be deemed to have the legal agreement or requirement to continue the management practice if:

- The Project Proponent can demonstrate that it has the legal right to, and has financial and management plans in place that will enable it to, enter onto all acreage included in the Program of Activities for the entire project longevity period and to collect and process such samples as may be necessary or advisable to duly account for and enable independent verification of carbon accruals or losses occurring on such acreage;

- The Project Proponent credibly demonstrates to the VVB that following the conversion to direct seeding/no-till crop production practices capable of increasing soil carbon accruals on such acreage, the reversion to tillage crop production, were it undertaken for the purpose of producing ERTs, would be deemed to be an "additional" activity using the common practice test and the implementation barriers test from the three-prong additionality test in the ACR Standard, as follows:
    - the Project Proponent shall demonstrate that among crop producers in the geographic region covered by the Program of Activities, it is not common practice for those who have converted to direct seeding/no-till crop production practices capable of increasing soil carbon accruals to revert to tillage crop production or to no-till practices that do no increase soil carbon accruals; and
    - following conversion to direct seeding/no-till crop production practices capable of increasing soil carbon accruals, the reversion to tillage crop production, or to no-till practices that do not increase soil carbon accruals, faces capital constraints and/or operations cost increases that are not offset by revenue increases from reversion to tillage crop production or to no-till practices that do not increase soil carbon accruals.

The result of this assessment is an overall risk category for the project, translating into a percentage or number of ERTs that must be deposited, at each new ERT issuance, into a shared nonpermanence buffer pool managed by ACR. In the event of a reversion to tillage or to no-till practices that do not increase soil carbon accruals on a parcel included in the Program of Activities, all soil carbon ERTs issued from the parcel will be considered to have been reversed unless the carbon losses from the reversion event on the parcel are duly accounted for and compensated by retiring existing ERTs from the Program of Activities or other projects and project types. This carbon loss shall be identified in a monitoring report and must be verified by a VVB.

---

[8] Currently the latest published version of the Verified Carbon Standard *AFOLU Non-Permanence Risk Tool.*

All buffer contributions, deductibles, and ERT replacements (in the case of intentional reversals) may be made in ERTs of any type and vintage. Buffer contributions for projects on public lands, that wish to claim credit for biotic sequestration, *must* be made in non-project ERTs.

Project risk is reassessed every five years, on verification, except in the case of a reversal triggering an immediate reassessment of the project baseline, risk category and buffer contribution.

Reductions in enteric, manure, fertilizer and fossil fuel GHG emissions are not subject to reversal risk so no buffer contribution is required for these SSRs.

7.0 Calculation of Total Net Greenhouse Gas Emissions Reductions

Net emission reductions shall be calculated as:
(1)
Where:

ERT_CLM$_t$ Emission reduction tonnes awarded to the CLM project activity at time *t*; tCO_2e.

E_ENT Net enteric emissions; t CO_2-e. From A-ENTERIC when annual enteric emissions are >5,000 tCO_2-e. For annual emissions <5,000 tCO_2-e, set E_ENT=E_ENT$_{MS}$ from A-MICROSCALE.

E_MAN Net manure emissions; t CO_2e. From A-MANURE when annual manure emissions are >5,000 tCO_2-e. For annual emissions <5,000 tCO_2-e, set E_MAN=E_MAN$_{MS}$ from A-MICROSCALE.

E_FERT Net fertilizer emissions; tCO_2-e. From A- FERTILIZER when annual fertilizer emissions are >60,000 tCO_2-e for projects in continental US, and >5,000 tCO_2-e for projects outside continental US. For annual emissions <60,000 tCO_2-e but >5,000 tCO_2-e in the continental US, set E_FERT=E_FERT$_{SS}$ from A-SMALLSCALE. For annual emissions <5,000 tCO_2-e, set E_FERT=E_FERT$_{MS}$ from A- MICROSCALE.

E_FF Net fossil fuel emissions; t CO_2-e. From A- SMALLSCALE when annual fossil fuel emissions are >5,000 tCO_2-e for projects in continental US. For all other projects set E_FF=E_FF$_{MS}$ from A- MICROSCALE.

S_BIO Net biotic sequestration/emission; t CO_2-e. From A- BIOTIC or VCS VM0021 Soil Carbon Quantification Methodology when annual biotic sequestration is >60,000 tCO_2-e for projects in continental US, and >5,000 tCO_2-e for projects outside continental US. For annual sequestration <60,000 tCO_2-e but >5,000 tCO_2-e in the continental US, set *E FF S BIO Buffer E LK ERT CLM $_t$ E ENT E MAN E FERT_* (_ * (1 %)) _S_BIO=S_BIO$_{SS}$ from A-SMALLSCALE. For annual emissions <5,000 tCO_2-e, set S_BIO=S_BIO$_{MS}$ from A- MICROSCALE.
Buffer% Buffer withholding percentage; %. From A-BIOTIC, A-SMALLSCALE or A-MICROSCALE.

E_LK Total emissions from leakage; tCO_2-e. From VCS Module VMD0032 and VMD0033.

7.1 Allowance for "positive leakage"

VCS Module VMC0032 and VMD0033 provide conditions under which activity shifting and market-effects leakage must be calculated and procedures for these calculations.

Emissions from activity shifting leakage (*E_AS*) will either be positive, or zero in the case where activity shifting leakage is allowed to be ignored.

Emissions from market-effects leakage (*E_ME*) may be positive or negative. If project output is more than 3% less than baseline output, market-effects leakage must be calculated; *E_ME*, as derived in equation (2) of L-CLM, will be positive.[9] This means that the decrease in project output is causing positive emissions due to market-effects leakage, and these emissions are subtracted from net emission reductions attributable to the project in equation (1) of this module.

If project output exceeds baseline output, *E_ME* will be negative. This means that due to the increase in project output, less output needs to be produced elsewhere, as compared to the baseline case, so emissions elsewhere are being displaced. This is sometimes referred to as "positive" market-effects leakage. *E_LK* will likewise be negative (since *E_ME* is negative and there is no activity shifting leakage), so when *E_LK* is subtracted from net emission reductions in equation (1) of this module, "positive leakage" (emissions displacement elsewhere) will be credited to the project activity.

This is permissible, but only in cases where the Project Proponent can demonstrate to ACR and the VVB that there is no potential for double crediting. Double crediting would occur whenever the emission reductions being credited as positive leakage could also be claimed by other producers or production facilities, e.g. where fossil fuel emissions or emissions from fertilizer production are "capped" in a regulated system and/or where crediting is occurring for reductions in these sectors.

8.0 Ex Post Monitoring

8.1 Interval of Monitoring and Verification

Issuance of ERTs is subject to monitoring and verification. The minimum duration of a monitoring period is one year and the maximum duration is 5 years, as dictated by ACR's required interval for field verification.

The required interval for verification is as specified in the *ACR Standard*: a desk-based audit at each request for issuance of new ERTs (may be annual, or less frequent), and a full verification including field visit by the VVB at the first verification and then at least once every five years.

[9] Except in the case that output from production shifted to non-project areas more than compensates for the decrease in output from the project area.

For a Program of Activities, Cohorts added subsequent to the initial Cohort shall be field-verified at the first interval of field verification for the initial Cohort, and subsequently join the regular five-year cycle. For example, if a PoA is established with an initial Cohort in year 0, and additional Cohorts added in years 2 and 4, all three Cohorts will be field-verified in year 5 and then subsequently on five-year intervals.

Validation of the GHG Project Plan is required once per Crediting Period. Validation may occur simultaneously with the first verification and be conducted by the same VVB.

All data collected as part of monitoring should be archived electronically and kept at least for 2 years after the end of the last Crediting Period.

8.2 Parameters to be Monitored

All parameters listed in the relevant accounting module must be monitored. One hundred percent of the data should be monitored if not indicated otherwise in the parameter tables of the relevant module.

In the event the relevant accounting module specifies use of a model, or allows various models to be used, the input parameters required by the model used must be monitored.

8.3 Monitoring of Project Implementation

Information shall be provided in each monitoring report to establish that:
(a) The geographic position of the project boundary is recorded for all areas of land, whether these are part of a single project, Aggregate, or Cohort of a PoA;
(b) The geographic coordinates of the project boundary (and any stratification inside the boundary) are established, recorded and archived. This can be achieved by field survey (e.g., using GPS), or by using georeferenced spatial data (e.g., maps, GIS datasets, orthorectified aerial photography or georeferenced remote sensing images).
(c) Standard operating procedures (SOPs) and quality control/quality assurance (QA/QC) procedures for field data collection and data management have been applied. Use or adaptation of SOPs available from published handbooks, or from the *IPCC GPG LULUCF 2003*,[10] is recommended.

8.4 Sampling Design and Stratification

Stratification of the project into relatively homogeneous units – either relatively homogenously managed land areas, or relatively homogenous animal populations spread across these land units at different times of the year and at different life stages – can either increase measurement precision without increasing the cost unduly, or reduce the cost without reducing measurement precision, because of the lower variance within each homogeneous unit. The Project Proponent should present in the GHG Project Plan an *ex ante* stratification of the project area (using VMD0018) or justify the lack of it. The number and boundaries of the strata defined *ex ante* may change during the Crediting Period (*ex post*).

---

[10] See http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html.

Stratification shall be updated *ex post* because of the following reasons:

- Unexpected disturbances occurring during the Crediting Period (e.g., due to fire, pests or disease outbreaks), affecting differently various parts of an originally homogeneous stratum;

- Management activities that are implemented in a way that affects the existing stratification.

Established strata may be merged *ex post* if reasons for their establishment have disappeared.

8.5 Conservativeness

In choosing key parameters or making assumptions based on information that is not specific to the project circumstances, such as in the use of default data, the Project Proponent should select values that will lead to an accurate estimation of net emission reductions and removal enhancements, taking into account uncertainties. If uncertainty is significant, the Project

Proponent should choose data that tends to under-estimate, rather than over-estimate, net emission reductions and removal enhancements.

The Project Proponent should identify key parameters that would significantly influence the accuracy of estimates. Local values that are specific to the project circumstances should be obtained for these key parameters, whenever possible. These values should be based on:

- Data from well-referenced peer-reviewed literature or other well-established published sources; or
- National inventory data or default data from IPCC literature that has, whenever possible and necessary, been checked for consistency against available local data specific to the project circumstances; or

- In the absence of the above sources of information, expert opinion may be used to assist with data selection. Experts will often provide a range of data, as well as a most probable value for the data. The rationale for selecting a particular data value should be briefly noted in the GHG Project Plan. For any data provided by experts, the GHG Project Plan shall also record the expert's name, affiliation, and principal qualification as an expert. A 1-page summary CV for each expert consulted shall be included in an annex to the GHG Project Plan.

Annex A: Rules governing Aggregates and Programs of Activities

See section 3.0 for definitions of terms and acronyms used in this Annex.

A.1 Information required for establishing an Aggregate

A Project Proponent proposing an Aggregate shall submit a GHG Project Plan encompassing all project instances, fields, producers or facilities included in the Aggregate. Project boundaries, baseline definition, additionality demonstration, and all other requirements are applied at the level of the Aggregate. The relevant thresholds (5,000 and 60,000 tCO_2-e) must be assessed at the level of the Aggregate and the appropriate accounting modules used.

The *ACR Standard* requirements for precision (±10% of the mean at a 90% confidence level) shall be applied at the level of the entire Aggregate for the purposes of monitoring and verification.

The GHG Project Plan for an Aggregate is subject to certification by ACR and third-party validation, once per Crediting Period.

If the Project Proponent anticipates adding more project instances, fields, producers or facilities before the end of the Crediting Period, they should instead register a PoA.

A.2 Information required for establishing a PoA[11]

The Project Proponent serving as aggregator for a PoA shall complete a GHG Project Plan covering the entire PoA as well as the first Cohort of Project Participants. The GHG Project Plan shall define the project boundary and baseline criteria encompassing the initial Cohort of fields, producers or facilities, and should be written broadly enough to encompass new Cohorts anticipated to be added in the future. The GHG Project Plan will specify project boundaries (geographic, temporal, and the GHG assessment boundary), a baseline scenario, and a monitoring/verification plan for the entire PoA, i.e. for the initial and future Cohorts.

A PoA may be created at the time of registering the first Cohort of fields, producers or facilities. Cohorts may be added at any time provided they conform to the project boundaries and baseline criteria established in the initial GHG Project Plan. A PoA will have multiple Start Dates and Crediting Periods, but a single overall baseline scenario and monitoring/verification plan. See section 4.2 for rules concerning the Start Date and Crediting Periods for Cohorts in a PoA.

The *ACR Standard* requirements for precision (±10% of the mean at a 90% confidence level) shall be applied at the level of each Cohort for the purposes of monitoring and verification.

The GHG Project Plan for a PoA is subject to certification by ACR and third-party validation, at the start of the Crediting Period for the first Cohort. Subsequently each Cohort Description must be reviewed by the VVB.

---

[11] This section adapted from Clean Development Mechanism Rulebook at http://cdmrulebook.org/452.

The Project Proponent must describe in the GHG Project Plan a management system that includes the following:

- Clear definition of the roles and responsibilities of personnel involved in the process of inclusion of new Cohorts;

- Procedures for technical review of inclusion of new Cohorts, made available to the VVB at the time of validation of the PoA;

- A procedure to avoid double counting (e.g. to avoid the case of including in a Cohort a project instance, field, producer or facility that has been or will be registered on ACR as its own project, or in a Cohort of another PoA);

- Records and documentation control process for each Cohort under the PoA, made available to the VVB at the time of request for inclusion of the Cohort.

The Project Proponent of the PoA shall identify measures to ensure that all Cohorts under its PoA are neither registered as an individual ACR project activity, nor included as Cohorts in another registered PoA. These measures are to be validated and verified by the VVB.

The Project Proponent shall demonstrate that net emission reductions and removal enhancements for each Cohort under the PoA are real and measurable; are an accurate reflection of what has occurred within the project boundary; and are uniquely attributable to the PoA. The PoA shall therefore define at registration the type of information which is to be provided for each Cohort to ensure that leakage, additionality, establishment of the baseline, baseline emissions, eligibility and double counting are unambiguously defined for each Cohort within the PoA.

A.3 Information required for subsequent Cohorts in a PoA

When a Project Proponent adds subsequent Cohorts to an existing PoA, the Project Proponent shall provide a Cohort Description including, but not limited to, the following information:

- Geographic information to uniquely identify the Cohort;
- Name/contact details of the entity/individual responsible for the operation of the Cohort;
- Start Date and duration of the Crediting Period of the Cohort. The Start Date of a Crediting Period for a Cohort shall be the date of its inclusion in the registered PoA on any date thereafter.
- Confirmation that the Start Date of any Cohort is not, or will not be, prior to the validation of the PoA;
- Information stipulated in the GHG Project Plan for the PoA, to demonstrate how the new Cohort meets PoA requirements with respect to:
    - Fulfilling the eligibility criteria, project boundaries, baseline scenario, and demonstration of additionality specified in the GHG Project Plan
    - Calculations of baseline emissions and estimated net emission reductions and removal enhancements

- Compliance with relevant environmental impact analysis requirements, if any, unless the analysis was undertaken for the whole PoA and applies equally to this Cohort;
- Information on how comments by local stakeholders were invited, a summary of the comments received and how due account was taken of any comments received, unless the comments were sought for the whole PoA and apply equally to this Cohort;
- Confirmation that the Cohort is neither registered as an individual ACR project activity, nor included as a Cohort in another registered PoA.

The Cohort Description shall be provided to ACR and the VVB.[12] The VVB must provide to ACR its opinion on inclusion of the Cohort, prior to registration. This opinion does not require a site visit.

A.4 Preventing debundling

"Debundling" here refers to separating individual project activities from an Aggregate, and/or splitting Cohorts from a PoA, for registration as a separate project, in order to keep the SSR impacts below the relevant thresholds (5,000 and 60,000 tCO_2-e) that would require the use of larger-scale accounting modules. Debundling is not allowed under this methodology, since the intent of the thresholds and simplified accounting procedures is to improve the feasibility and cost-effectiveness of activities that have truly "micro" or "small" impacts on the atmosphere. It is therefore important to set criteria by which debundling can be recognized and prevented by ACR and the VVB.

For the purposes of registration of an Aggregate or PoA, a proposed project activity or Cohort shall be deemed to be a debundled component of an Aggregate or PoA if there is already a project activity or Cohort:

a) Registered by the same Project Proponent; AND
b) In the same CLM project category and technology/measure; AND
c) Registered within the previous 2 years; AND
d) Whose project boundary is within 1 mile of the boundary of the proposed project activity or Cohort, at the closest point.

If a proposed project activity or Cohort is deemed to be a debundled component of an Aggregate or PoA, but the total size of the project activity or Cohort combined with the already registered Aggregate(s) or Cohort(s) does not exceed the applicable thresholds specified in Section 2, then the proposed project activity or Cohort may use the simplified accounting modules relevant to the combined threshold.

The VVB shall review the GHG Project Plan and/or Cohort Description for any newly proposed project activity or Cohort to determine whether it is a debundled component of an Aggregate or PoA and thus ineligible for separate registration. Project activities or Cohorts deemed to be

[12] Preferably the same VVB who validated the original GHG Project Plan for the PoA. If this is not possible or practical, the Project Proponent may use a new VVB to validate subsequent Cohorts and should communicate to ACR the reason for the change.

debundled may still register using the larger-scale accounting methods dictated by the applicable threshold.

A.5 Addition of Cohorts causing accounting thresholds to be passed

It is possible that a project, using T-XANTE, initially estimates micro-scale effects (<5,000 tCO_2-e annually) on a particular SSR and thus chooses A-MICROSCALE, or initially estimates small-scale effects (60,000 tCO_2-e annually) and thus chooses A-SMALLSCALE, but with the addition of subsequent Cohorts, the effects on this SSR exceed those thresholds.

Note that T-XANTE will estimate for the entire Crediting Period, so if the Project Proponent plans from the beginning to bring in a sufficient number of Cohorts to exceed the relevant threshold for a SSR, these plans should be reflected in the GHG Project Plan for the PoA, and the project should adopt the next larger-scale accounting module for that SSR from the beginning.

However, if the exceedance is unexpected, then starting from the registration of the new Cohort going forward, the entire PoA must use the SSR accounting module corresponding to the relevant threshold. It is not required to recalculate emission reductions/removals for the PoA for the years prior to addition of the Cohort(s) that caused the threshold to be exceeded.

AMERICAN CARBON REGISTRY

METHODOLOGY SCREENING

Title:	*Cropland Management Greenhouse Gas Mitigation Methodology*
Date Submitted:	Submitted November 11, 2014
Methodology Authors:	Native Energy, Applied Ecological Services

A. General comments

The draft methodology requires significant revision prior to acceptance for public comment. ACR's substantive comments on the draft methodology are found in Section B. In Section C, ACR's proposed next steps are documented.

B. Substantive comments

1) The original GLLM methodology was intended to cover a broad range of beef and dairy management practices that could be implemented alone or in combination. It seems from the tracked changes in the draft Cropland Management Greenhouse Gas Mitigation Methodology (CLMM) that there may only be three major cropland management practices that this draft is intended to cover - conversion to direct seeding farming, rotational cropping, and fertilizer management. From what we understand, rotational cropping is usually considered common practice and would therefore not likely be eligible for crediting. If a project proponent was interested in implementing a fertilizer management project they can use one of the two previously approved ACR fertilizer management methodologies. It is unclear, generally, what practices the methodology is meant to include, but conversion to direct seeding seems to be the only eligible practice change for which a methodology does not already exist on ACR. If that is the case we feel it would be more appropriate to simply design a project type-specific methodology around that practice change, which could also take into account changes in fertilizer needs.

2) If there are only three relevant sources and sinks for the intended management practices - fossil fuels, biotic and fertilizer - it is unclear why this type of modular design would be necessary. ACR has approved other land-based methodologies that quantify increases in soil carbon sequestration and avoided N_20 from fertilizer (e.g. Avoided Conversion of Grasslands and Shrublands). The same standard methodology design would be more appropriate here.

3) There seem to be a number of applicability conditions that need to be reconsidered in the context of cropland management projects (e.g. references to public lands, drainage, conversion of land). It is unclear why these applicability conditions were, at minimum, not revised. These applicability conditions should be justified in the context of CLMM project activities.

4) The methodology continually references enteric methane and manure methane emissions from dairy and beef cattle operations. It is unclear how enteric methane and manure methane emissions are relevant to cropland management. All references to enteric and manure methane should be removed from the methodology.

5) Section 5.5 – Early Adopters:

ACR does not accept the addition of language in this section regarding an increase by a factor of 25%. Please remove this language to maintain consistency with the early adopter language found in GLLM. Likewise, under the "Renewal of the Crediting Period" subsection, remove language suggesting an alternate approach allowing an increase "…by a factor of XX."

6) Section 6.0 – Mitigation of Risk of Reversals in Biotic Sequestration:

It is unclear why the language found in the four bullets has been added to this section. A risk assessment will always be required. The language found here would be more appropriately placed under general project eligibility and additionality requirements.

7) Quantification

   a. Section 2.1 – Page 4 – Projects greater than 60,000t CO_2e in the U.S. and Projects outside the U.S. greater than 5,000t CO_2e:

      i. These sections require modules found in VCS VM0021 *OR* the A-Fertilizer and A-Biotic modules from GLLM. It is unclear when a Project Proponent would use which quantification modules. One quantification approach should be applied. Alternatively, the methodology should include a discussion of applicability when one method versus another will apply.

   b. Section 2.2 – Page 5 – Inclusion of VCS VM0021

      i. The draft CLMM references and relies upon multiple VCS modules for GHG quantification. If the methods cited in each of the VCS modules are to be used in the context of an ACR methodology, each of the modules would need to be submitted individually by the module authors for formal approval on ACR or revised to be included within CLMM prior to resubmission.

      ii. The VCS VM0021 methodology is cited in this section specifically rather than individual modules that are cited within the VCS VM0021 methodology. This is problematic for several reasons including that, among others, VCS VM0021 contains its own boundary conditions, additionality assessment, baseline scenario justification, and validation and verification requirements none of which apply to the ACR program.

      iii. Only relevant modules should be included within the methodology. In addition to comment 7)(b)(i), several modules found within VCS VM0021 do not appear to be applicable to the projects that would use CLMM. Additionally, certain modules are unnecessary such as VMD0030 – Estimation of Emissions from Power Equipment (it is stated in section 2.1 that fossil fuel emissions are quantified using A-SMALLSCALE or A-MICROSCALE) and VMD0034 – Methods for Developing a Monitoring Plan. Only those modules that are relevant and necessary should be included for review. Note also that as certain modules will not apply, any module that references a non-applicable module (for instance VMD0035 references certain modules that will not apply to CLMM project activities), must be revised prior to resubmission.

C. Next steps

Please prepare a revised methodology based on the comments in Section B. Once a revised draft is accepted by ACR, it will be posted for public comment for approximately 4 weeks. At your request, and following acceptance of the revised methodology and initiation of the public comment period, ACR can organize and conduct a stakeholder consultation webinar during the public comment period to solicit additional public input. At the conclusion of the public comment period, ACR will compile all received comments into a document for response by the authors. The authors should then prepare another methodology revision, incorporating changes from the public comments and justifying in the comment-and-response document any changes not incorporated.

This revision will be sent to a peer review team, generally one lead and 2-3 secondary reviewers. ACR will compile peer review comments into a similar comment-and-response document, and again the authors will incorporate revisions and justify in the peer review comment-and-response document any changes not incorporated. There are at least two rounds of peer review comments and responses. At the conclusion of peer review, the final methodology is published on the ACR website, along with the process documentation.

At your request, pending methodology revision and consideration of our above comments and prior to the public comment period, ACR will prepare a proposed contract, between Winrock International and Native Energy, covering ACR's costs to administer the public comment and peer review process. This contract will include target dates for each step of the process. The cost included in the contract will cover ACR's time to manage the public comment and peer review processes. The cost will be inclusive of funds to compensate a team of peer reviewers.

METHODOLOGY FOR SOIL CARBON SEQUESTRATION FROM LOW DISTURBANCE CROPPING

1. METHODOLOGY DESCRIPTION

1.1. Summary Description of the Methodology

This methodology provides for the quantification of increases in soil carbon levels resulting from conducting maximum disturbance threshold one or two-pass No-Till crop production (as further defined below, "Low Disturbance Cropping") in the United States. Conventional crop production using Tillage farming causes soil carbon to be released to the atmosphere. Low Disturbance Cropping can increase carbon sequestered in the soil. This results in reduced carbon dioxide in the atmosphere and lower nitrous oxide (N20) emissions from less soil disturbance. In addition, fewer Tillage passes on a farm field reduces fossil fuel emissions from farm equipment.

The methodology uses performance standard baseline methodology to quantify GHG reductions resulting from Low Disturbance Cropping.

1.2. Definitions

Aggregate: the grouping of multiple project instances, fields, producers or facilities into a single project activity registered on ACR. An Aggregate must be coordinated by a Project Proponent (public or private entity) serving as the aggregator. The GHG Project Plan will define the overall project boundary and baseline conditions encompassing all project instances, fields, producers or facilities. An Aggregate will have a single Start Date and Crediting Period.

Cohort: a new group of Project Participants, meeting required eligibility, project boundary, baseline and additionality criteria of an already established Program of Activities (PoA).

Cohort Description: a document provided to ACR and the Validation/Verification Body (VVB) at the time of addition of a Cohort to the PoA, summarizing all necessary information on the Cohort. Each Cohort Description becomes an addendum to the greenhouse gas (GHG) Project Plan for the PoA.

Cropland: a land-use category that includes areas used for the production of crops for harvest on cultivated lands. Cultivated grains include row crops or close grown crops, cover crops and also hay or pasture in rotation with cultivated grains. Cropland also includes land with alley cropping and windbreaks as well as lands in temporary fallow.

Crop Production: the processes involved in the production of crops for harvest, including soil preparation, planting, nutrient management, integrated pest management, irrigation, drainage, harvest and storage.

Farm Operator: the person or entity that controls the operations of a farm. The farm operator may or may not be the Land owner depending on the farming arrangement.

Landowner: the fee owner of land included in the Project.

Low Disturbance Cropping: a method of continuous or near-continuous[1] No-Till Crop Production with soil disturbance limited to up to two passes with low disturbance openers (up to 38% each)[2] or one pass with openers up to 46%, and with a minimum of 40% residue coverage after seeding.

No-Till: a procedure where seeds are planted directly into the soil with no primary or secondary Tillage (cultivation). No-Till is distinguished from Low Disturbance Cropping in that it also encompasses methods of No-Till that result in higher soil disturbance than the maximum allowed for Low Disturbance Cropping.

Participant Field: a defined area of land on which a Project Participant conducts Low Disturbance Cropping as part of the project.

Project Participant: an individual producer participating in an Aggregate, or in a Cohort of a PoA.

Project Proponent: per the *ACR Standard,* "an individual or entity that undertakes, develops, and/or owns a project. This may include the project investor, designer, and/or owner of the lands/facilities on which project activities are conducted. The Project Proponent and landowner/facility owner may be different entities." As used in this methodology, the Project Proponent may be a producer, a carbon project developer representing the producer, a carbon project aggregator representing multiple Project Participants in an Aggregate, or a carbon project aggregator representing multiple Cohorts of Project Participants in a PoA.

---

[1] The term "near-continuous" is used merely to distinguish Low Disturbance Cropping from the largely intermittent No-Till experimentation conducted in the Reference Region during the 1980s and 1990s by a few farmers that failed to produce significant increases in soil carbon. As such, no minimum continuity of Low Disturbance Cropping is required in the Project scenario. As this methodology relies on quantification of soil carbon through sampling and measurement rather than modeling, Tillage events are permitted as their effects will simply result in lower measured soil carbon accruals, or, if frequent enough, reversals. See section 6 of this methodology below.

[2] Percentage values associated with openers are based on maximum opener width divided by the spacing between the shanks of the implement.

Program of Activities (PoA): a project in which successive Cohorts of fields, producers or facilities are added incrementally to a project over time. A PoA must be coordinated by a Project Proponent (public or private entity) serving as the aggregator. In order to register a PoA the Project Proponent must use an approved baseline and monitoring methodology that defines the appropriate boundary, avoids double-counting, accounts for leakage, and ensures that the emission reductions are real, measurable, verifiable, and additional to any that would occur in the absence of the project activity.[3]

Reference Region: the area composed of Major Land Resource Areas 7 – Columbia Basin, 8 – Columbia Plateau and 9 – Palouse and Nez Perce Prairies within Land Resource Region B – Northwest Wheat and Range Region, as identified in U.S. Department of Agriculture Handbook 296 – Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin.

Stratum: an area of land within which the value of a variable, and the processes leading to change in that variable, are relatively homogenous.

Tillage: a mechanical disturbance of the soil profile to modify soil conditions (including moisture), manage crop residues, control weeds, and/or incorporate chemicals and manure for crop production.

1.3. Applicability Conditions

- The methodology is applicable to any Low Disturbance Cropping project activity implemented on a crop farming operation in the Reference Region.
- The methodology is applicable regardless of the magnitude of emissions or removals estimated *ex ante.*
- In the baseline scenario and/or as of the project Start Date, project lands must be managed for Crop Production implementing either Tillage farming or No-Till farming that did not meet the specific criteria for Low Disturbance Cropping as defined in this methodology. Woody vegetation must be absent in the baseline scenario.
- In the project scenario, project lands must be managed for Crop Production. The methodology is not intended for activities taking cropland out of production, due to leakage concerns.
- Recognizing that some cropland is leased rather than owned, the Project Proponent need not necessarily demonstrate land ownership, but must demonstrate offset title and effective control over the monitoring of the GHG sources and sinks from which the credited reductions/removal enhancements originate, for the duration of the specified

[3] Adapted from Clean Development Mechanism Rulebook at http://cdmrulebook.org/452.

Minimum Project Term. This applicability condition may be met by providing a letter from the landowner granting offset title to the Project Proponent and guaranteeing access to the land for soil sampling.

- If project activities lead to a decrease greater than 3% in product output, relative to the baseline case, the potential for market-effects leakage emissions must be accounted for following the procedures in Appendix D.
- Change by the Project Proponent to the drainage conditions on project lands are not permitted in any instance in which such changes would significantly increase emissions of greenhouse gases.
- Aggregated projects and Programs of Activities (PoAs) must comply with the definitions in 1.2 and the rules in Appendix A.

2. PROJECT BOUNDARIES

2.1. Spatial Boundary

2.1.1. Stratification

Stratification of the project into relatively homogeneous units can either increase measurement precision without increasing the cost unduly, or reduce the cost without reducing measurement precision, because of the lower variance within each homogeneous unit. The Project Proponent should present in the GHG Project Plan an *ex ante* stratification of the project area or justify the lack of it. Upon inclusion in a PoA, each subsequent Cohort shall be stratified *ex ante* or the lack of it justified for purposes of Verification. The number and boundaries of the strata defined *ex ante* may change during the Crediting Period (*ex post*). All such stratifications shall be conducted in accordance with Appendix B – Methods to Determine Stratification.

Stratification shall be updated *ex post* because of the following reasons:

- Unexpected disturbances occurring during the Crediting Period (e.g., due to fire, pests or disease outbreaks), affecting differently various parts of an originally homogeneous stratum;
- Management activities that are implemented in a way that affects the existing stratification.

Established strata may be merged *ex post* if reasons for their establishment have disappeared.

2.1.2. Recording the Project Area and Project Region

Project Proponents shall clearly define the geographic boundaries of the project so as to facilitate accurate measuring, monitoring, accounting, and verifying of the project's emissions reductions and removals.

The geographic boundary shall include all facilities and lands where Low Disturbance Cropping is undertaken as part of the project in the project scenario. The geographic boundary may not be defined so as to exclude lands or facilities where emission increases attributable to the project may occur. The geographic boundary must be justified to ACR and the VVB.

The project may contain more than one discrete area of land. When describing physical project boundaries, the following information shall be provided per discrete area:

- Name of the project area (e.g., field number, facility, etc.);
- Unique ID for each discrete parcel of land or facility;
- Map(s) of the area (preferably in digital format);
- Total land area and number of facilities.

The project may also span several Landowners and Farm Operators. The geographic boundary shall be defined to include all entities over which the Project Proponent (or the Farm Operators with whom the Project Proponent has contractual agreements to implement the project) has effective control of offsets produced and monitoring access. The geographic boundary shall however exclude lands and entities controlled by the Project Proponent that are unrelated to the project.

See Appendix A for guidance on specifying the geographic boundary in Aggregates and Programs of Activities.

2.2. Temporal Boundary

2.2.1. Start Date

Start Date is the date on which Low Disturbance Cropping began, upon conversion from Tillage farming or No-Till farming that did not meet the specific criteria for Low Disturbance Cropping as defined in this methodology.

A PoA will have multiple different Start Dates: a Start Date for the PoA overall, and Start Dates for each new Cohort. The Start Date of a Crediting Period for a Cohort shall be the date of its inclusion in the registered PoA or any date thereafter. See Appendix A.

2.2.2. Project Crediting Period

Crediting Period is the finite length of time during which the project's GHG Project Plan is valid, and during which a project can generate offsets for registration on ACR against its baseline.[4] For projects using this methodology, the Crediting Period shall be 10 years.

A PoA will have multiple different Crediting Periods: a Crediting Period for the first Cohort (the Cohort included in the GHG Project Plan at the time of establishment of the PoA), and Crediting Periods for each new Cohort. See Annex A.

Per the ACR Standard, Crediting Periods may be renewed without limitation. Renewing the Crediting Period requires re-assessing the project baseline, every 10 years, unless a reversal triggers an earlier baseline revision.

2.2.3. Project Term

Minimum Project Term is the minimum length of time for which a Project Proponent commits to project continuance, monitoring and verification. For projects using this methodology, a project term of 40 years is required.[5]

See Appendix A for guidance on specifying the Temporal Boundaries in Aggregates and Programs of Activities.

3. CARBON POOLS AND GREENHOUSE GAS BOUNDARIES

Each Participant Field must account for all carbon pools and GHG sources that are likely to result in a significant increase in GHG emissions or decreased carbon storage in the project scenario relative to the baseline.

Specific carbon pools and GHG sources, including carbon pools and GHG sources that cause project and leakage emissions, may be deemed *de minimis* and do not have to be accounted for if in the aggregate the omitted decrease in carbon stocks (in carbon pools) or increase in GHG emissions (from GHG sources) amounts to less than three percent (3%) of the total *ex ante* estimate of GHG benefit generated by the project. The latest version of the CDM A/R *Tool for testing the significance of GHG emissions in A/R CDM project activities* may be used to determine whether decreases in carbon pools and increases in GHG emissions are *de minimis*.

---

[4] See *ACR Standard.*
[5] See ACR *Forest Carbon Project Standard*.

3.1. Carbon Pools

The Project Proponent must account for all carbon pools that are likely to significantly decrease in the project scenario relative to the baseline for all Participant Fields. The Project Proponent may elect to include optional carbon pools that are likely to increase in the project scenario relative to the baseline.

Carbon Pools	**Included?**	**Justification/Explanation**
Above-ground biomass	No	Crop Production in the baseline scenario indicates lack of significant non-crop above-ground biomass
Below-ground biomass	Yes	Likely to be a significant source of carbon loss in the baseline scenario. Below-ground tree biomass is conservatively excluded; projects may elect to account for below-ground non-tree biomass.
Soil organic carbon	Yes	Major carbon pool subject to project activity
Soil inorganic carbon	Yes/No	Major carbon pool subject to project activity and site specific conditions. If pH is less than 7, SIC is not considered a concern or required to be measured/accounted.
Dead wood	No	Not a major carbon pool in the baseline or project scenario
Wood products	No	Not a major carbon pool in the baseline or project scenario

3.2. Greenhouse Gas Sources

The project must account for any significant increases in the GHG emissions for the project scenario relative to the baseline. The project may elect to account for optional GHG emissions sources that decrease in the project scenario relative to the baseline.

Sources	Gas	Included?	Justification/Explanation
Soil Management	CO_2	Yes/no	May be accounted for in the soil carbon pool
	CH_4	No	Not a significant gas for this source
	N_2O	Yes/no	Must be included if emissions from fertilizer use are expected to be higher in the project scenario than in the baseline. Quantified using ACR Methodology for N20 Emissions Reductions from Changes in Fertilizer Management v1.0.
Fossil Fuel Combustion	CO_2	No	Baseline emissions can be expected to be larger than project scenario. Conservatively excluded.
	CH_4	No	Not a significant gas for this source
	N_20	No	Not a significant gas for this source

4. PROCEDURE FOR DETERMINING ADDITIONALITY

Low Disturbance Cropping project activities must yield GHG emission reductions or removal enhancements that exceed any GHG reductions or removals required by law or regulation, and exceed any GHG reductions or removals that would otherwise occur in a conservative business-as-usual scenario.

To demonstrate additionality, ACR requires all project activities to 1) be surplus to applicable enforced regulations and either 2a) pass a performance standard test, or 2b) demonstrate that the activity is not common practice and faces at least one implementation barrier (financial, technological or institutional), making it less attractive than the business-as-usual scenario.

4.1. Regulatory Surplus

The regulatory surplus test involves existing laws, regulations, statutes, legal rulings, or other regulatory frameworks that directly or indirectly affect GHG emissions associated with a project action or its baseline candidates, and which require technical, performance, or management actions.

The Project Proponent shall conduct a review of applicable regulations (e.g., air quality, water quality, water discharge, nutrient management, endangered species and protection, etc.), mandates, legal rulings, consent decrees etc., that affect the project facilities or lands. The Project Proponent must demonstrate in the GHG Project Plan that the proposed project activity is not required by any existing applicable and enforced mandate. In determining whether an action is surplus to regulations, the Project Proponent should not consider voluntary agreements without an enforcement mechanism, proposed laws or regulations, optional guidelines, or general government policies.

Projects that are deemed regulatory surplus are considered surplus for the duration of the Crediting Period. If laws or regulations change during the Crediting Period, this may make the project ineligible for renewal.

4.2. Practices Deemed Additional

ACR conceptually supports the approach that certain practices, which can be shown to have a very low common practice adoption rate, may be included on a "positive list" of practices deemed additional. These practices, implemented in the specified regions, are eligible for crediting provided they meet the Regulatory Surplus test, without requiring a project-specific demonstration of implementation barriers or common practice adoption rates as specified in 4.4.

As documented on Appendix F, Low Disturbance Cropping is conducted on approximately 1 to 3 percent of the acreage in Crop Production in the Reference Region. As such, a performance standard is justified for the practice in the Reference Region, and all eligible Project Participants are eligible to use the common practice baseline(s) applicable on their Participant Fields based on the results of the stratification thereof, as provided in Section 5. See Appendix E for justification of the use of this performance standard.

4.3. Three-Prong Test

For practices not included in 4.2, Project Proponents shall demonstrate additionality in the GHG Project Plan using the ACR "three-prong" test (regulatory surplus, not common practice, and faces at least one implementation barrier) as supported by application of an ACR-approved additionality tool.[6] Such tools will help the Project Proponent to identify credible alternative land use scenarios, evaluate the attractiveness of all identified scenarios, and demonstrate that the project scenario is not the most economically or financially attractive of the identified scenarios, or faces higher barriers than those faced by another identified land use scenario, and is not common practice in the sector and geographic region.

5. QUANTIFICATION OF BASELINES

As presented in Appendix E, Quantification of Baseline Soil Carbon Stocking and Loss Rates in the Reference Region, the applicable baseline soil carbon stocking levels for Wetter Zone Up Slope and Down Slope, and for Drier Zone Up Slope and Down Slope (as such terms are defined in Appendix E), and the applicable baseline rates of decline in those stocking levels from Tillage Crop Farming are as set forth in Table 1.

Table 1

	Avg. 2012 Stocking (MTCO2e/ha)	Avg. Tillage Loss Rate (MTCO2e/ha/yr)
Wetter Up Slope	367	2.02
Wetter Down Slope	488	2.02
Drier Up Slope	286	2.37
Drier Down Slope	322	1.70

Baseline stocking level shall be calculated for each field (or the applicable strata area on each field) upon inclusion of the field, and at the time of each verification, in the Project by subtracting from the applicable Average 2012 Stocking level from Table 1 the product of the applicable Average Tillage Loss Rate times the number of years since 2012 at the time of such inclusion and/or such verification. Project Proponents may choose to use the baselines so calculated for all fields in the Project, as applicable based on stratification, or may choose to conduct sampling and measurement to determine the initial baseline stocking level for purposes of such calculation, in accordance with Appendix C.

[6] Such as the "ACR Tool for Determining REDD Project Baseline and Additionality" at http://americancarbonregistry.org/carbon-accounting/tools-templates, or the CDM Tool for the Demonstration and Assessment of Additionality at http://cdm.unfccc.int/methodologies/PAmethodologies/tools/

6. QUANTIFICATION OF GHG REDUCTIONS AND REMOVALS

Project scenario soil carbon levels shall be quantified in accordance with Appendix C – Estimation of Stocks in the Soil Carbon Pool, adjusted for leakage calculated pursuant to Appendix D. Baseline and project scenario N_2O emissions shall be calculated using ACR Methodology for N_2O Emissions Reductions from Changes in Fertilizer Management v1.0.

This section provides the methods required to sum up the estimated atmospheric GHG flux associated with the project area under either the baseline or project scenario for a given time period, and to estimate the uncertainty of project and baseline scenario carbon stock and emission calculations. Because GHG emissions are accounted as permanent, while GHG removals contained in pools have varying levels of impermanence risk, GHG pools and emissions are summarized separately. The uncertainty determination method may be used for project planning and must be used for GHG benefit determination. The method allows the project to determine whether the uncertainty of the atmospheric GHG benefit determination exceeds the appropriate level.

Summation of GHG pools:

$$PoolC_t = \sum_s(SoilC_s) \cdot 44/12 \qquad \text{Eq. 19.1}$$

Where:

$PoolC_t$	=	Total carbon in carbon pools at time t, tCO_2e
s	=	Strata
$SoilC_s$	=	The carbon content of the soil pool in stratum s at time t, tC
44/12	=	Conversion factor from C to CO_2, tCO_2/tC

Notes on variables:

All variables: Any carbon pools not accounted must be set to 0 in this equation.

$SoilC_s$: Values are derived from estimations carried out Appendix C, *Estimation of Stocks in the Soil Carbon Pool.*

Summation of GHG pools:

$$EmissionC_t = \sum_z(E_s) \qquad \text{Eq. 19.2}$$

Where:

$EmissionC_t$	=	Total emissions from time t=0 to time t, tCO_2e
z	=	The years from time t=0 to time t, yr
E_s	=	Emissions from soil resulting from management activities, tCO_2e/yr

Notes on variables:

- Any emissions not accounted must be set to 0 in this equation.

Summation of Leakage:

$$LeakageC_t = E_d + E_m \qquad \text{Eq. 19.3}$$

Where:

$LeakageC_t$ = Quantified leakage of the project over the baseline over the selected period, tCO_2e

E_d = Emissions from displacement leakage over the selected period, tCO_2e

E_m = Emissions from market leakage over the selected period, tCO_2e

Summation of net change carbon stocks:

$$NetchangeCarbonstocks_{t=z} = PoolC_{t,P} - PoolC_{t,B} \quad \text{Eq. 19.4}$$

Where:

$Netchangecarbonstocks_{t=z}$ = Difference in carbon stocks in baseline and project scenario, tCO2e

$PoolC_{t,P}$ = Total carbon in carbon pools at time t=z under the project scenario, tCO_2e

$PoolC_{t,B}$ = Total carbon in carbon pools at time t=z under the baseline scenario, tCO_2e

Summation of net change in GHG emissions:

$$NetGHGemissionchange_{t=z} = (EmissionC_{t,B} - EmissionC_{t,P}) \quad \text{Eq. 19.5}$$

Where:

$NetGHGemissionchange_{t=z}$ = Net change in GHG emissions for a period ending at time t=z due to the project activity, tCO_2e

$EmissionC_{t,B}$ = Total emissions from time t=0 to time t= z, under the baseline scenario, tCO_2e

$EmissionC_{t,P}$ = Total emissions from time t=0 to time t= z, under the project scenario, tCO_2e

Summation of net change in atmospheric GHGs:

The net changes in GHGs due to the project activities at time t=z will be:

$$\begin{aligned} TotalGHGCreditsgenerated &= (NetchangeCarbonstocks_{t=z} - NetGHGemissionchange_{t=z} - LeakageC_t) \\ &\quad - (NetchangeCarbonstocks * Buffer\%_t) \end{aligned}$$

Eq. 19.6

Where:

TotalGHGCreditsgenerated = GHG benefit of the project net of leakage and buffer.

$Netchangecarbonstocks_{t=z}$ = Difference in carbon stocks in baseline and project scenario, tCO_2e

$NetGHGemissionchange_{t=z}$ = Net change in GHG emissions at time t=z due to the project activity, tCO_2e

$LeakageC_t$ = Quantified leakage of the project over the baseline over the selected period, tCO_2e

Buffer$\%_t$ = Percentage of required buffering as per latest *ACR AFOLU Non Permanence Tool* requirements

Project uncertainty:

Estimated carbon emissions and removals arising from AFOLU activities have uncertainties associated with the measures/estimates of: area or other activity data, carbon stocks, biomass growth rates, expansion factors, and other coefficients. It is assumed that the uncertainties associated with the estimates of the various input data are available, either as default values given in IPCC Guidelines (2006), IPCC GPG-LULUCF (2003), expert judgment, or estimates based on sound statistical sampling. Alternatively, indisputably conservative estimates of values can also be used, which will allow proponents not to calculate uncertainties for those variables, provided that the values used are based on verifiable literature sources or expert judgment. In this case the uncertainty is assumed to be zero for that variable.

This procedure combines uncertainty information and conservative estimates allowing the estimation of overall ex-post project uncertainty.

The uncertainty across the baseline and project emissions and carbon stocks is determined through the following three steps. In Steps 1 and 2 the uncertainty of the various carbon stocks, and emissions in both the baseline (step 1) as well as the project scenario (step 2) will be determined. In Step 3 both uncertainties are summarized in one project uncertainty.

Step 1a: Estimation of the baseline uncertainty within the strata

Uncertainty must be expressed as the 95% confidence interval as a percentage of the mean.

$$\text{Uncertainty}_{BSL,SS,s} = \frac{\sqrt{(U_{BSL,SS1,s} * E_{BSL,SS1,s})^2 + (U_{BSL,SS2,s} * E_{BSL,SS2,s})^2 + \ldots + (U_{BSL,SSn,s} * E_{BSL,SSn,s})^2}}{E_{BSL,SS1,S} + E_{BSL,SS2,s} + \ldots + E_{BSL,SSn,s}} \qquad \text{Eq. 19.7}$$

Where:

$\text{Uncertainty}_{BSL,SS,s}$	Percentage uncertainty in the combined carbon stocks and greenhouse gas emissions in the baseline scenario in stratum s, %
$U_{BLS,SS,s}$	Percentage uncertainty (expressed as 95% confidence interval as a percentage of the mean where appropriate) for carbon stocks and greenhouse gas sources in the baseline scenario in stratum s (1,2,….s represents different carbon pool and/or GHG source,%
$E_{BLS,SS,s}$	Carbon stock or GHG sources (e.g. soil organic carbon, emission from fertilizer addition, emission from biomass burning etc.) in stratum s (1,2,…s represent different carbon pools and/or GHG sources) in the baseline case; tCO_2e
i	1,2,3,… s strata

In equation 19.7 the errors in each pool and emission are weighted according to the size of the pool or emission.

Step 1b: Total uncertainty of the baseline scenario is the square root of the sum of the squares of all the stratum uncertainties on a weighted basis.

$$\text{Uncertainty}_{baseline} = \frac{\sqrt{(\text{Uncertainty}_{BSL,SSs1} * E_{BSL,s1})^2 + (\text{Uncertainty}_{BSL,SSs2} * E_{BSL,s2})^2 + \ldots + (\text{Uncertainty}_{BSL,SSS} * E_{BSL,is})^2}}{E_{BSL,s1} + E_{BSL,s2} + \ldots + E_{BSL,sS}}$$

Eq. 19.8

Where:

$\text{Uncertainty}_{\text{Baseline}}$	Total uncertainty in the combined carbon stocks and greenhouse gas sources in the baseline scenario, %
$\text{Uncertainty}_{\text{BSL,SS,s}}$	Percentage uncertainty in the combined carbon stocks and greenhouse gas sources in stratum s in the baseline scenario, %
$E_{\text{BLS,SS,s}}$	Carbon stock or GHG sources (e.g. soil organic carbon, emission from fertilizer addition, emission from biomass burning etc.) in stratum s (1,2,…s represent different carbon pools and/or GHG sources) in the baseline scenario; tCO_2e
i	1,2,3,… s strata

Step 2a: Estimation of the project scenario uncertainty within the strata

$$\text{Uncertainty}_{P,s} = \frac{\sqrt{(U_{P,SS1,s} * E_{P,SS1,s})^2 + (U_{P,SS2,s} * E_{P,SS2,s})^2 + \ldots + (U_{P,SSn,s} * E_{P,SSn,s})^2}}{E_{P,SS1,s} + E_{P,SS2,s} + \ldots + E_{P,SSn,s}}$$

Eq. 19.9

Where:

$\text{Uncertainty}_{\text{P.s}}$ =	Uncertainty in the combines carbon stocks and greenhouse gas sources in the project scenario in stratum,%
$U_{\text{p,SS,s}}$=	Percentage uncertainty (expressed as 95% confidence interval as the percentage of the mean where appropriate) for the carbon stocks, Greenhouse gas emissions and leakage emissions in the project scenario in stratum s (1,2…s represents different carbon pools and/or GHG sources in the with-project case; tCO_2e)
$E_{\text{P,SS,s}}$=	Carbon stocks or GHG emission (Living biomass, , Soil carbon etc.) in stratum I (1,2…s represents different carbon pools and/or GHG sources) in the with-project case; tCO_2e
s=	1,2,3.. s strata

Step 2b: Total uncertainty of the project line scenario is the square root of the sum of the squares of all the stratum uncertainties on a weighted basis

$$\text{Uncertainty}_{Project} = \frac{\sqrt{(\text{Uncertainty}_{Ps1} * E_{Ps1})^2 + (\text{Uncertainty}_{Ps2} * E_{Ps2})^2 + \ldots + (\text{Uncertainty}_{PsM} * E_{P,iM})^2}}{E_{P,s1} + E_{P,s2} + \ldots + E_{P,sM}}$$

Eq. 19.10

Where:

$\text{Uncertainty}_{\text{Project}}$ =	Total uncertainty in project scenario, %
$\text{Uncertainty}_{\text{P,s}}$ =	Uncertainty in the combines carbon stocks and greenhouse gas sources in the project scenario in stratum,%

$E_{P,sM}$=	Sum of combined carbon stocks and GHG sources (e.g. soil carbon, emissions from leakage in stratum s (1,2,3, …s)
i,=	1,2,3, s strata

Step 3: Total project uncertainty:

$$\text{Uncertainty}_{Total\ project} \sqrt{\text{Uncertainty}^2_{Baseline} + \text{Uncertainty}^2_{Project}} \qquad \text{Eq. 19.11}$$

Where:

$\text{Uncertainty}_{\text{Total project}}$ =	total uncertainty of the projects atmospheric GHG benefit, %
$\text{Uncertainty}_{\text{Baseline}}$ =	total uncertainty of the baseline scenario emissions and carbon stock quantification, %
$\text{Uncertainty}_{\text{Project}}$ =	total uncertainty of the project scenario emissions and carbon stock quantification, %

7. PERMANENCE

Projects seeking credit for soil carbon sequestration are subject to risks of both unintentional and intentional reversals. These risks must be assessed as detailed in the ACR *Forest Carbon Project Standard*.

Project Proponents shall conduct a risk assessment using the latest ACR-approved tool.[7] In using such tool in the case of Programs of Activities involving conversion to Low Disturbance Cropping, the Project Proponent shall be deemed to have the legal agreement or requirement to continue the management practice if the Project Proponent can demonstrate that it has the legal right to, and has financial and management plans in place that will enable it to, enter onto all acreage included in the Program of Activities for the entire project longevity period and to collect and process such samples as may be necessary or advisable to duly account for and enable independent verification of carbon accruals or losses occurring on such acreage.[8]

---

[7] Currently the latest published version of the Verified Carbon Standard *AFOLU Non-Permanence Risk Tool.*

[8] Project Proponents will not be able to secure participation by Crop Producers if the "legal agreement to continue the management practice" referred to in the ACR-approved tool is interpreted to require the Farm Operator to commit to zero tilling for 40 years. Crop farmers must be able to till periodically when soil conditions require it for viable crop production, such as in unusually wet years. Periodic Tillage on some fields within a much larger project area is the atmospheric equivalent of timber harvest in some areas within a larger forest conservation project. Permitting periodic Tillage is consistent with the principles behind the provisions in the ACR Forest Carbon Project Standard that "Timber harvest included in the Project Plan is not considered an intentional reversal. Only the decision to discontinue forest carbon activities, monitoring and verification is treated as an intentional reversal." Version 2.1, at p. 33. Periodic Tillage based on environmental conditions does not equate to a decision to "discontinue [Low Disturbance Cropping] activities, monitoring and verification," and thus, as under the ACR Forest Carbon Project Standard, should not be deemed to be an intentional reversal. As such, securing the 40 year commitment to permit land access for sampling for monitoring and verification should be adequate for the "legal

The result of this assessment is an overall risk category for the project, translating into a percentage or number of ERTs that must be deposited, at each new ERT issuance, into a shared non-permanence buffer pool managed by ACR. In the event of a reversion to Tillage Crop Production (or No-Till not qualifying as Low Disturbance Cropping) on one or more parcels included in the Project Area, all soil carbon ERTs issued from the parcel will be considered to have been reversed unless the carbon losses from the reversion event on the parcel are duly accounted for and verified and soil carbon levels across the entire Project Area then remain higher than the levels demonstrated in the then preceding verification, in which case no reversal shall be deemed to have occurred.[9] To the extent soil carbon levels across the entire Project Area are verified as lower than the levels demonstrated in the then preceding verification, the deficiency shall be deemed to be the result of an unintentional reversal[10] and compensated by retiring existing ERTs from the ACR buffer pool as in the case of unintentional reversals, and the requirement to regenerate soil carbon levels prior to incremental crediting. This carbon loss shall be identified in a monitoring report and must be verified by a VVB.

All buffer contributions, deductibles, and ERT replacements (in the case of intentional reversals) may be made in ERTs of any type and vintage.

Project risk is reassessed every five years, on verification, except in the case of a reversal triggering an immediate reassessment of the project baseline, risk category and buffer contribution.

8. LEAKAGE

As the Project Area must be managed for Crop Production in both the baseline and the project scenario, there is no potential for activity-shifting leakage. The conditions under which market-

---

agreement or requirement to continue the management practice" requirement. Furthermore, as this methodology quantifies soil carbon accruals through measurement rather than modeling, the consequences of Tillage events will be known as long as the access and sampling continue to be permitted.

[9] There is no reason to conservatively assume that all accrued and credited accruals are lost if one or more farmers goes so far as to permanently revert to Tillage farming. The consequences of some parcels in a PoA reverting permanently to Tillage (or No-Till not qualifying as Low Disturbance Cropping) would only serve to slow the accrual rate within the PoA as a whole. . Nevertheless, imposing a penalty of ERT loss on the failure to monitor and verify soil carbon on reverted acreage will serve as an incentive to the project to continue monitoring and verification.

[10] On their face, Tillage events are intentional, in substance such events are a necessary response (if the farmer wants to produce a crop that year) to environmental conditions beyond the farmers' control, analogous to deliberately control-burning a firebreak to stop the further spread of a wildfire – intentional, but necessitated by environmental factors.

effects leakage must be calculated and procedures for these calculations are set forth in Appendix D.

Emissions from market-effects leakage may be positive or negative. If project output is more than 3% less than baseline output, market-effects leakage must be calculated.[11] This means that the decrease in project output is causing positive emissions due to market-effects leakage, and these emissions are subtracted from net emission reductions attributable to the project.

If project output exceeds baseline output, market-effects leakage will be negative. This means that due to the increase in project output, less output needs to be produced elsewhere, as compared to the baseline case, so emissions elsewhere are being displaced. This is sometimes referred to as "positive" market-effects leakage. Overall leakage will likewise be positive (since market-effects leakage is positive and there is no activity shifting leakage), so when overall leakage is subtracted from net emission reductions, "positive leakage" (emissions displacement elsewhere) will be credited to the project activity.

This is permissible, but only in cases where the Project Proponent can demonstrate to ACR and the VVB that there is no potential for double crediting. Double crediting would occur whenever the emission reductions being credited as positive leakage could also be claimed by other producers or production facilities, e.g., where fossil fuel emissions or emissions from fertilizer production are "capped" in a regulated system and/or where crediting is occurring for reductions in these sectors.

9. MONITORING

9.1. Interval of Monitoring and Verification

Issuance of ERTs is subject to monitoring and verification. The minimum duration of a monitoring period is one year and the maximum duration is 5 years, as dictated by ACR's required interval for field verification.

The required interval for verification is as specified in the *ACR Standard*: a desk-based audit at each request for issuance of new ERTs (may be annual, or less frequent), and a full verification including field visit by the VVB at the first verification and then at least once every five years.

For a Program of Activities, Cohorts added subsequent to the initial Cohort shall be field-verified at the first interval of field verification for the initial Cohort, and subsequently join the regular five-year cycle. For example, if a PoA is established with an initial Cohort in year 0, and

[11] Except in the case that output from production shifted to non-project areas more than compensates for the decrease in output from the project area.

additional Cohorts added in years 2 and 4, all three Cohorts will be field-verified in year 5 and then subsequently on five-year intervals.

Validation of the GHG Project Plan is required once per Crediting Period. Validation may occur simultaneously with the first verification and be conducted by the same VVB.

All data collected as part of monitoring should be archived electronically and kept at least for 2 years after the end of the last Crediting Period.

9.2. Parameters to be Monitored

All parameters listed below must be monitored. One hundred percent of the data should be monitored if not indicated otherwise in the parameter tables of the relevant Appendix. In the event the relevant Appendix specifies use of a model, or allows various models to be used, the input parameters required by the model used must be monitored.

Parameter	**Unit**	**Description**	**Source**
ts	g/cm^3	Mass of Soil	Calculated from sampling
l	#	The soil layers found in the plot	Plot data
sd_x	cm	Thickness of the soil layer	Plot measurement
$sdens_x$	g/cm^3	Soil bulk density	Measured from field samples
E	% of the mean	Allowable error	Determined by standard set
t	Dimensionless	t value	
L	#	Amount of strata	Measured
sh	Depends on estimated variable	Estimated standard deviation	Calculated
Ch	$	Cost to select and sample a plot in the stratum	Computed
N	#	Total number of samples	Apriori design
Nh	#	Number of samples per stratum	Apriori design
Wh	Dimensionless	Proportion of samples in stratum of total amount of samples	Calculated
SCy	kg/m^2	Amount of carbon per square meter	Laboratory measured and computed
X	#	Number of soil layers	Field and laboratory measured
sd_l	cm	Thickness of soil layer	Field measured
LCF%	%	% of large coarse fragments	Measured Laboratory testing of field samples

$sden_l$	g/cm^3	The average bulk density of soil layer l	Measured from field samples and average calculation completed
$\%osc_l$	%	Percentage of organic soil carbon in layer l	Laboratory testing of field samples
isg_l	Tonnes	Mass of inorganic soil carbon emitted as CO_2	Laboratory testing of field samples
m_{iscl}	kg	Mass of sample tested using acid test	Laboratory measurement of testing sample
12/44	Dimensionless	Coversion from CO_2 to C	Periodic table
$AC_{s,t}$	Tonnes	Carbon in soil amendments	Acounting of carbon containing soil amendments applied
$\#y_s$	#	Number of plots	Field data
A_s	m^2	Stratum area	Measured using GPS or other means of similar accuracy

9.3. Monitoring of Project Implementation

Information shall be provided in each monitoring report to establish that:

(a) The geographic position of the project boundary is recorded for all areas of land, whether these are part of a single project, Aggregate, or Cohort of a PoA;

(b) The geographic coordinates of the project boundary (and any stratification inside the boundary) are established, recorded and archived. This can be achieved by field survey (e.g., using GPS), or by using georeferenced spatial data (e.g., maps, GIS datasets, orthorectified aerial photography or georeferenced remote sensing images).

(c) Standard operating procedures (SOPs) and quality control/quality assurance (QA/QC) procedures for field data collection and data management have been applied. Use or adaptation of SOPs available from published handbooks, or from the *IPCC GPG LULUCF 2003*,[12] is recommended.

9.4. Conservativeness

In choosing key parameters or making assumptions based on information that is not specific to the project circumstances, such as in the use of default data, the Project Proponent should select values that will lead to an accurate estimation of net emission reductions and removal

[12] See http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html.

enhancements, taking into account uncertainties. If uncertainty is significant, the Project Proponent should choose data that tends to under-estimate, rather than over-estimate, net emission reductions and removal enhancements.

The Project Proponent should identify key parameters that would significantly influence the accuracy of estimates. Local values that are specific to the project circumstances should be obtained for these key parameters, whenever possible. These values should be based on:

- A data compendium from the study region, from farms and fields included in the baseline sampling and analysis using the stratification process required.
- Confirmation that said regional data compendium from the study region has been reviewed locally by experts, or has been presented at subject matter conferences, workshops, seminars, and in technical papers, that may include peer-reviewed proceedings or papers or other outlet for such technical information/data.
- Data from well-referenced peer-reviewed literature or other well-established published sources; or
- National inventory data or default data from IPCC literature that has, whenever possible\ and necessary, been checked for consistency against available local data specific to the project circumstances; or
- In the absence of the above sources of information, expert opinion may be used to assist with data selection. Experts will often provide a range of data, as well as a most probable value for the data. The rationale for selecting a particular data value should be briefly noted in the GHG Project Plan. For any data provided by experts, the GHG Project Plan shall also record the expert's name, affiliation, and principal qualification as an expert. A 1-page summary CV for each expert consulted shall be included in an annex to the GHG Project Plan.

9.5. Description of the Monitoring Plan

The monitoring plan must detail how the following will be monitored:

a) Project implementation.

b) Accounted pools and emissions.

c) Natural disturbance.

d) Leakage.

These are expanded upon in the sections below. The project proponent must prepare a monitoring plan describing (for each separately) the following:

a) Purpose of the monitoring.

b) Technical description of the monitoring task.

c) Data to be collected.

d) Overview of data collection procedures.

e) Frequency of the monitoring.

f) Quality control and quality assurance procedure.

g) Data archiving.

h) Organization and responsibilities of the parties involved in all the above.

9.6. Project Implementation

The rationale of monitoring project implementation is to document all project activities implemented by the project (including leakage prevention measures) that could cause an increase in GHG emissions compared to the baseline scenario.
The project proponent must perform the following:

a) Describe, date and geo-reference, as necessary, all measures implemented by the project.

b) Collect all relevant data to estimate carbon stock changes due to project activities and displacement of baseline activities, as well as GHG emissions due to leakage prevention measures. Refer to the relevant modules for the variables to be measured.

c) State whether the measures deviate from those described in the project description.

d) Record and justify any deviation to the interventions planned.

9.7. Accounted Pools and Emissions

The monitoring plan must include the following:

a) A description of the estimation, modeling, measurement or calculation approaches to be used in monitoring the variable.

b) A description of how methods and procedures given in each relevant module will be used to estimate the values of monitored variables.

c) A description of how a requirement for re-stratification will be identified for all monitored variables, and how the re-stratification will be undertaken.

d) Where applicable, the standards to be used for derivation of data from remote sensing, if remote sensing is to be used. The standards given should be consistent with those used during the preparation of ex-ante projections.

e) Procedures to be followed in the case of an improvement of the quality of data and data analysis methods during the project crediting period.

9.8. Natural Disturbance

Natural disturbances such as tsunami, sea level rise, volcanic eruption, landslide, flooding, permafrost melting, and pest and disease can impact the carbon stocks and non-CO_2 GHG emissions of a project. Such changes can be abrupt or gradual and when significant, they must be factored out from the estimation of ex post net anthropogenic GHG emission reductions, as follows:

a) Where natural disturbances reduce the area within which the project activities are undertaken, or within which they have effect, measure the boundary of the polygons lost from the project area and exclude the area within such polygons from the project area in both the baseline and project scenarios.

b) Where natural disturbances have an impact on carbon stocks, measure the boundary of the polygons where such changes happened and the change in carbon stock within each polygon. Assume that a similar carbon stock change would have happened in the project area under the baseline scenario.

9.9. Leakage

All sources of leakage identified as significant in the ex-ante assessment are subject to monitoring. The monitoring plan must detail the methods to be used to monitor leakage.

9.10. Quality Assurance and Quality Control

Project proponents must undertake ongoing QA/QC during the preparation of the project description and other project documents, including monitoring reports, as follows:

a) Project proponents must document all steps undertaken during the use of this methodology, including the sources of data where data is not generated internally, and the methods used to generate data for data generated internally.

b) Project proponents must describe specific quality criteria for tasks or data types that are given in the modules. Where such criteria are given project proponents must document the steps taken to meet these quality criteria.

c) Project proponents must undertake preparation and documentation of specific guidance on data collection techniques used, training of field crews in these techniques, and development of systematic procedures for checking on adherence to these standards.

d) For data derived from external sources, project proponents must include in their documentation any assessment of uncertainty attached to that data.

e) For data generated internally, project proponents must also generate uncertainty estimates for that data. During the preparation of project description and other documentation, project proponents will utilize and generate both qualitative and quantitative data. Depending on the type of data generated, uncertainty estimates must include one or both of the following elements:

   i. For all data types: A qualitative data assessment. A qualitative data assessment is an assessment of the factors which might influence the accuracy of the data. For example:

      1) Where the project proponent utilizes qualitative data on future management intentions of local farmers, gathered in interviews with farmers, the project proponent might assess factors such as:

- The representativeness of the farmers interviewed, in relation to the total project area.
- The conditions under which farmers were interviewed, including any possible biasing factors.
- The range of conditions within which the answers are likely to remain valid.

2) Where the project proponent gathers quantitative data on soil carbon, the project proponent must assess factors such as:
   - The range of past soil forming conditions within which the data gathering methods used would not be expected to produce accurate data (for instance, where soils consist of uneven layers of high and low carbon alluvial deposits, such that the specified sampling depth fails to capture a specific carbon rich layer where active change is expected to occur).
   - The possible influence of local scale change (change at a scale smaller than the scale of stratification) on soil carbon values, and possible sampling bias arising from these changes.
   - The possibility that a systematic sampling method has given rise to a sampling bias.
   - The possibility that the sampling equipment used introduced some contamination or bias.

For all data types, the qualitative assessment of possible error is of primary importance, and will form the context for the quantitative assessment of error.

ii. For quantitative data types: A quantitative data assessment. Where quantitative data is gathered, the project proponent should utilize appropriate statistical methods to assess the degree of certainty of the data generated. Specific modules give methods and allowable ranges of uncertainty for specific data types.

Based on the above, project proponents must include as an appendix to the project description, and to each monitoring report, an assessment of the overall uncertainty of the estimation of current conditions, and where applicable the baseline or project projections. This assessment must include:

a) Documentation of the data gathering procedures used, and the results of the systematic checking procedures to ensure that these procedures were followed.
b) A qualitative summary of the possible sources of error or uncertainty with relation to the baseline and project projections, including:
   - The possible sources of methodological error in the collection of internally generated data, and the steps taken to ensure that such errors do not, have not or are not occurring.

- The range of possible conditions, under which the estimations or projections are expected to remain accurate, and the types and estimated likelihood of conditions under which either estimations of current conditions or projections of future conditions might be significantly inaccurate.
- Future conditions under which a re-assessment of the baseline condition must be considered, due to significant deviation from the expected conditions.

Where appropriate, and recognizing the qualitative assessment undertaken above, a quantitative assessment of the range of uncertainty associated with the assessment of current conditions, or the baseline or project projections must be undertaken. Care must be taken not to rely on such quantitative assessments where factors identified in the qualitative assessment may limit the reliability of statistical procedures.

....

APPENDIX A
RULES GOVERNING AGGREGATES AND PROGRAMS OF ACTIVITIES

See section 1.2 for definitions of terms and acronyms used in this Appendix.

A.1 Information required for establishing an Aggregate

A Project Proponent proposing an Aggregate shall submit a GHG Project Plan encompassing all project instances, fields, producers or facilities included in the Aggregate. Project boundaries, baseline definition, additionality demonstration, and all other requirements are applied at the level of the Aggregate.

The *ACR Standard* requirements for precision (±10% of the mean at a 90% confidence level) shall be applied at the level of the entire Aggregate, but may be statistically justified for the purposes of monitoring and verification, to be analyzed and summarized by strata using the stratification as developed for project sampling and monitoring,

The GHG Project Plan for an Aggregate is subject to certification by ACR and third-party validation, once per Crediting Period.

If the Project Proponent anticipates adding more project instances, fields, producers or facilities before the end of the Crediting Period, they should instead register a PoA.

A.2 Information required for establishing a PoA[13]

The Project Proponent serving as aggregator for a PoA shall complete a GHG Project Plan covering the entire PoA as well as the first Cohort of Project Participants. The GHG Project Plan shall define the project boundary and baseline criteria encompassing the initial Cohort of fields, producers or facilities, and should be written broadly enough to encompass new Cohorts anticipated to be added in the future. The GHG Project Plan will specify project boundaries (geographic, temporal, and the GHG assessment boundary), a baseline scenario, and a monitoring/verification plan for the entire PoA, i.e. for the initial and future Cohorts.

A PoA may be created at the time of registering the first Cohort of fields, producers or facilities. Cohorts may be added at any time provided they conform to the project boundaries and baseline criteria established in the initial GHG Project Plan. A PoA will have multiple Start Dates and

---

[13] This section adapted from Clean Development Mechanism Rulebook at http://cdmrulebook.org/452.

Crediting Periods, but a single overall baseline scenario and monitoring/verification plan. See section A.2 for rules concerning the Start Date and Crediting Periods for Cohorts in a PoA.

The *ACR Standard* requirements for precision (±10% of the mean at a 90% confidence level) shall be applied at the level of each Cohort for purposes of monitoring and verification, but may be statistically justified to be analyzed and summarized by strata using the stratification as developed for project sampling and monitoring and verification,
The GHG Project Plan for a PoA is subject to certification by ACR and third-party validation, at the start of the Crediting Period for the first Cohort. Subsequently each Cohort Description must be reviewed by the VVB.

The Project Proponent must describe in the GHG Project Plan a management system that includes the following:

- Clear definition of the roles and responsibilities of personnel involved in the process of inclusion of new Cohorts;

- Procedures for technical review of inclusion of new Cohorts, made available to the VVB at the time of validation of the PoA;

- A procedure to avoid double counting (e.g. to avoid the case of including in a Cohort a project instance, field, producer or facility that has been or will be registered on ACR as its own project, or in a Cohort of another PoA);

- Records and documentation control process for each Cohort under the PoA, made available to the VVB at the time of request for inclusion of the Cohort.

The Project Proponent of the PoA shall identify measures to ensure that all Cohorts under its PoA are neither registered as an individual ACR project activity, nor included as Cohorts in another registered PoA. These measures are to be validated and verified by the VVB.

The Project Proponent shall demonstrate that net emission reductions and removal enhancements for each Cohort under the PoA are real and measurable; are an accurate reflection of what has occurred within the project boundary; and are uniquely attributable to the PoA. The PoA shall therefore define at registration the type of information which is to be provided for each Cohort to ensure that leakage, additionality, establishment of the baseline, baseline emissions, eligibility and double counting are unambiguously defined for each Cohort within the PoA.

A.3 Information required for subsequent Cohorts in a PoA

When a Project Proponent adds subsequent Cohorts to an existing PoA, the Project Proponent shall provide a Cohort Description including, but not limited to, the following information:

- Geographic information to uniquely identify the Cohort;
- Name/contact details of the entity/individual responsible for the operation of the Cohort;
- Start Date and duration of the Crediting Period of the Cohort. The Start Date of a Crediting Period for a Cohort shall be the date of its inclusion in the registered PoA on any date thereafter.
- Confirmation that the Start Date of any Cohort is not, or will not be, prior to the validation of the PoA;
- Information stipulated in the GHG Project Plan for the PoA, to demonstrate how the new Cohort meets PoA requirements with respect to:
    - Fulfilling the eligibility criteria, project boundaries, baseline scenario, and demonstration of additionality specified in the GHG Project Plan
    - Calculations of baseline emissions and estimated net emission reductions and removal enhancements
- Compliance with relevant environmental impact analysis requirements, if any, unless the analysis was undertaken for the whole PoA and applies equally to this Cohort;
- Information on how comments by local stakeholders were invited, a summary of the comments received and how due account was taken of any comments received, unless the comments were sought for the whole PoA and apply equally to this Cohort;
- Confirmation that the Cohort is neither registered as an individual ACR project activity, nor included as a Cohort in another registered PoA.

The Cohort Description shall be provided to ACR and the VVB.[14] The VVB must provide to ACR its opinion on inclusion of the Cohort, prior to registration. This opinion does not require a site visit.

[14] Preferably the same VVB who validated the original GHG Project Plan for the PoA. If this is not possible or practical, the Project Proponent may use a new VVB to validate subsequent Cohorts and should communicate to ACR the reason for the change.

APPENDIX B
METHODS TO DETERMINE STRATIFICATION

Introduction

Stratification is the process of dividing an area up into strata, based on variations in one or more specific variables, *X, Y, Z, etc.* *X (Y, Z, etc.)* is any variable whose value varies across the project area or another relevant area – for instance, *X* may be a variable such as soil texture, soil carbon density, various slopes and aspects, slope positions, or amount of biomass per unit area. Areas are often heterogeneous in terms of micro-climate, soil condition and vegetation cover and management history, leading to the requirement for stratification. Stratification can increase the accuracy of the measuring and monitoring in a cost-effective manner. Stratification of an area into relatively homogeneous units can either increase the measuring precision without increasing the cost unduly, or reduce the cost without reducing measuring precision because of the lower variance within each homogeneous unit.

The Project Proponent should recognize that mistakes in stratification could lead to significant increases in the cost and complexity of preparing a project description, and/or undertaking sampling and monitoring. At the same time, over-stratification (breaking an area into too many strata based on very small differences in the value of the variable) could equally lead to increases in cost and project complexity. In general, while stratification usually draws on quantitative data, ultimately most stratification is based to some degree on qualitative and subjective judgments.

For this reason, the Project Proponent must document the rationale for such judgments at each step of the process.

Stratification will often be undertaken both before and after sampling, with the first stratification ("pre-stratification") serving to increase the efficiency and effectiveness of the field sampling. After the sampling is complete, the Project Proponent can choose to refine the stratification using the results from the sampling, providing a final stratification.

The required steps of stratification are as follows:

Step 1: Identification of the type of stratification variable *X*

Goal: To identify the type of stratification to be undertaken based on whether or not subsequent sampling will be required to determine values of *X* across the project area.

Output: Identification of the type of stratification to be undertaken, allowing the determination of the stratification methods to be used.

Method: Classify the type of variable for which stratification is being undertaken. Three types of variables can occur:

1) Variables for which the distribution of the variable across the area is known. For instance, existing surveys or remote sensing interpretation may have already quantified the variation in the cropland across the area.
2) Variables for which stratification has previously been carried out within the area, but where changes in stratification are believed to have occurred, or are projected to occur, based on history or planning.
3) Variables for which the distribution of the variable across the area is not known. For instance there may be existing soil mapping, but the distribution of soil carbon across the site may not be known.

Step 2: Identification of the time span of the stratification, and the variation through time of the variable *X*

Goal: To identify the correct temporal context for the stratification of *X*.

Output: A clear definition of the temporal period of interest for *X*.

Method: Stratification may be purely for analysis of current conditions, or may also be designed to be applicable throughout a longer period of time, during which changes to the variable *X* may occur. The types of time spans which can occur are:

1) Single point in time – stratification is to be used for the analysis of data from a single point in time. Therefore, analysis of processes leading to changes in *X* need not be taken into consideration.
2) Historic time sequence – stratification is to be used for the analysis of a historic time sequence of data regarding the variable *X*. If so, stratification must take into account an analysis of the differences in processes leading to change in *X* at different locations, rather than the status at any given time.
3) Future processes – stratification is aimed at enhancing the feasibility or accuracy of projections of future conditions, and thus considers both current conditions, and projected changes in the dynamics of the processes influencing *X*.

Identify which one or more of these time spans *X* falls into. In cases where *X* falls into more than one, methods applicable to each of the time spans must be used, and it may be beneficial to stratify separately for each of the time span types.

Step 3: Selection of a stratification method

Goal: To identify the series of steps required to stratify for the variable *X*.

Output: Sequence of tasks to be undertaken to complete the stratification process.

Method: Select the series of steps to be undertaken to complete the stratification, based on the type and time span of the stratification for the variable X, as follows:

1) If the variable is of type 1 (the distribution of the variable across the area is known), and the time span of the stratification is either for a single point in time or for the variable over a historic period, complete the following sequence of steps:
   - Step 5: Pre-stratification
   - Step 7: Post-stratification
2) If the variable is of type 1 (the distribution of the variable across the area is known), but the stratification is to be undertaken for projection of future processes and states, complete the following sequence of steps:
   - Step 4: Identification of key factors
   - Step 5: Pre-stratification
   - Step 7: Post-stratification
3) If the variable is of type 2 (stratification has already been carried out, but conditions are thought to have changed), and the stratification is being undertaken for any temporal period, complete the following step:
   - Step 8: Re-stratification
4) If the variable is of type 3 (the distribution of the variable across the area is not known), and the stratification is being undertaken for any temporal period, complete the following sequence of steps:
   - Step 4: Identification of key factors
   - Step 5: Pre-stratification
   - Step 6: Qualitative truthing of stratification during sampling
   - Step 7: Post-stratification

Step 4: Identification of key factors influencing the variable *X*

Goal: To develop an understanding, based on available information, of the factors and processes which determine the value of *X* at a given location, and the change in *X* through time.

Output: A list of key factors influencing the variable *X*, identifying for each factor:

- The name of the factor
- The nature of the effect of that factor on *X*

- A relative ranking of the importance of that factor, compared with other identified factors

Method: Identify, for the variable *X*, the key factors. For any variable *X*, there will be a number of key factors within the area, either currently or in the future which tend to cause change in the variable, and where the amount of change caused by that factor is expected to vary across the area. For instance, if *X* is the slope aspect of a farm field such as the northeast or southwest aspect, solar insolation and soil heating will vary by aspect; concomitant moisture loss (evaporation, and evapotranspiration rates) and plant productivity will also vary. In cases where management has or is expected to influence *the effects of X*, management activities may also be included. For instance, if *X* is plant foliar coverage, planting of dense cover crops may reduce the soil heating and evaporative water losses which may lead to improved plant productivity and improved erosion control that could correlate with reduced erosional losses of soil carbon and improved soil carbon accruals. Thus slope aspect would be key stratification criteria.

For the purposes of stratification, identification of a key factor influencing *X* needs to be specific enough to allow different parts of the area to be distinguished depending on the degree of influence of the factor. However, this identification is not intended to allow quantitative projection of the future magnitude of effect on *X*. Thus for instance, the fact that improved vegetation cover lowers the soil temperature on a sloping farm field with a southwest aspect and will favorably influence soil carbon accrual rates when compared to similar conditions in the absence of dense vegetative cover is sufficiently specific to distinguish an influence of that factor, it will not yield a quantitative value of carbon accrual without measurements. The intention of identifying key factors is to identify influences, not specific effects, which are to be measured under this method.

Step 5: Pre-stratification

In cases where the data on which stratification will ultimately be based is not yet fully known, pre-stratification must be used to guide the data collection process.

Goal: Based on existing information and, if required, low intensity sampling, to divide the area into relatively homogenous sub-areas based on variation in the variable *X*. The pre-stratification will be used to guide the more intensive sampling process.

Output: A series of outputs to facilitate stratification:

- A map showing the area divided into discrete sub-areas based on variation in the current or historic values of the variable *X*, or the processes influencing *X*.
- A stratum definition for each stratum, giving the expected characteristics defining the stratum.

- A key factors definition for each stratum, identifying the key factors which are believed to be causing this stratum to be different from others.

Method:

Step 5a: Collection of information

Local information on key factors identified in Step 4 must be collected, such as:

- Local site classification maps and/or tables.
- The most updated land use/cover maps, satellite images and/or aerial photography.
- Soil types, parent rocks and preferably soil maps, depth to bedrock, depth to shallow water table, etc.
- Slope and aspect mapping
- Cropping and land use history maps
- Landform information and/or maps.
- Ecosystem maps.
- Fire regime maps or descriptions.
- Historical records of management.
- Management plans.
- Other information relevant to key factors identified above.

Data sources may include archives, records, statistics, study reports and publications of national, regional or local governments, institutes and/or agencies, literature and local knowledge.
For each data source collected assess the following:

- When was the work to derive the information undertaken?
- What specific work was undertaken to derive the data? For instance, if the data source is a soil map, was the map derived from actual sampling carried out within the area, or from extrapolation based on samples collected elsewhere?
- To what standards were the data collection and collation carried out? For instance, soil samples may have been analyzed in a lab, or may have been classified based on field texturing.

Based on these assessments, determine the overall quality of the data. This is particularly critical where the intention is to use existing data on the value of the variable as the majority of the basis for stratification.

Even where the data is of high quality, it is generally recommended that some truthing of the data, based on field reconnaissance, remote sensing data or other primary sources be undertaken to confirm the accuracy of the data.

Step 5b: Preliminary stratification

The preliminary stratification must be conducted in a hierarchical order that depends on the significance of key factors on variations in *X*, or the differences in the key factors across the project area. The hierarchy of the key factors must be determined based on the degree of influence that each factor has on the value of the variable.

In many cases it may be difficult to determine which factor has the most influence on the value of *X*. For instance, soil carbon may be influenced by soil texture, biotic community and management, and it may not be clear which of these is the most important. In such cases, it is recommended that the factor which is least changeable be designated the highest level factor. In the example given, soil texture is likely the least changeable, and would therefore be the highest level factor, while biotic community might be second, and management might be third. The Project Proponent must document the reasons for their choice and ranking of factors.

The factor with the most influence must be the first factor considered, then the factor with the next most influence, and so on. At each level in the hierarchy, stratification must be conducted within the strata already determined based on higher level factors. For example, if climatic differences across the area are the factor with the highest influence on the value of *X*, the stratification process must begin with stratification according to difference of the climate. If the second most important factor is soil type, then each stratum determined based on climatic differences must be further stratified based on differences of soil type.

Preliminary stratification is often most easily carried out on a Geographical Information System (GIS) platform, where information, maps collected, and field data can be overlaid. Whether or not the preliminary stratification is carried out using a GIS system, the Project Proponent must document the steps taken during the stratification process, and the reasons for each decision made.

Step 5c: Supplementary sampling survey

Where existing information leaves doubt as to the homogeneity within or differences between preliminary strata, the Project Proponent should carry out a supplementary sampling survey to allow estimation of the value of *X* in each preliminary stratum. For example, the following characteristics can be surveyed to allow estimation of the value *X* within the preliminary stratum:

- Vegetation cover can be assessed by measurement with high resolution multispectral aerial imagery of 6” on ground pixel size or comparably by measuring robustly selected plots.
- Site and soil factors can be assessed based on soil morphology, soil texture, slope gradient, slope aspect, intensity of soil erosion, depth to shallow ground water,

bedrock, or other limiting layer, and sampling soils for soil organic and inorganic carbon.
- Human intervention such as cropping history, land forming, drainage, fencing, field breaks, windrows, and farm roads can be assessed by background research or local interviews.

The survey must use the methods given for sampling the variable in question in this methodology. Since the goal of this sampling is more qualitative than quantitative, sampling at this stage need not meet any specific standards for statistical variance.

Step 5d: Strata homogeneity check

If pre-sampling was conducted, a further stratification must be completed based on supplementary information collected from Step 5c above, by checking whether or not each preliminary stratum is sufficiently homogenous, or whether the difference among preliminary strata is significant with regard to the variable X. The degree of homogeneity may vary from project to project and may be assessed based on stratum size in the context of the project, the degree of natural variability and the significance of the variability to the project and baseline scenarios. A stratum within which there is a significant variation in the value of the variable X must be considered for subdivision. On the other hand, two or more strata with similar features can be merged into one stratum. At the end of this step, strata should differ significantly from each other in terms of either current value or projected future values of X. For example, sites with different soil textures would usually form separate strata. Sites with a more intensive management (for instance cropland versus permanent pasture) might also be a separate stratum. On the other hand, site and soil factors may not warrant a separate stratum as long as all lands have a similar trajectory with regard to future values of X.

Step 5e: Pre-stratification map

A pre-stratification map, stratum definitions, and key factors definitions must be created, as follows:
- For the total area being stratified, prepare a pre-stratification map, preferably using a GIS (documenting “where is it different?”).
- For each stratum, document the unique characteristics which are believed to make this stratum different from all the others (documenting “what is different?”).
- For each stratum, document the specific processes which are believed to make this stratum different (documenting “why is it different?).

Step 6: Qualitative truthing of stratification during sampling

Goal: To estimate the accuracy of the stratification through qualitative review of the stratification during field work.

Output: Sketch revision of the stratification maps, and draft revisions of the strata definitions and the key factors for each stratum, based on a qualitative review.

Method: In cases where stratification is part of a process including ground sampling, stratum types and boundaries established during the pre-stratification phase must be checked in the field during sampling. While the sampling itself will provide quantitative data which must be used during the post-stratification in Step 7, qualitative data must also be gathered during the sampling phase, and reviewed on an ongoing basis against the pre-stratification. Notes on observations, giving the location of the observation and what was observed, must be documented. Best practices for qualitative truthing include:

a) Line intersect notes. While establishing plots or other sampling points, and during other work during the sampling phase, the routes traveled between plots and other points should be tracked, and compared at that time with the proposed stratification. Notes on observations, giving the location of the observation and what was observed, must be taken. Field workers should observe and investigate the following questions:
   - Is there an observable difference in the field at the location proposed for the stratum boundary, in terms of the variable X, or factors which are believed to influence the variable X?
   - Does this observable difference instead, or additionally, occur at other places, which might serve to refine the stratum boundary?
   - Do the proposed strata appear different in the ways predicted during the pre-stratification, or are there in fact strata which could be amalgamated?
   - Does a proposed stratum appear to contain two or more different distinct subtypes, in terms of the variable X, which might justify creation of further strata?

b) Sketch mapping. Based on the line intersect notes, sketch mapping reflecting the observations made in the field should be prepared, noting any possible changes in stratification boundaries or strata definitions.

c) Stratum redefinition. Based on the field observations, proposed changes to the stratum definitions should be documented, including amalgamation or splitting of strata.

d) Stratum process redefinition. Based on the field observations, proposed changes to the documentation of the processes which are believed to be driving the status of the variable X within each stratum should be documented.

Step 7: Post-stratification

Goal: Finalization and refinements of the stratum definitions and stratum mapping.

Output: Documented stratum definitions, and final stratum maps.

Method: After the intensive sampling phase, undertaken using the techniques in the relevant modules, or based on the known distribution of the variable, post-stratification must be undertaken to determine or refine the stratification based on the quantitative and qualitative data collected or already existing. Using the data collected in the field or the existing data:

- Refine the stratum definitions, including subdivision or amalgamation of strata where necessary.
- Refine the stratum mapping to produce final stratum maps. This remapping must be based both on any changes indicated by the data collected, as well as on the sketch mapping undertaken in Step 6.

Refining of both stratum definitions and stratum maps should strongly consider both the pre-stratification, if undertaken, and the qualitative data gathered in Step 6, or the existing data if the distribution of the variable is known. During the post-stratification phase there is often a tendency to trust the quantitative plot data despite qualitative or other evidence which suggests that the quantitative data may not be representative. During post-stratification, the limits of statistical reliability, particularly of single plots as an indicator of stratum boundaries, should be acknowledged, and considerable weight should be given to the qualitative observations of experienced field people.

Note that if the stratification is being determined for use in projecting future conditions, the key factors and processes influencing the variable, determined in Step 4, must be considered in determining the stratification. A stratum must not only be similar in the value of the variable X at the present, but the processes and key factors must also be similar, such that the future values of the variable within the stratum are expected to remain similar. If this is not the case, consideration must be given to breaking the stratum into two or more strata, based on groupings of key factors and processes driving the future value of the variable X.

Step 8: Re-stratification

Goal: To correct stratification to reflect changes in conditions.

Output: Documented revised stratum definitions, and stratum maps.

Method: Through time, changes in conditions or processes can lead to changes in stratification. Implementation of treatments may ultimately take place using different methods, in different areas, and at different time than was forecast in the project plan. Also, natural events may substantially change the nature and processes of areas within or across previously established strata.

The Project Proponent must routinely re-examine project area conditions to determine where events or actions may have occurred that could cause changes in stratification. The Project Proponent must conduct such a review prior to each monitoring event. Where such events or actions have occurred, the Project Proponent must repeat any or all of Steps 4 through 7, as required, to determine if, when and where, stratum boundary revisions are required.

Where re-stratification is conducted, changes in permanent sample plots are required under the following circumstances:

- Where re-stratification results in the subdivision of existing strata, the Project Proponent must assess whether additional sample plots need to be added to meet statistical requirements for sampling of the variable in question. Where re-stratification results in combining two or more strata, permanent sample plots must not be dropped even if the total number of plots in the new stratum exceeds the number required to achieve required levels of statistical accuracy.
- Where re-stratification results in a permanent sample plot lying on the boundary between two strata, the plot must be dropped.

APPENDIX C
ESTIMATION OF STOCKS IN THE SOIL CARBON POOL

This Appendix provides the methods to be used to estimate the required number of soil plots in each stratum, design and establish the plots, determine the carbon stock in the soil carbon pool, and check the statistical rigor of the results.

1 DEFINITIONS

Coarse Fragments: Pieces of rock or cemented soils > 2mm in diameter, and therefore too large to pass through the sieve used in the laboratory prior to laboratory analyses, and must be accounted for in Bulk Density analyses.

Ex-ante: Before the fact. Projection of values or conditions in the future.

Large Coarse Fragments: Coarse fragments greater than 10 mm in diameter, and therefore and must be accounted for in Bulk Density analyses.

Long Lived: Carbon which is in a form such that more than 80% of the carbon will remain in the soil for more than 10 years.

Monitoring Interval: The length of time between monitoring events.

Organic Soil Soils are organic if they:

1. Are saturated with water for less than 30 days (cumulative) per year in normal years and are not artificially drained, but contain more than 20 percent (by weight) organic carbon; or
2. Are saturated with water for 30 days or more cumulative in normal years (or are artificially drained) and, excluding live roots, have an organic carbon content (by weight) which is:
   a. 18 percent or more, if the mineral fraction contains 60 percent or more clay; or
   b. At least 12 percent, if the mineral fraction contains no clay; or
   c. Greater than 12 percent plus 0.1 multiplied by the clay percentage (12%+0.1*clay %), if the mineral fraction contains less than 60% clay.

Pedogenic: Arising from processes occurring within the soil.

Pedogenic Carbonate: Soil inorganic carbon derived from ongoing soil processes The probable rate limiting factors for accumulation include free calcium, favorable pH, available moisture, healthy soil microbial and fungal communities, and selected photosynthesizing plants growing in the soils.

Reference Condition: A condition of the ecosystem which is believed to have existed at some time, and which reasonably approximates the intended condition which will exist if the project is successful.

Small Coarse Fragments: Coarse fragments between 2mm and 10 mm in diameter, and therefore small enough to be captured within the soil core sample used to measure bulk density of a sample and must be accounted for in Bulk Density analyses.
.

Soil Type: (Technically known as Soil Series) The lowest taxa of the U.S. system of soil taxonomic classification; a conceptualized class of soil bodies (polypedons) that have morphological limits and ranges more restrictive than all higher taxa. Each soil series consists of soil layers (horizons) with similar soil color, texture, structure, pH, and consistence as well as mineral and chemical composition. Standardized soil type/series classification systems shall be used where available.

Soil Layer: (Typically known as soil horizons) Layer of soil whose physical, chemical and/or biological characteristics distinctively differ from the layers below and/or above.

2 APPLICABILITY CONDITIONS

This Appendix is not applicable for sampling or estimation of soil carbon content in organic soils Primarily because of the specialized sampling equipment needed, and changes in bulk density that occur through cycles of growth, dewatering and wetting up. To measure these changes by sampling organic soils, especially saturated or submerged organic soils requires different sampling equipment than what is typically used for sampling terrestrial soils. If appropriate sampling techniques according to the published peer reviewed technical literature can be demonstrated to be suitable for soil carbon sampling, carbon density estimation, and bulk density estimation, then this applicability condition may be waived.

3 PROCEDURES

Introduction

The goal of soil sampling is to gather information on soil carbon concentrations with statistical rigor sufficient to permit estimation of the total soil carbon per unit area. Soil sampling must always be conducted on a stratified basis, using the stratification procedures laid out in Appendix B – *Methods to Determine Stratification*. During stratification, existing data such as soil maps, landforms classes, slope gradients, slope aspects, land cover classifications, and data from previous soil surveys are gathered. The actual work of stratification and estimating soil carbon using this Appendix is undertaken on an overlapping basis, as data from work undertaken in each Appendix refines the work undertaken in the other Appendix.

Stratification for soil carbon sampling must consider at minimum the following variables*:*

- Existing soil classifications and mapping
- Soil texture, mineralogy and parent material
- Soil profile depth
- Geomorphic position and related soil processes, including, but not limited to:
  - surface shape (concavity/convexity),
  - slope position,
  - rates of erosion and deposition,
  - drainage and water regime,
- Ecology, plant community, and related soil processes, including, but not limited to:
  - Factors which may influence nutrient cycling and inputs, such as natural or synthetic fertilizer applications, nitrogen fixation, rooting intensity and depth, and biomass turnover,
  - Factors which may influence rates of plant mortality and forms of carbon input, such as differences in harvest regime and residue management associated with differences in cropping practices.
- Land use and management history and duration
- Farming history and landscape modifications

Soil sampling must be undertaken using a permanent sample plot or sample point technique, and a plot or sample point design which allows repeated sampling without bias resulting from disturbance caused by previous sampling. Sampling must be undertaken using the following 6 steps:

1. Land reconnaissance and presampling
2. Selection of sampling parameters

3. Identification of sampling requirements
4. Sampling
5. Laboratory procedures and quality assurance
6. Data verification and calculation

Conditions under which inorganic carbon is accounted

This method contains guidance for quantification of both organic and inorganic carbon in soils. However, in many cases changes in inorganic carbon content are slow and unlikely to be significant. Furthermore, accurate estimation of reductions in atmospheric GHGs due to accretion of inorganic carbon may be difficult, for several reasons:

- Carbonates may be transported from other locations in dust, or in solution, and increases in carbonates in the soil may therefore not represent the formation of new carbonates.
- Available calcium or magnesium for the formation of carbonates may be derived from the breakdown of carbonates at another location.
- Uncertainty over the age of the carbonates. If on a project, using standard electron microscopy (crystalline formation temporal sequencing), carbon dating (C isotope ratio analysis), or other acceptable techniques, that the uncertainty on the carbonates developing as a part of the agricultural project can be confirmed, (verses being paleo-carbonates), then the carbonates with further justification on their origin, may be accounted for in a project.

In general, therefore, it is recommended not to account inorganic carbon under most project scenarios, with the following exceptions:

1. Inorganic carbon must be accounted where project activities are likely to lead to changes in soil chemistry or processes (for instance, increased acidity in the soil), which may be expected to lead to the breakdown of carbonates and the release of carbon compounds to the atmosphere. For instance, under some management regimes ammonium sulfate fertilizer may be added to high pH soils with the goal of reducing pH to a 6.5 to 7.5 range. This pH change will tend to result in the breakdown of inorganic soil carbon and the release of carbon compounds to the atmosphere.

2. Inorganic carbon may be accounted where it can be demonstrated that:
    a. Increases in inorganic carbon in the soil are not the result of the transport of carbonates from outside the project area, or from below the sampled depth, for instance through irrigation or percolation.
    b. Calcium and magnesium for the formation of carbonates are not sourced from breakdown of carbonates outside the project area or below the sampled depth.

c. Increases in pH change which may provide an environment conducive to the accumulation of inorganic carbon, if other precursors are also present. For example, if the topsoil is truncated and an acidic subsoil is present pH (< 7) at the surface, as the topsoil can be re-grown and re-established with Low Disturbance Cropping or other forms of conservation Tillage, it may self adjust to a pH ≥ 7, then under these circumstances, new soil inorganic carbon can be sequestered. This can also happen if agricultural fields are subjected to high density short rotational livestock grazing where large volumes of calcium oxalate ingested by the grazing livestock from forage materials, are deficated (manure and urine) and can contribute to increased soil inorganic carbon stocks in the soil.

In either case, projection of a baseline for inorganic carbon must take into account the full range of carbonate formation, transport and breakdown processes and environmental conditions. If possible, and if suitable sites are available, strong consideration should be given to the use of a monitored baseline in addition to the ex-ante estimation, due to the complexity of inorganic carbon processes.

Step 1: Land reconnaissance and pre-sampling

Goal: Production of a qualitative assessment of soil carbon variation based on landscape processes and factors, and stratified sampling.

Product: Information on the expected values and distribution of soil carbon across the project area.

Method: In this step, the project area and, if used the reference region, are formally reconnoitered to understand the variability in site conditions in each major soil type (typically major soil types are derived from existing regional or national level soil classification systems, and associated mapping).

For the purpose of preparing an ex-ante estimation of soil carbon levels under the project scenario in Task 3, it may also be desirable to locate and presample reference areas during this step. Sampling of reference area locations where conditions reasonably resemble the soil conditions expected to occur under the project scenario may increase the accuracy of ex-ante projections.

Organize and implement field reconnaissance to observe site conditions, soil types, vegetation types and land uses in the project area, and reference region. During the field visit, mark areas on the aerial photographs (or other maps) that represent a conspicuous difference in the condition of vegetation and soils in each major proposed stratum, fence lines and agricultural field boundaries which may be management unit boundaries, and other conspicuous physical and ecological differences of the land. The reconnaissance must be systematic, and will begin to provide some understanding of changes in soil characteristics across the project area.

The goal of this step is to bring greater definition to the soil and vegetation conditions found in each proposed stratum. This information must be used to refine stratification and plan sampling strategy and intensity.

1. Pre-sampling Strategy: In each proposed stratum, during the reconnaissance period, complete a satisfactory number of soil sampling investigations (follow the procedures in Step 3 below) to determine whether or not the existing proposed stratification of the site is supported in the field, and to gather some information on the range of variation within the project area and stratum. The location of the plots during this step should be determined by deliberate selection of areas thought to be typical of a given proposed stratum, rather than by random or systematic sampling, and statistical assessment of the plot results need not be undertaken.
2. Pre-sampling Soils: In each area sampled, record the soil layers, textural characterization and associated depths of each sample. In each location, triplicate soil pits or probe samples will be required to affirm this characterization following the procedures as in Step 4.
3. Recording Vegetation: In each area sampled, record vegetation composition. The goal is to identify vegetation species and their corresponding percent cover values and communities which may be indicators of soil conditions. Recording vegetation during this phase is aimed at fine tuning soil classification, and not at developing a vegetation classification.

Following pre-sampling, revise the proposed stratification as required, following the techniques given in the Appendix B – *Methods to Determine Stratification*. Note also that pre-sampling may be used to identify and eliminate areas containing organic soils, which may be sampled using the methods given below, but must not be accounted using this method.

Step 2: Selection of sampling parameters

Goal: Determination of the sampling parameters.

Product: Requirements for sampling intensity and depth, and calculated depth

Method:

Determining sampling intensity

The number of plots depends on the variation in soil carbon levels, the required level of accuracy and the length of the *monitoring interval*. Based on the pre-sampling work, select an initial number of plots for each stratum. The goal is to install enough plots to meet the required statistical rigor, as discussed in Step 6.4 below. The Project Proponent may use a number of statistical methods to estimate the expected number of plots required, including those given in Wenger (1984), and in the CDM A/R Methodological Tool *Calculation of the number of sample plots for measurements within A/R CDM project activities* (AR-AM Tool 03 Version 02 or later version).

It is possible to reasonably modify (e.g. increase or decrease) the sample size after the pre-sampling or first monitoring event based on the actual variation of the carbon stock changes determined from taking the initial samples. However, the goal is to install sufficient baseline sample plots such that repeated monitoring of these plots can also encompass anticipated increases in variation over time.

Determining calculated depth and sampling depth

Calculated Depth: For each stratum, determine the calculated depth. This is the depth which will be used in the calculation of total soil carbon. This depth must be determined based on the following criteria:

- The calculated depth must be set to a depth great enough to capture at least 90% of the expected change in soil carbon resulting from the project activity as compared with the projected soil carbon change under the baseline scenario within the project crediting period, or 2m, whichever is less. Identification of the depth above which 90% of the change is expected to occur must be based on current research which has examined changes at depth, since much of the older research limited sampling to 30 cm or less, and did not quantify soil carbon dynamics at depth. Project proponents must start from an expectation of a 1m calculated depth, and adjust to reflect the particular dynamics of the project area. Thus, for instance, if research shows that 90% of the change in soil carbon resulting from the implementation of the project activity within the project crediting period is expected to occur in the upper 70 cm of the soil, the calculated depth might be set at 70 cm. Determination of the calculated depth must be undertaken based on the available literature, reference area measurements and knowledge of changes in soil carbon under the ecological and treatment conditions expected to apply. Note that some treatments may result in increases in soil carbon in some soil layers, and decreases in soil carbon in others. If this is the case, it is critical to capture both layers in the calculations.

- While bedrock or cemented layers may limit the total depth of the soil in some plots to less than the chosen calculated depth, soil depth in a majority of the plots must be expected to be greater than or equal to the calculated depth.
- The calculated depth must be less than the sampled depth, with the exception of individual plots in which the sampled depth is restricted by bedrock or a cemented layer, in which case the calculated depth may be equal to the sampled depth for that plot.

The calculated depth must be set for each stratum. However, note that within a stratum the actual depth used in the calculations may vary from plot to plot and from time to time due to one of the following conditions:

- Presence of bedrock or a cemented layer at a depth shallower than the calculated depth.
- Changes in soil depth or bulk density, as discussed in Steps 3.1 and 6 below.

Sampling Depth: The chosen sampling depth must be greater than the calculated depth, to allow for detection of change caused by the project in deeper layers, and to allow for changes in soil characteristics over time, as discussed in Step 6. Note that as with the calculated depth, the actual depth sampled may be less than the chosen sampling depth if bedrock or cemented layers are present which prevent deeper sampling. Sampling depth must be great enough to ensure that all soil layers where significant changes in soil carbon may occur are sampled. For instance:

- In sites where Tillage has been or will be practiced, sampling depth must be great enough to sample both those layers where Tillage is occurring, as well as at least one layer below the maximum depth of the Tillage, or the crop rooting depth, whichever is greater, but not exceeding 2 meters, to capture effects of downward migration of soil carbon from the Tillage and rooting layer.
- In untilled sites, sampling must be deep enough to capture the “C” layer – the soil layer consisting of un-weathered parent material with little organic input. However, where the “C” layer begins more than 2 meters below the soil surface, sampling depth may be limited to 2 meters.

In some cases the examples given above might lead to excessive sampling depths – for instance, in alluvial soils where repeated depositions of soil lead to very deep layers of organically modified soils. In such cases, sampling depth need not be greater than 2 meters. Typically sampling depth should be 10 – 20% greater than calculated depth, to allow for changes in soil density during subsequent sampling events.

Field reconnaissance and digging of a few test pits or probe samples may be required to determine the appropriate sampling depth. The goal of this reconnaissance is to identify the depth to which active and significant modification of the soil carbon is occurring due to both natural and anthropogenic processes. Identifying the depth will therefore require knowledge of the processes impacting the soil, and the reconnaissance will consist of identifying the depth at which these processes are occurring, and will require on expert judgment. Indicators may include process indicators such as active rooting, Tillage disturbance, soil color changes indicating active carbon accumulation or leaching, textural changes resulting from mobilization of fine fractions, etc.

Step 3: Identification of sampling requirements where soil processes exist which may generate inaccuracies in the estimation of soil carbon

Goal: Determination of the sampling requirements where soil processes could result in inaccuracies in estimation of GHG effects.

Product: Sampling methods which will allow for the adjustments required to compensate for changes in soil density or depth.

Method: Soils are dynamic systems whose properties, such as density, chemistry, depth, and other variables can change over time. The goal of this methodology is to allow accurate estimation of that total amount of carbon in the soils of a site, and changes in that total carbon. Amounts of carbon are determined based on the following 3 key variables:

- The amount of carbon in the soil as a percentage of the mass of the soil.
- The density of the soil (the amount of soil mass per unit volume).
- The volume of soil for which calculations are being done (the depth times the surface area).

The goal of the sampling and calculation methods given in this Appendix is to allow the accurate estimation of changes in atmospheric carbon resulting from changes in soil carbon. For this reason, it is critical to ensure that calculations do not result in erroneous estimations of the amount of carbon removed from or emitted to the atmosphere from soil processes. Such errors may occur for a variety of reasons. The most common potential causes of errors are:

1. Changes in soil density (compaction, accrual of organic matter, Tillage, etc.);
2. Apparent changes in soil depth resulting from sampling methods; or,
3. Actual changes in soil depth resulting from erosion or deposition of soils.

The calculation methods to be used are to ensure that false attributions of change in atmospheric carbon do not result from these potential causes of error given in Step 6. However, for changes in soil density and erosion or deposition, changes in sampling technique may need to be undertaken, as detailed below.

Step 3.1 Changes in soil density

Changes in soil density may occur when soils are subject to treatments such as compaction or Tillage, or compositional changes such as that which can occur with increased organic matter. These processes may result in more or less soil being present to the calculated depth, and may thus result in incorrect estimation of the total amount of soil carbon present if not corrected. Where such events are identified as a possible process resulting from the project activity or existing soil processes, the calculated depth may increase over time, and thus the sampling depth must be set to a depth great enough to ensure that sampling captures the data required for the calculations after changes in soil density have occurred.

Step 3.2 Actual changes in soil depth resulting from erosion or deposition of soils

Where erosion or deposition is expected to occur under the project scenario, Project Proponents must monitor changes in soil depth arising from these causes, to be able to account for these processes when undertaking calculations. Several techniques may be used, including:

- Installation of pins: Using the plot layout given in Step 4.1 below, select a point which is not expected to be sampled. At this point, during the first sampling of the plot, install a metal rod surface just flush with the top of the mineral soil layer. The metal rod should be longer than the calculated depth, or equal to the depth to bedrock or a cemented layer, whichever is less.

During each sampling, the metal rod must be relocated, and the amount of erosion or deposition (the length of the rod exposed, or the amount of soil above the top of the metal rod) measured. Care must be taken not to disturb the soil in the area of the rod during each sampling event. Where deposition or accrual has occurred, measurement of the depth of the soil on top of the rod should wherever possible be undertaken using a thin metal probe, to minimize the disturbance of the soil. Where disturbance occurs, the soil must be replaced after measurement.
Note that this technique must not be used where frost heave is expected to occur, or in expansive clay soils, since these processes may change the vertical location of the metal rod, leading to false results.

- Use ground based surveying techniques from known elevation markers to determine changes in elevation to sub centimeter accuracy.
- Use GPS to determine changes in elevation to sub centimeter accuracy.

Along with these techniques, soil profile descriptions must be re-measured by soil layers using standard data forms and procedures given below to determine changes in soil profile and strata thicknesses.

At the same time the bulk density must be estimated using standard techniques given below to distinguish between erosion or deposition and changes soil depth caused by compaction or de-compaction, Tillage, expanding clays, or other causes.

Step 4. Sampling

Goal: Collection of data which will allow the calculation of a quantitative estimate of soil carbon variation to the degree of statistical precision specified in Step 6.5.

Product: Plot data on total soil carbon, and organic and inorganic soil carbon separately.

Method:

Step 4.1 Locating plots

To avoid subjective choice of plot or sample point locations (point locations, plot centers, plot reference points, movement of plot centers to more "convenient" positions), the permanent sample plots or sample points must be located randomly or systematically with a random start within each identified stratum. The geographical position (GPS coordinate); administrative location, and stratum of each plot must be recorded and archived. Also, the sampling plots are to be distributed proportionately. For example, if one stratum consists of three geographically separated sites, then the following steps should be undertaken:

- Divide the total stratum area by the number of expected necessary plots, resulting in the average area per plot.
- Divide the area of each site within the stratum by this average area per plot, and assign the integer part of the result to this site. e.g., if the division results in 6.3 plots, then 6 plots are assigned to this site and 0.3 plots are carried over to the next site, or strata and so on.

Random location of plots or sample points can be accomplished in one of two ways:

- Locate plots or sample points systematically with a random start. In this case the plots are located using a systematic method – usually on a grid, with the location of the first points on the grid determined randomly. This must be undertaken prior to field work, with the plot locations specified on a map or aerial photos, and locations specified either as distance and direction from a known point or as a GPS coordinate.
- Locate individual plots or sample points randomly, using a randomization procedure in a GIS to specify the coordinates of each plot.

Timing of sampling

In addition to random location of the plots, it is critical that plot sampling is undertaken at the same time of year each time repeat sampling at permanent sample plots is undertaken. The goal is to sample the plots under, to the greatest degree possible, the same ecological and treatment conditions with each repeat sampling. Thus the day and month of establishment of permanent sample plots, and the ecological conditions existing at that time, must be recorded. Future samples at these plots/points should be established within 60 days of the same day in the year in which the plots are resampled, unless significantly changed ecological or treatment conditions (for instance a very late spring, late Tillage, etc.) mandate a greater gap between the initial sampling date and a specific later repeat sampling date.

Step 4.2 Soil Sampling Plot/Sampling Point(s)[15] Design

The sampling plot/point is designed to allow for very efficient installation and permanent field marking to ensure it can be relocated and re-sampled in the future. The design is shaped in circular form, that typically fits natural patch sizes in the field better then square or rectangular or linear plot shapes. Figure 1 shows the dimensions and provides an example of how individual soil sampling locations within the plot could be randomly sampled using several different soil sampling methods, and resampled over time to accommodate resampling. The plot is designed to accommodate at least three soil sampling methods: the use of soil core sampling technologies and extraction; the use of dug soil pits where rocks, roots and unconsolidated substrate conditions do not allow core sampling to be effective; and, the use of newer in-situ methods that involve inserting direct reading probes into the soil without necessarily having to extract soil samples en-mass as the core and pits methods, and correlations between these methods.
The plot design physically separates these three intervention methods and by following the instruction below, no interaction, bias, or violation of statistical independence occurs.

[15] Because GPS technology can support complete technical randomization and independence between the locations of future samples, sampling points can be used, rather than sample plots. If sampling points are used, repeat sampling must confirm that subsequent repeat sampling in the future must demonstrate this spatial independence by meeting acceptable GPS accuracy specifications for the coordinates generated for each sampling point, that accurately confirms points are no closer than .25 meters.

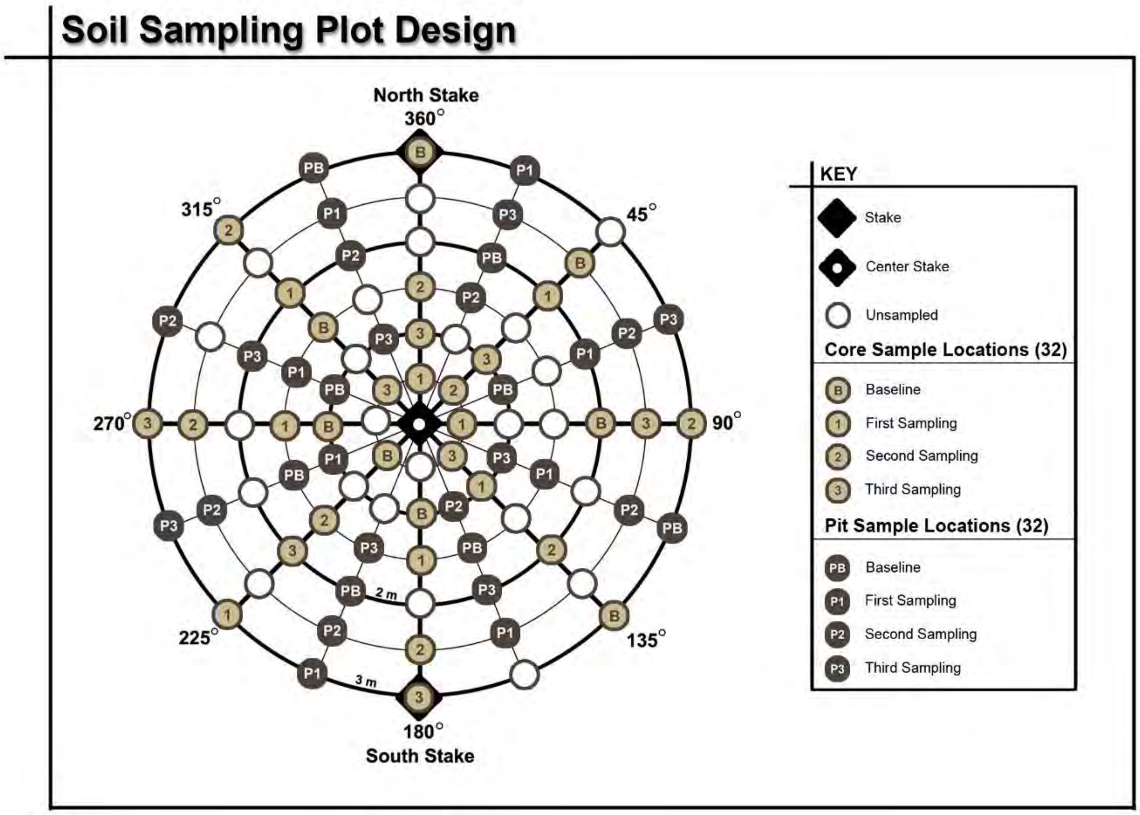


Figure 1. Layout of core and soil pit sampling site marking. Permanent plots centers and key radial end points allows easy metal detector relocation, re-measuring and gives statistical robustness and power.

Step 4.3 Initial Plot Establishment and Subsequent Relocations Steps

Step 4.3a Plot location: Using a handheld GPS with sub-meter accuracy, walk to the coordinates determined during Step 4.1, which locates the plot center. Achieving sub-meter accuracy may require use of control points (points with a known location). During initial plot establishment, install re-locatable marker. This marker may consist of:

- A 15-20 cm long by 0.25-0.50 cm diameter steel or iron rebar stake or 20-30 cm wire stake flag pins inserted into the soil at the plot center, and in the other locations as indicated in the sample plot figure. The rebar or wire stake pin must be completely buried by a minimum of 3-5 cm of soil to prevent discovery and damage to this marker, or injury to wildlife, livestock or humans, and vehicle tires in the future. This method should only be used where management does not include use of implements which could displace the center marker, or be damaged by the marker.

- A power line marker or similar detectable marker buried 30 to 50 cm deep (at least 1.5 times the depth of expected disturbance) at the plot center where management disturbance (Tillage or other activities) is possible.
- A surface marker outside the plot area along a fence line or other location where disturbance is unlikely. In this case the distance and direction from the marker to the plot center must be accurately determined and recorded.

If the sample plot location falls in an area of exposed bedrock or impermeable parent material (for instance compacted glacial till soils) or an impermeable man made material (for instance a road surface), determine whether the area is representative (more than 5% of the stratum area is composed of areas of this type). If the area is representative, the sample plot must not be moved. On the other hand, if the area is anomalous (less than 5% of the stratum area is composed of areas of this type), the entire sample plot may be systematically relocated by moving the plot to a randomly located point, unless the project scenario includes activities which are expected to rebuild soil systems in locations of exposed bedrock or impermeable parent material.

When previously established plots are being re-sampled, a metal detector may be required to locate the exact location of the plot center and north stakes. Where an erosion measurement point has also been established, both the plot center stake and the erosion monitoring point must be found, to ensure that the correct stake is identified as the plot center.

Step 4.3b Plot layout: Laying out the plot in the field may be undertaken using the following steps:

Step 4.3b1 Mark the center point of the plot using the techniques described in Step 4.3a below.

Step 4.3b2 Secure one end of a precut and graduated tape or rope at the center stake and pull the tape or rope taught and strait on a magnetic north bearing (bearing of 360).

Step 4.3b3 Sight back over the tape or rope and ensure the back bearing registers a 180 degree magnetic north bearing. Adjust position as necessary to achieve this alignment of the tape/rope over the 180 degree back bearing.

Step 4.3b4 Establish the direct north stake point with another pounded rebar stake or buried marker, installed as in Step 4.3a. For relocating a formerly established north stake, use the same GPS and metal detector technique for relocating the metal center stakes.

Step 4.3b5 Establish the direct south point, located 3 meters south of the center point. Use the pre-measured tape or rope that is pulled to align the center of the length over the center stake and north end over the north stake. Flag the south end location with a temporary wire stake flag.

Step 4.3b6 Establish the 6 meter long radial that is magnetically aligned with the east (90 deg) to west (270 deg) compass bearings. Stretch the rope or tape taught between endpoint stake temporary flags and center the tape over the center plot stake.

Step 4.3b7 Establish the 6 meter long northeast (45 deg) to southwest (225 deg) tape or rope using the same method as in Step 4.2e.

Step 4.3b8 Establish the 6 meter long northwest (315 degrees) to southeast (135 deg) tape or rope using the same method as in Step 4.2e.

Step 4.3c Sampling point relocation The goal is to ensure that previous sampled points within a plot are not re-sampled on subsequent resampling events. Prior to commencing with plot installation, randomly select pit or core sample locations (an example is shown in Figure 1) for each planned sampling event. Five, to as many as eight, of the points within the plot should be sampled during each sampling event. If the planned number of sampling events requires more sample points than those shown in the diagram, the plot may be expanded or the number of sample points sampled per event can be reduced to a minimum of three. An additional point sampled at each sampling event will be a soil pit. If obstacles, such as large surficial rocks or trees, which have soil underneath them within the sampling depth, prevent collecting samples at designated points, it may be necessary to move sampling locations. For core samples, adjust by moving the center of the core sample in 5 centimeter increments north of prior designated point(s). For pits, randomly choose another of the pit sampling locations, shown on Figure 1. If, on the other hand, an outcrop of bedrock or compacted material, or an embedded boulder (a large rock extending down to below the sampling depth) prevents collecting samples, the sampling point should not be moved, and the soil depth should be recorded as zero. Note that results from such sampling points must only be used in determining the average soil depth used in the calculations, and must not be used in the determination of average soil carbon percentage within the stratum.

Step 4.3d Plot maintenance and records: To ensure independence among samples from the first and all subsequent soil sampling events, no extracted soil materials must be deposited on the surface of the sample plot. The soils removed from pits will be used to backfill the pits and backfill or cap the boreholes. During the sampling process the Project Proponent must ensure that even small amounts of soils or other materials are not accidently dropped from the core or shovel used during sampling onto other areas of the sampling plot.

Denote on the sample plot diagram and record which sampling points and pit locations have been sampled during each sampling period. Accurate recording of which sample points are actually sampled is necessary as points sampled in the field may be different than the a-priori randomly selected sample points. Also, record when adjustments are made to respond to rock, bedrock,

tree roots, not being able to find a sample point, or where changes in the sample point justify it as atypical or modified from other representative conditions in the sample plot.
Sampling methods must remain constant from one measurement round to the next.

Step 4.3e Recording of soil layers: At each sampling location, use either a sampling probe (a 1 to 8 cm diameter stainless steel probe with a functional length equal to or greater than the sampling depth) or a shovel to extract or expose soil layer samples for observations, recording the depth of each soil layer. At minimum these must include depths of surficial humus layers, "A" and "B" layers, interbedded layers, hydrological indicators such as mottling or gleying, and depth to the "C" layer. Additionally, any other soil information commonly used to determine soil types in national, regional or local soil classification systems should be collected. For each soil layer record the texture, colours (using a Munsel standard colour book), hydrological indicators (e.g. mottles, reduction indicators), and the thickness. The sequence of soil layers must be determined down to the sampling depth.

Soil sampling will be undertaken using either core probe samples (may include power auger and core samples, etc.), or soil pits. Use soil pits if roots, rock or unconsolidated substrates do not allow the sampling and collection of soil samples using core probe samples, as defined above.

Step 4.3f Sampling soil carbon and bulk density: From each sample point, collect a separate soil sample from each soil layer. Place each sample in a plastic bag which is labeled with sample plot sample point and layer identification code, to ensure identification for later processing and analysis.

Additionally, for each soil layer, collect a single composite soil sample that combines equal amounts of soil from each of the three sampling points within the plot. Alternatively, the composite sample for each plot can also be created by removing from each previously bagged core or pit substrates sample, a homogenized subsample which is then added to the composite sample bag and labeled as above to record the plot number, composited strata layer, and date. The composite and individual collected samples will be submitted to analytical laboratories for carbon and other analyses.

To allow determination of the bulk density of each layer of soil, collect a known volume of undisturbed soil from each sampled soil layer within the plot. Typically this can be achieved by pressing a soil can of known volume into an undisturbed section of soil from the intact sides of a pit, or cutting a section of known length out of a sufficiently large diameter core sample and bagging it. Where soils are cohesive, this may require carving a block of soil to precisely fit the sampling can. Bulk density canisters need to be of a size appropriate to capture inherent soil structure variance such as found where aggregated soil structures are found. Typically, a canister of 74-150 cubic centimeters is adequate for this purpose. Advanced soil sampling technologies such as the use of hydraulic soil core samplers can also be used for sampling the complete soil profile to the desired/required sampling depth and retaining sufficient sample for analyses including bulk density by layer within the core sample. To use a core sampler for also measuring bulk density the core sampler should have an inside diameter or no less than 1.75 inches (4.5 cm) or more. Care should be taken to minimize compressional impacts during sampling. Regardless of soil sampling method, the goal is to extract intact sections that have not been compressed or altered by the sampling methodology and equipment, that are representative of each of the soil strata present, and to ensure that bulk density sampling, used to determine carbon content by soil volume, is accurate.

Step 4.3g Sampling coarse fragment content: Where soils contain a significant component of *coarse fragments* (rock and cemented fragments larger than the screen size used in the laboratory prior to testing for soil carbon), the percentage of the soil composed of these fragments must be determined. One or both of the two methods given below should be used, depending on the size of the *coarse fragments* present:

Small coarse fragments (Coarse fragments between 2mm and 10 mm in diameter, and therefore small enough to be included in the bulk density sample)
Where soil contains significant amounts of coarse fragments small enough to be included in the bulk density sample, the mass of the bulk density sample without the coarse fragments must be determined. This is done either in an eligible laboratory, or in the field, by screening the bulk density samples. Determination must be done separately for each soil layer.

Large coarse fragments (Coarse fragments greater than 10 mm in diameter, and therefore too large to be included in the bulk density sample, but not too large to move)
Where soils contain significant amounts of coarse fragments too large to be contained in the bulk density sample, the percentage of the volume of the soil composed of these fragments must be determined. Typically this can be accomplished by excavating soil from a hole of known volume, containing a minimum of 25 kg of soil, screening out the coarse fragments meeting the specified size criteria, and determining the volume of these fragments using water displacement, conversion from weight to volume, or other techniques. This determination must be done separately for each soil layer. Note that these coarse fragments do not include large embedded boulders, which are accounted as described in Step 4.3b above.

Step 5 Soil Sample Preparation and Laboratory Procedures

Goal: Completion of laboratory tests on soil properties.

Product: Accurate soil test results for measured soil properties.

Method:

Step 5.1 Soil Sample Preparation

All samples need to be inventoried, labeled and packaged for shipping to ensure they are accurately recorded, and to ready the samples for laboratory analyses and archival preservation. ***Sample preparation.*** If the nitrogen content of the soils is to be tested, freeze soil samples prior to delivery of the samples to a laboratory. Specimens need to be delivered to the testing laboratory immediately or at least as fast as possible once sample labeling is completed and the soil sample is recorded in a tracking system. Soil sample drying is done by the laboratory to which the samples are to be delivered, using repeated weighing to achieve and demonstrate constant dried weight is achieved which is required for bulk density precision. Note that for some soils (some clays and volcanic soils in particular) achieving a constant weight may be difficult without high heat drying. In that case, a subset of the soil sample should be weighed, dried at high heat, and weighed again, and a correction factor for the soil density derived from this subsample. Details of this procedure are found in the manual: *Soil Survey Laboratory Methods Manual* (USDA 2004).

Bulk Density. Measure the volume and initial wet and achieved final dry weight of the soils in the bulk density samples, and calculate the weight per unit volume based on these measurements. Screen the bulk density sample and determine the weight per unit volume of soil without the *coarse fragments*, as discussed in Step 4.3f above.

Chain of Custody. For fresh or dried samples, submit a chain of custody form to the soil testing laboratory and ensure that the laboratory maintains the chain of custody records.

QA/QC. The chosen soil testing laboratory must have a rigorous Quality Assurance program that meets or exceeds the US EPA QA/QC requirements or similar international standards for laboratory procedures, analysis reproducibility, and chain of custody. The laboratory must also provide a document that defines the pre-analysis sample processing procedures, and the specific chemistry test methods they use at the laboratory, including the minimum detention limits for each constituent analyzed.

Sample Archiving. Samples must be large enough to permit future re-testing. To do so, make arrangements with the chosen laboratory to create archival quantity samples. Archived samples must be either completely dried or frozen, to prevent ongoing biological activity from changing soil carbon densities, or their chemistry. Archived samples of all soil samples submitted should be kept at minimum until completion of the next verification. Additionally, a sufficient number of samples from each sampling event to cover the range of conditions expected to be found in the project area under the project scenario should be stored for the life of the project to allow recalibration of results where future advances in soil testing methods may result in potential loss of comparability between results.

Step 5.2 Laboratory Procedures

All laboratory procedures must follow the methods given in the most current version of the following manual: *Soil Survey Laboratory Methods Manual,* Soil Survey Investigations Report No. 42, Version 4.0 by the USDA Natural Resources Conservation Service, dated November 2004, or a standard of equivalent rigor.

Precision Levels

Two forms of testing error may occur at the lab: systematic and specific. The laboratory must meet the following precision levels:

Systematic Error. Systematic error occurs when instrument miscalibration or other problems result in consistent errors in results. Laboratories must demonstrate that in testing of standardized control samples the difference between the sample results and the known carbon content is not greater than +/- 2% of the known carbon content of the control sample.

Specific Error. Specific error occurs when testing of a given sample results in incorrect results, even though no systematic error is present. In order to test for specific errors, split a homogenized sample and submit both split samples labeled differently. Compare test results between the two subsamples and determine the specific error. Differences between split samples must not be greater than 10% of the greater of the two reported results.

As a standard procedure, for projects with a small number of samples (≤50) at least 10% of the samples must be split and independently tested and compared. For projects with larger sample sets (>100), no less than 10 samples must be split and independently tested.

Step 6 Analytical Laboratory Data Checking and Calculation

Goal: Accurate calculation of soil parameters based on laboratory results.

Product: Laboratory results which are quality checked, and calculated soil parameters based on the laboratory results.

Method:

Step 6.1 Data checking

Evaluate if all reported values are within the expected data ranges based on prior analysis and reports. Identify any that appear aberrant. Review the quality of the variances from the split blind samples. If results do not indicate that the estimated soil carbon levels of the split samples are from the same population or soil setting (10% variance with a 90% confidence interval). Retesting of soil samples may be required. These tests must be undertaken for soils collected from the same soil type, slope, vegetation cover typing, based on the *stratification* described in the introduction and Step 1 of this module.

Conclude which points appear to be outlier data points with what appear to be significantly skewed or divergent reported data outside the range of similarity to other data point results. If these are present in the data set, reasons for the variance must be determined based on the plot characteristics. Based on this analysis, one of the following options must be followed:

- If no significant differences in plot characteristics are found, compared with other plots in the stratum, the results must be retained and used in calculations for the stratum.
- If significant differences in plot characteristics are found, and these characteristics resemble the characteristics of another stratum, the plot may be re-assigned to the other stratum.
- If significant and highly anomalous differences in plot characteristics are found, and it can be demonstrated that these anomalous characteristics are unique and do not exist elsewhere within the stratum, the plot may be deleted.

Request retesting by the laboratory of archived samples if some results appear to be aberrant and cannot be explained.

Step 6.2 Adjustment of variables

As discussed in Step 3, certain soil processes (compaction, accrual, erosion, deposition, etc.) have the potential to result in errors in estimation of the changes in atmospheric carbon resulting from soil carbon fluxes. The following methods must be used to reduce the risk of errors in estimation when using the equations given above. Note that in some cases more than one of these soil altering processes may be present, and more than one method may be needed to reduce the risk of errors in calculation of soil carbon. In such cases, the Project Proponent must justify the suite of methods used, and demonstrate that the methods will not to result in an overestimation of the reductions in atmospheric carbon resulting from the project.

Step 6.2a Changes in soil density

Changes in soil density may occur as a result of compaction or decompaction. For each sampling point where the sampling depth was not restricted by bedrock or a cemented layer, and for each sampling time after the initial sampling, if the soil density (bulk density) changes by more than 5% from the first sampling event to subsequent sampling events, the calculated depth for that plot must be adjusted such that the factor *ts* is the same for each sampling period, where *ts* is calculated as follows:

$$ts = \sum_{l} sdens_l \cdot sd_l \qquad (5.1)$$

Where

ts	=	The total mass of soil in a 1 cm^2 column, g/cm^3
l	=	The soil layers found in the plot
sd_l	=	The depth (thickness) of soil layer x above the calculated depth, cm
$sdens_l$	=	The bulk density of soil layer x, g/cm^3

Example:

For the project, a calculated depth is 30 cm has been chosen. During the first sampling the soil is found to consist of two layers, as shown in table 6.3.1 below

Sampling time 1

Soil layer	Thickness above the calculated depth, cm	Bulk Density, g/cm3
A	20	1.1
B	10	1.2
		ts=34

Table 6.2.1 T=1 sampling

During the second sampling, the soil is found to be as follows:

Sampling time 2

Soil layer	Thickness above the calculated depth, cm	Bulk Density, g/cm3
A	22	1
B	10	1.1
		ts =30.8

Table 6.2.2 T=2 sampling

Because the soil bulk density has changed, the total amount of soil above the calculated depth has changed – in this case it has gone down, due to decompaction. The calculated depth must therefore be adjusted, to ensure that calculations are based on the same amount of soil. In this case, the new calculated depth will be 32.9, as shown in the table 6.3.3.

Sampling time 2, adjusted

Soil layer	Thickness above the calculated depth, cm	Bulk Density, g/cm3
A	22	1
B	10.9	1.1
		ts =34.0

Table 6.2.3 T=2 sampling, with calculated depth adjusted, such that *ts* for time 2 = *ts* for time 1

Note that if the new calculated depth extends below the bottom of the lowest soil layer calculated at time T=1 (in this case stratum B), the thickness of that soil layer must be the thickness found in the field, and data from the next soil layer down must be used for the remaining depth. For this reason it is critical to ensure that sampling in the field includes a substantial depth below the expected calculated depth as decompaction could potentially occur.

Step 6.2b Changes in the amount of soil present

Changes in the amount of soil present may occur through processes of erosion or deposition, or through the planned addition of soil amendments such as char. Where such processes are predictable (for instance, where regular alluvial deposition of soils occurs within a floodplain), their amount and location must be projected when preparing the baseline carbon estimates for the project. Also, where such processes are predictable, Project Proponents must ensure that plots are distributed to be reasonably representative of the range of erosion and deposition processes within the site. For instance, if a rolling agricultural site sees regular movements of soil from steeper areas of the topography to valleys and benches during intense rainstorms, plots must be located to representatively capture both the steeper erosion areas and the flatter deposition zones. In some cases these two areas may be separate strata, in which case plots will automatically be representative. In other cases, however, the impact of other processes and factors on soil carbon may be so much greater than this movement of soil that both the steeper and flatter areas fall within a single stratum, and the plots within that stratum must to be representative of that diversity.

Soil Amendment: Where changes in the amount of soil result from the addition of amendments, no changes in sampling depths or calculation depths should be undertaken to adjust for the amendment. However, note that amendment may result in changes in bulk density which may result in adjustments to the calculated depth as described in Step 6.3a above.

Erosion: Erosion events occurring within the project area may consist of small specific events (for instance, a small slippage), or may consist of large areas of sheet erosion or other comparable processes. Where plots within a stratum fall in small, unrepresentative (<1 / (number of plots times 2) % of the stratum area) erosion areas, the plots must be dropped. On the other hand, where erosion covers a larger portion of the stratum area, plots must be retained. Project proponents may choose either to continue to include the erosion area within the existing stratum, if the erosion impacts were relatively small, or to create a new stratum consisting of the eroded area, where the impacts of the erosion event were greater. Creation of a new stratum may lead to a requirement to install new permanent sample plots to ensure that the new strata meet statistical requirements.

Where changes in soil depth result from erosion, the amount and form of carbon released to the atmosphere as a result of the erosion process may vary widely, depending on the nature to the erosion event, the degree of separation of the carbon fraction of the soil from the mineral fraction of the soil during the erosion event, and the nature of the location where the carbon fraction of the eroded soil is eventually deposited. Due to these uncertainties, no changes to the calculated or sampled depths may be made after the erosion event, unless the event takes place in an area with a bedrock or cemented layer which restricts the sampling depth, in which case erosion may by default reduce the calculated and sampled depths.

The one exception to this rule will occur in the case that the sampling subsequent to the erosion event finds a new soil layer, high in carbonates, or consisting of a buried surface soil horizon, at the bottom of the sample. In such cases the actual carbon percentage of this layer must not be used, and the carbon content of the layer must be calculated using the carbon percentage found in the layer immediately above it.

Deposition: As with erosion, deposition may occur in small localized areas (for instance, at the tail of a slide) or across a broader area, as in the case of wide alluvial deposition zones. The same rules must be followed for elimination or retention of a plot falling into a deposition area, and restratification where necessary, as those given above for erosion.

Where changes in soil depth result from deposition, total sampling and calculation depths must not be changed. Where sampling and calculation depths were restricted by bedrock or cemented layers, subsequent sampling and calculations must only be undertaken to the depths previously used, even though more soil is now present.

Note that both deposition and erosion may result in changes in the nature and sequence of soil layers within the sample.

Step 6.2c Apparent changes in the amount of soil present where bedrock or cemented layers are present

Where soil sampling depths are restricted by bedrock or cemented layers, the sampling depth may change from point to point within a plot, even though no actual change in the amount of soil present, and no compaction or decompaction, has occurred. For instance, the depth to bedrock of the three sampling points at a given plot might be as follows:

	Total Sampling depths, cm		Changes in values between first and second sampling time	
Sample	First sampling time	Second sampling time	Erosion or deposition	Bulk density
1	28	29	No	No
2	24	26	No	No
3	27	30	No	No
Total	79	85		

Table 6.2.4 Changes in sampling depths between two sampling times, due to different depths to bedrock at different points within the plot**.**

If significant changes in bulk density have occurred, or significant deposition or erosion is found, adjustments to the calculated depth must be made using the methods given in Steps 6.3a or 6.3b, as applicable. However, if, as in the example given, no such significant changes are found, then the layer depths and total calculation depth used in the calculations for the first sampling time must also be used in the calculations for the second sampling time as well, in place of the actual measurements from the second sampling time, to eliminate false attributions of changes in total carbon resulting from different depths to bedrock or cemented layers across the plot.

Step 6.3 Accounting for soil carbon added as amendments

Some treatments, such as the addition of lime, char or manure to the soil, may directly add carbon to the soil. Adjustments to calculations of soil carbon may be required, depending on the source of the amendment.

Step 6.3a Amendments sourced within the project area

Amendments are considered to be sourced within the project area under the following conditions:

- For amendments other than manure, at least 95% of the biomass carbon must be sourced from within the project area, and must come from an accounted carbon pool. Thus for instance if char is derived from living biomass grown within the project area, and living biomass pools are accounted, the amendment is considered to be sourced within the project area. This will be the case even if the biomass is processed into char outside of the project area. On the other hand, if lime is sourced from within the physical boundaries of the project area, but comes from rock deposits or other sources which are not accounted pools, it cannot be considered to be sourced from the project area for the purposes of carbon accounting.

- For manure, the feedstock used for the animals must be at least 80% sourced within the project area. The percentage of feedstock sourced within the project area will be measured based on annual calorific value available to the animals. It is not required that the animals themselves be kept within the project area.

Where amendments meet the criteria given above, no adjustment to the soil carbon estimates is required. However, the following qualifications on emissions should be noted:

- If the processing of biomass into char, compost, or similar materials, or the processing of lime occurs within the project area, all emissions from the processing must be accounted as project emissions.
- If the processing of biomass into char, compost or similar materials, or the processing of lime occurs outside of the project area, the emissions must be accounted as leakage.
- If the animals from which the manure is sourced are kept within the project area, their emissions will be accounted as required in this methodology. If the animals from which the manure is sourced are kept outside of the project area, their emissions must be accounted as leakage. Where only a portion of the manure from these animals is used as soil amendment within the project area, the emissions may be prorated based on the percentage of the total manure used within the project area.

Step 6.3b Amendments sourced outside of the project area:

Where carboniferous amendments are sourced from biological or non-biological sources outside the project area, a deduction must be made from the calculated soil carbon as follows:

- Where amendments are long lived, meaning that at least 80% of the carbon in the amendment tends to remain in the soil for more than 10 years – for instance, where the amendment is char – 100% of the carbon content of the amendment must be deducted from the calculation of soil carbon in Step 6.6.
- Where amendments are not “long lived” – for instance, where the amendment is manure, 80% of the carbon in amendment must be deducted from the calculation of soil carbon in Step 6.6, unless the Project Proponent can show scientific evidence demonstrating that less than 80% of the carbon derived from the amendment will remain in the soil 10 years after application, in which case a

percentage of the carbon contained in the amendment may be deducted. The percentage used must be conservative, based on the available scientific literature.

In either case the deduction need not be made if it can be shown that at least 95% of carbon in the amendment comes from a source within the project area of another carbon project, and the source biomass pool is being accounted in that project. In this case, if the emissions from processing the amendment are not being accounted within the other carbon project, they must be accounted as leakage within this project.

Step 6.4 Data Calculation: Total soil carbon:
Subject to the guidance given in step 6.3, the following equation is used to calculate soil carbon per unit area.

$$SC_y = \sum_l^x (sd_l \cdot (1 - LCF\%_l) \cdot sdens_l \cdot \%osc_l \cdot 10^1) + \sum_l^x (sd_l \cdot (1 - LCF\%_l) \cdot sdens_l \cdot iscg_l \cdot m_{iscl}^{-1} \cdot (12/44) \cdot 10^1) \quad (5.2)$$

Where

SC_y	=	Total measured soil carbon per square meter at plot y, kg/m^2
x	=	The number of soil layers measured
l	=	Soil layers
sd_l	=	The average depth (thickness) of soil layer x found in the sampling points within the plot, cm
$LCF\%$	=	The % of soil volume composed of large coarse fragments, %
$sdens_l$	=	The average oven dry bulk density of soil layer x after removal of coarse fragments, found in the sampling points within the plot, g/cm^3
$\%osc_l$	=	The average mass of organic soil carbon in layer x, as a percentage of the total mass of the samples, as measured in the laboratory, %
$iscg_l$	=	The average mass of CO_2 emitted from the soil samples during acid testing, g
m_{iscl}	=	The average mass of the samples tested using acid testing , g.
12/44	=	Conversion from CO_2 to C

Note: The depth sd_x of the bottom-most measured soil layer is the thickness of that layer from the top of the layer to the calculated depth, or to bedrock or a cemented layer, whichever is less.
Note: The laboratory will often provide the term $iscg_l \cdot m_{iscl}^{-1}$ as a single value, percentage inorganic carbon.
Note: As discussed in the introduction, where changes in inorganic carbon are not expected to be significant, only organic carbon may be accounted.
Note: $\%osc_l$ and $iscg_l$ will be the average value determined from the samples submitted to the laboratory for that plot. If one or more sampling points within the plot have no soil (exposed

bedrock, for instance), no sample will be submitted, and the sampling point will not be included when calculating $\%osc_l$ and $iscg_l$.

Step 6.5 Statistical Calculations

Calculate the standard deviation and the confidence interval for total carbon for each stratum. If soils contain significant amounts of inorganic soil carbon, and these amounts are not expected to change, statistical calculations must be undertaken based on the amount of organic soil carbon only, to avoid the masking effects of the large and static pool of inorganic soil carbon. In these cases only organic soil carbon may be accounted and reported, and the portion of the equation accounting inorganic carbon must be set to 0.

Where the confidence interval exceeds +/- 10% with 90% confidence, Project Proponents may undertake one of three actions:

a. Re-stratify: Where the variance in the samples appears to be correlated to geographic or other factors, re-stratification should be considered, as discussed in Appendix B – *Methods to Determine Stratification*. If re-stratification is undertaken, confidence intervals must be re-calculated for the new strata. Re-stratification will require the installation of further randomly or systematically located plots if the confidence interval in one of the new strata fails to meet the required confidence standards, unless the Project Proponent elects to use option c for that stratum.
b. Increase the number of plots: Where the variance appears to be inherent to and distributed across the stratum, the Project Proponent may choose to install further plots. An estimate of the required number of further plots must be calculated, using the equation below (3), and further plots installed, located systematically or randomly.

$$N = t^2 \cdot s^2 \cdot (0.1 \cdot m)^{-2} \qquad (5.3)$$

Where

N	=	Total number of plots expected to be required
t	=	Student t-test 0.90 value for n-1, n being the number of plots already established
s	=	Standard deviation for the existing plot values
m	=	Mean value of the variable from the existing plots

c. Recalculate $SoilC_s$

In some cases, due to project size or other factors, installing enough plots to meet the required confidence interval may not be economically viable. In these cases, and provided that Project Proponents install a minimum of 10 plots per stratum, Project Proponents may proceed with data gathered to a lower confidence interval. However, Project Proponents must recalculate $SoilC_s$ (from Step 6.6 below) as follows:

1. Where sampling is undertaken prior to project start date to determine the baseline.

$$SoilC_s = SoilC_s \cdot (1 + (ci - 0.1)) \qquad (5.4)$$

Where:

$SoilC_s$	=	Total soil carbon in stratum s, t
ci	=	The calculated confidence interval at 90% confidence

2. Where sampling is undertaken after project commencement to determine soil carbon under the project scenario.

$$SoilC_s = SoilC_s \cdot (1 - (ci - 0.1)) \qquad (5.5)$$

Where

$SoilC_s$	=	Total soil carbon in stratum s, t
ci	=	The calculated confidence interval at 90% confidence

Step 6.6 Calculating the total accounted soil carbon for the stratum

The total accounted soil carbon for the stratum will be calculated using the following equation.

$$SoilC_s = (\sum_{y_s} (SC_y) \cdot \# y_s^{-1} \cdot A_s \cdot 10^{-3}) - AC_{s,t} \qquad (5.6)$$

Where

$SoilC_s$	=	Total soil carbon in stratum s, t
y_s	=	The plots in stratum s
$\#y_s$	=	The number of plots in stratum s, dimensionless
SC_y	=	The average soil C per m^2 in plot y, kg/m^2
A_s	=	The area of stratum s, m^2
10^{-3}	=	Conversion from kg to t
$AC_{s,t}$	=	Carbon added to the soil as accounted amendments in stratum s to time t, t

Note: See Step 6.3 to determine the value of the variable AC_y. The carbon in all accounted amendments applied from the start of the project to the time of the calculation must be deducted.

4 PARAMETERS

Data Unit / Parameter:	ts
Data unit:	g/cm^3

Description:	Mass of soil
Source of data:	Calculated from sampling
Justification of choice of data or description of measurement methods and procedures applied:	The total mass of soil in a 1 cm^2 column to the calculated depth
Any comment:	

Data Unit / Parameter:	*L*
Data unit:	#
Description:	The soil layers found in the plot
Source of data:	Plot data
Justification of choice of data or description of measurement methods and procedures applied:	The various soil layers found in the plot, distinguished on the basis of texture, density, soil organic carbon content, or other features
Any comment:	

Data Unit / Parameter:	sd_x
Data unit:	*Cm*
Description:	Thickness of the soil layer
Source of data:	Plot measurement
Justification of choice of data or description of measurement methods and procedures applied:	The depth (thickness) of soil layer x above the calculated depth,
Any comment:	

Data Unit / Parameter:	$sdens_x$
Data unit:	g/cm^3
Description:	Soil bulk density
Source of data:	Measured from field samples
Justification of choice of data or description of measurement methods and procedures applied:	The bulk density of soil layer x,
Any comment:	

Data Unit / Parameter:	*E*
Data unit:	% of the mean
Description:	Allowable error

Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	e.g. ±10% of the mean
Any comment:	

Data Unit / Parameter:	*T*
Data unit:	Dimensionless
Description:	t value
Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	Student's t-test value for the confidence level (e.g. 90%)
Any comment:	

Data Unit / Parameter:	*L*
Data unit:	#
Description:	Amount of strata
Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	Total of number of strata types in the area to be sampled
Any comment:	

Data Unit / Parameter:	*sh*
Data unit:	Depending on estimated variable
Description:	Estimated standard deviation
Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	estimated standard deviation of stratum h
Any comment:	

Data Unit / Parameter:	*Ch*
Data unit:	$
Description:	Cost to select and sample a plot in the stratum
Source of data:	

Justification of choice of data or description of measurement methods and procedures applied:	Cost to select and sample a plot in the stratum
Any comment:	

Data Unit / Parameter:	*N*
Data unit:	#
Description:	Total Number of samples
Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	Number of sample units (all strata) $N=\sum Nh$
Any comment:	

Data Unit / Parameter:	*Nh*
Data unit:	#
Description:	Number of samples per stratum
Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	Number of sample units for stratum h calculated by dividing the area of stratum h by area of each plot.
Any comment:	

Data Unit / Parameter:	*Wh*
Data unit:	Dimensionless
Description:	Proportion of samples in stratum of total amount of samples
Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	Nh/N
Any comment:	

Data Unit / Parameter:	*SCy*
Data unit:	kg/m^2
Description:	Amount of carbon per m^2

Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	Total measured soil carbon per square meter at plot y to a specified depth
Any comment:	

Data Unit / Parameter:	*x*
Data unit:	#
Description:	Number of soil layers
Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	The number of soil layers measured
Any comment:	

Data Unit / Parameter:	***l***
Data unit:	#
Description:	Soil layers
Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	Soil layer(s)
Any comment:	

Data Unit / Parameter:	sd_l
Data unit:	Cm
Description:	Thickness of soil layer
Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	The depth (thickness) of soil layer l
Any comment:	

Data Unit / Parameter:	*LCF%*
Data unit:	%
Description:	% of large coarse fragments

Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	The percentage of the soil volume composed of large coarse fragments
Any comment:	

Data Unit / Parameter:	$sdens_l$
Data unit:	g/cm³
Description:	The average bulk density of soil layer l
Source of data:	
Justification of choice of data or description of measurement methods and procedures applied:	The bulk density of soil layer l,
Any comment:	

Data Unit / Parameter:	$\%osc_l$
Data unit:	%
Description:	Percentage of organic soil carbon in layer l
Source of data:	Laboratory testing of field samples
Justification of choice of data or description of measurement methods and procedures applied:	The percentage of organic soil carbon in layer l, as measured in the laboratory from soil samples collected at the plots
Any comment:	

Data Unit / Parameter:	$iscg_l$
Data unit:	Tonnes
Description:	Mass of inorganic soil carbon emitted as CO_2
Source of data:	Laboratory testing of field samples
Justification of choice of data or description of measurement methods and procedures applied:	The mass of inorganic soil carbon emitted as CO2 during acid testing in the laboratory
Any comment:	

Data Unit / Parameter:	m_{iscl}
Data unit:	Kg

Description:	Mass of the sample tested using acid testing
Source of data:	Laboratory measurement of tested sample
Justification of choice of data or description of measurement methods and procedures applied:	The mass of the sample tested using acid testing in layer l
Any comment:	

Data Unit / Parameter:	*12/44*
Data unit:	Dimensionless
Description:	Conversion from CO_2 to C
Source of data:	Periodic table
Justification of choice of data or description of measurement methods and procedures applied:	Conversion from CO_2 to C
Any comment:	

Data Unit / Parameter:	$AC_{s,t}$
Data unit:	Tonnes
Description:	Carbon in soil amendments
Source of data:	Accounting of carbon containing soil amendments applied
Justification of choice of data or description of measurement methods and procedures applied:	Carbon added to the soil as accounted amendments to time t
Any comment:	

Data Unit / Parameter:	$\#y_s$
Data unit:	#
Description:	Number of plots
Source of data:	Field data
Justification of choice of data or description of measurement methods and procedures applied:	The number of plots in stratum s
Any comment:	

Data Unit / Parameter:	A_s
Data unit:	m^2

Description:	Stratum area
Source of data:	Measured using GPS or other means of similar accuracy
Justification of choice of data or description of measurement methods and procedures applied:	The area of stratum s,
Any comment:	

5 REFERENCES AND OTHER INFORMATION

Burt, Rebecca, Editor 2004, Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, version 4.0, Natural Resources Conservation Services, USDA, Lincoln, NE, 700p[3]
Hillel, D, 1980 Fundamentals of Soil Physics, Academic Press, New York, 413 p
Kabata-Pendias, A. and H. Pendias, 1985, Trace Elements in Soils and Plants. CRC press, Boca Raton, FL. 315 p
Lal, R., T.M. Sobecki, T. Iivari, and J.M. Kimble, 2004, Soil Degradation in the United States—Extent, Severity, and Trends. Lewis Publishers, Florida (USA), CRC Press LLC, 204 p
Lal, R, J.M. Kimble, R.F. Follett, B.A. Stewart, 2001, Assessment Methods for Soil Carbon. Lew Publishers, Florida (USA), CRC Press LLC, 676p
Moffitt, F, and H. Bouchard, 1975, Surveying, sixth edition. In text Educational Publishers, NY 879p
Muller-Domboise, D. and H. Ellenberg, 1974, Aims and Methods of Vegetation Ecology, John Wiley and Sons, NY. 547p
Soil Survey Investigations Report 45, Soil Survey Laboratory Information Manual 1995, USDA, NRCS. National Soil Survey Center, Soil Survey Laboratory, Lincoln, NE, 305p
USDA, 1999, Soil Taxonomy- A basic system of soil classification for making and interpreting soil surveys, second edition, Agricultural Handbook 436, Superintendant of Documents, USDA Government Printing Office, Washington, DC, 20402
USDA 2010, Field Indicators of Hydric Soils in the United States: A Guide for Identifying and Delineating Hydric Soils, Version 7.0,
Soil Survey Laboratory Methods Manual. Soil Survey Investigations Report No. 42, Version 4.0. Natural Resources Conservation Service, USDA, November 2004
Wenger, K.F. (ed). 1984. Forestry handbook (2nd edition). New York: John Wiley and Sons.

APPENDIX D
ESTIMATION OF EMISSIONS FROM MARKET LEAKAGE

The module provides methods for estimating whether reductions in the production of commodities (such as wood, animals or agricultural products) resulting from the project activity is likely to result in increased emissions from the production of those products elsewhere, and provides methods for determining the volume of such emissions.

1 PROCEDURES

Step 1: Identification of commodities and services

Identify all commodities or services whose supply may be reduced on a local, regional, national or international scale due to implementation of the project activity. These commodities and services must include any commodity or service which meets the following criteria:

- Prior to project commencement the commodity or service was produced within the project area, and;
- The commodity or service was not produced solely for the producer`s use, but was sold or bartered to others (it was a market commodity or service), and;
- The commodity or service provided more than 5% of the total cash and barter income earned by residents within the project area.

Data for this step may be derived from:

- Existing statistical data,
- Economic studies,
- Market studies, or
- Oral testimony, including Participatory Rural Appraisals

Identify the current markets for the products or services, in terms of the percentage of the product produced within the project area going to local, regional, national and international markets, and the scale of each of those markets, in product units (e.g. kg), and record in the following table:

Table 1: Market and product table

Market	Product 1 – (%)	Product 1 – Market scale (units/yr)
Local (within the community or communities immediately surrounding the project area)		

Regional (within the province/s or other generally recognized region/s containing the project)		
National (within the country, or in some cases, within the group of countries, where close economic integration exists, containing the project)		
International (worldwide)		
Total	100%	

Information on markets will typically be best derived using interviews with producers, combined where necessary with interviews with market intermediaries to determine the final destination of the product or service, where the producer is not sure. This information may be supplemented with information from existing studies or existing statistical databases.

Step 2: Barrier analysis

For each of the markets for each individual products or services, determine the barriers surrounding that market. Barriers may consist of distribution costs, tariff or regulatory barriers, or other circumstances which tend to reduce the introduction of the goods or services from markets at the next scale/s up (for instance introduction of a product from the provincial or national market to the local market), or from neighboring markets of the same scale (for instance from the next town, the next province). Grade these barriers on the following scale:

Table 2: Barrier grades

Grade	Description
Low	Products or services are readily substituted from markets at the next scale/s up, or from neighboring markets at the same scale. For instance, no significant barriers exist to bringing the product or service into the local market from the regional or national market (price differences less than 5% more expensive, no other barriers).
Medium	Barriers do exist, but their effects are limited to price differentials for goods or services from markets at the next scales up or from neighboring markets. Goods brought from neighboring markets or markets at the next scale up are not more than 15% more expensive than those currently available in the market. For instance, fruit from another province can be brought to the local area with a price premium of about 10%.
High	Significant barriers exist. Products or services cannot be brought from markets at the next scale up or neighboring markets, or are significantly more expensive (greater than 15% more) due to transport costs, tariffs, or

	for other reasons.

Where existing information on market barriers does not exist in statistical databases or previous studies, interviews with market participants, producers, and/or intermediaries may be the best source of this information. Market participants may have in depth knowledge of the nature and degree of barriers to marketing of specific products.

Step 3: Re-assessment of markets

Recalculate the market percentages, beginning with the local market and working up. For each product or service:

- If the barriers between that market and the next market are low, add that market percentage to the next market up. For example, if the product sells 20% to the local market and 80% to the regional market, but the barriers between the local and regional markets are low, the market for the product should be recalculated as 100% regional.
- If the barriers between that market and the next market are medium, move 50% of the market percentage to the next market up. For example, if the product sells 20% to the local market and 80% to the regional market, but the barriers between the local and regional markets are medium, the markets for the product should be recalculated as 10% local and 90% regional.
- If the barriers between that market and the next market up are high, no recalculation need be undertaken.

Step 4: Percentage of the market supplied

Multiply the revised market percentages by the total amount of that product or service provided from the project area prior to the project start date. For each market which the project supplies, calculate the percentage of the total market which the project supplies.

> Example: The project area produces 10,000 kilograms of oranges per year. These oranges are sold 10% to the local market, and 90% to the regional market. The barriers between the local, and regional and national markets are low, but there are high barriers between the national and international markets. The revised market percentage for the oranges is thus 100% to the national market. The total national market for oranges is 500,000 kilograms. Thus the project area supplies 2% of the national market.

Data on total markets for a given product are typically best found in government or institutional databases. Some information may also be found in existing studies, and market participants, particularly larger scale intermediaries, may also have significant knowledge on this. At times local or regional scale data may have to be inferred from national data, using appropriate methods, such as weighting by population.

Step 5: Market significance

If for a given product the project supplies less than 3% of the total market in each market that it supplies, go to Step 10. If the project supplies more than 3% of any given market, proceed to Step 6.

Step 6: Replacement paths

For each product market, for which the project area supplies more than 3% of the total market volume of that product, determine the least cost replacement path. Paths to be examined include:

- Replacement by production from higher scale markets, with additional costs resulting from the barriers between markets.
- Replacement by existing alternate items within the market area.
- Increased production within the market area.

Assess the cost increase resulting from each of these replacement paths.

Typically market participants, particularly medium and large scale intermediaries, will have an excellent idea of the most likely replacement paths. Local producers are likely to have a good idea of the cost barriers to increased production within the local market area.

Select the replacement path which gives the lowest cost increase.

- If this path is replacement by existing alternate items, calculate the percentage of the market for the alternate items represented by the substitution, and return to Step 4.
- If the path is replacement by production in a higher scale market, recalculate the percentage of the product going to the higher level market as the sum of the percentage going to the current market and the percentage going to the higher level market, and return to Step 4.
- If the path is increased production within the market area, proceed to Step 7.

Step 7: Market impact

Assess the market impact of the replacement path.

- Estimate the expected price of the commodity or service required to allow increased production within the market area. This estimation must be based on an analysis of the least cost route to increased production. For instance, increased production of grain might be achieved through production intensification through increased plant populations or by increasing the quantity of fertilizer used per acre annually in order to increase yields. Each of these options will have a cost associated with it such as the cost of seeding at higher densities, or adding more fertilizers. This method assumes that the grain farmer will increase the production of grain using whichever method adds the least costs per bushel of grain produced.

Once the least cost route to increased production is determined, the expected price of the commodity or service required to allow this production will be the new cost of production, plus the typical overhead coverage and profit margin for this commodity or service, which is usually best determined through interviews with local producers of the commodity.

  - If this price is less than 5% greater than the current market price, increase of production of this commodity or service from other providers within the market area is expected to be equal to 100% of the reduction caused by the project. Proceed to Step 8.
  - If this price is more than 5% greater than the current market price, quantify the expected impact of the increased price on consumption of the commodity or service. Analysis must include the impacts of product substitution, reductions in use, and changes in the use of discretionary income.

- Based on this analysis, quantify the expected actual increase in production of the commodity or service in the market area from sources outside of the project area.

Example 1:
The project area currently produces 10,000 kilos of wheat a year, all going to the local market. High transportation costs mean that there are significant barriers between the local and regional markets. Farmers in the local area would readily produce more wheat if they could find a market, by increasing grain production yields in the wheat fields, even at the same price. Therefore, when wheat production is stopped in the project area, other farmers in the local market area are expected to readily increase their production by 10,000 kilos of wheat a year to replace the lost production.

Example 2:
As above, the project area produces 10,000 kilos of wheat a year, all going to the local market, and high transportation costs mean that there are significant barriers between the local and regional markets. However, the current price for wheat in the local market is resulting in farmers getting out of wheat production. The price would have to be 20% higher to incentivize farmers to grow more wheat. A price increase of this magnitude would result in many people no longer buying wheat, or buying less. The result would be that an estimated 7,000 kilos less wheat would be consumed per year. Thus, the most likely increase in wheat production as a result of the project activity is 3,000 kilos.

Step 8: Land impact

Identify the area of land required to produce the amount of product or service identified in Step 7, and the most probable land base on which this production will take place. For this land base, identify the probable management regime required to commence and continue production (e.g., plowing up remaining native grasslands and planting of wheat fields).

Step 9: Carbon impact

Using sampling, modeling and widely accepted values, quantify the total carbon stocks on the identified land base under the management regime present in the baseline scenario (ie, the management regime that existed before market leakage effects occurred), and model the projected carbon stocks on the land base under the management regime required to produce the product or service in the project scenario (ie, the management regime in the project scenario caused by the market leakage). Carbon impact of market leakage will be calculated using the following equation:

$$E_m = C_c - C_m \tag{17.1}$$

Where:

E_m	=	Market leakage, t CO_2e
C_c	=	Carbon stocks of the identified land base under the management regime present in the baseline scenario, tCO_2e
C_m	=	Carbon stocks of the identified land base under the management regime expected to result from the market leakage in the project scenario, tCO_2e

The change in onsite carbon stocks through time between the management regime before and after market leakage occurred, on the affected land, is the leakage attributable to the project. Changes in offsite GHG emissions not arising from changes in carbon pools on the land base, (for example emissions from fossil fuel use and fertilization), are not accounted, as these emissions are expected to be similar to those that occurred within the project area prior to the commencement of the project.

Step 10: Market flexibility

Where the project causes a less than 3% change in the supply of a given product or service to any market, as determined in Step 5, market changes caused by the project may reasonably be assumed to be indistinguishable from normal market "noise", and it is unlikely that any pricing change attributable to the project will incentivize a change in behavior on the part of suppliers to the market. However, Project Proponents must examine the market conditions to determine if flexibility mechanisms exist within the market which will mask or compensate for the effects of the project.

Such mechanisms may include:

- Surplus - The market for the good is typically in a surplus situation, with some wastage or low value use consuming the surplus.
- Substitution - Substitution of another existing good is likely to occur if any temporary shortfall occurs, and the substitute is in surplus.
- Under-utilized capacity - Existing lands suitable for production of the good without further clearance or other carbon impacts are under-utilized, and any shortfall could be made up from these lands.
- Intensification capacity - Intensification of production on existing lands producing the

good represents the lowest cost path to replacement of the losses attributable to the project.

The best source for this data is likely to be local producers and intermediaries with a clear knowledge of the market dynamics and production limitations for the commodity or service.

If any of these mechanisms, or similar mechanisms which would tend to mask market signals, demonstrably exists, no leakage is assumed to occur for this product or service in this market. Otherwise, return to Step 6.

2 PARAMETERS

Data Unit / Parameter:	E_m
Data unit:	tCO_2e
Description:	Market leakage CO_2 for year y
Source of data:	Calculated
Justification of choice of data or description of measurement methods and procedures applied:	The market leakage estimated for a given year
Any comment:	

Data Unit / Parameter:	C_c
Data unit:	tCO_2e
Description:	Carbon stocks of the identified land base under the management regime present in the baseline scenario
Source of data:	Calculated using appropriate modules
Justification of choice of data or description of measurement methods and procedures applied:	Tonnes of CO_2e on the identified land based under the management regime that was present in the baseline scenario
Any comment:	

Data Unit / Parameter:	C_m
Data unit:	tCO_2e
Description:	Carbon stocks of the identified land base under the management regime expected to result from the market leakage in the project scenario
Source of data:	Calculated using appropriate modules
Justification of choice of data or description of measurement methods and procedures applied:	Carbon stocks of the identified land under the management regime expected to result from the market leakage in the project scenario
Any comment:	

APPENDIX E
QUANTIFICATION OF BASELINE SOIL CARBON STOCKING AND LOSS RATES IN THE REFERENCE REGION

1. Introduction—Discussion of Sampling

The data collection from the reference region involved a two-step process: pre-sampling and baseline sampling. The pre-sampling was designed to measure the distribution of soil carbon on the Palouse regional dune-like landforms. Sampling transects were laid out perpendicular to the landforms in order to sample slope positions (summit, shoulder, back, foot, and toe) and aspect (cardinal directions). Core samples were collected to 1 meter depth and incrementally analyzed to determine the vertical soil carbon fraction distribution. The soil carbon distribution was correlated with slope position, slope aspect, and regional climatic moisture zones. The pre-sampling informed the design and allocation of sample points for baseline sampling across the larger Palouse landscape.

In this Appendix E, “Tillage” refers to and includes both Tillage farming and No-Till Farming that does not qualify as Low Disturbance Cropping.

2. Discussion of overall analysis and separation into Wet/Dry Zones and Up Slope and Down Slope positions

The larger Palouse eco-region was physically stratified based on the pre-sampling results and the use of GIS analytical capabilities for handling multiple large data sets. The available data sets analyzed in conjunction with pre-sampling indicators included: NAIP imagery (USDA), DEMs (USGS), SSURGO (USDA) consisting of soil attribute information such as mineralogy, texture, depth to bedrock, depth to water table, etc., land use/land cover (USGS and USFWS), hydrography and drainage maps (USGS), and meteorology (NOAA) consisting of long term average precipitation, evaporation, snow loads, etc. Using the analytical capabilities of GIS, baseline sampling was focused on the most homogenous 7 million acre region of the Palouse. Within that more homogeneous region the project further focused on slope position, climatic moisture, and agricultural practices in the region, specifically Low Disturbance Cropping methods.

Based on the pre-sampling data, statistical correlations for total soil carbon (e.g. soil organic carbon + soil inorganic carbon) amounts were identified between slopes in the higher climatic moisture zone and the period of time that Low Disturbance Cropping was practiced. The climatic moisture zone correlation divided the 7 million acres into two zones; a wetter zone receiving >= 16.816878 inches of average annual precipitation (the “Wetter Zone”), and a drier zone receiving < 16.1816878 inches (the "Drier Zone"), based on NOAA data.[16] The amount of total soil carbon was most strongly correlated with Low Disturbance Cropping on upper slope positions in the Wetter Zone (the "Up Slope")[17]. There was no Low Disturbance Cropping statistical correlation for lower slope positions ("Down Slope"). Down Slope soils in the Reference Region are typically carbon saturated. Down Slope locations represent a very small percentage of the overall acreage in the landscape of the reference region.

The stratification process helped refine the types of landscape strata actually existing on farms. Several strata were not present frequently enough to be statistically represented and were eliminated from further analysis. An equal-"n" sampling design resulted in a stratified random allocation of sampling points across the remaining landscape strata identified in the stratification process and illustrated in Figure 1. The stratified random sample location points were auto-generated; each point was assigned a numeric code, bar code identifier (used to create labels to track each soil core sample), and GPS coordinates. All points were located in fields that were managed for continuous Tillage or Low Disturbance Cropping on participating farms.

Figure 1. Planned equal "n" and actual allocation of soil carbon sample points across the primary sampled strata in the Reference Region, sampled in 2012.

			Direct Seed History													
			2011 or None Conventional H1		2007-2010 1-5 Yrs H2		2000-2006 6-12 Yrs H3		1992-1999 13-20 Yrs H4		1990 or earlier 21 + Yrs H5		CRP Any H6		MISC (Irrigated) H7	REFERENCE H9
Precip Zone	Slope Position	Aspect	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Allocated	Sampled	Sampled	Sampled
P2	UP	SW		4			5	5	1	1			5	6		1
P2	UP	NE					5	5	1	1			5	5		3
P2	LO	SW		2			5	5	1	1			5	6		7
P2	LO	NE		2			5	5	1	1			5	5		11
P3	UP	SW	1	3	5	5	5	5	5	5	1	1	5	3		3
P3	UP	NE	1	5	5	5	5	5	5	5	1	1	5	5		2
P3	LO	SW	1	8	5	5	5	5	5	5	5	5	5	4		9
P3	LO	NE	1	5	5	5	5	5	5	5	5	5	5	5		8
P4	UP	SW	2	2	5	4	5	5	5	5	5	5	5	4	1	4
P4	UP	NE	2	4	5	2	5	5	5	5	5	5	5	6	1	8
P4	LO	SW	2	5	5	3	5	5	5	5	5	5	5	6	5	5
P4	LO	NE	2	3	5	4	5	5	5	5	5	5	5	5	1	4
P5	UP	SW		3	5	5	5	5	5	5	5	5	5	5		6
P5	UP	NE		7	5	5	5	5	5	5	5	5	5	7		4
P5	LO	SW		2	5	5	5	5	5	6	5	5	5	4		6
P5	LO	NE		4	5	5	5	5	5	5	5	5	5	4		7
P6	UP	SW		4	5	5	5	5	5	5			5	5		5
P6	UP	NE		6	5	5	5	5	5	5			5	5		5
P6	LO	SW		7	5	5	5	5	5	4			5	6		7
P6	LO	NE		5	5	5	5	5	5	5			5	5		4
Pre-Allocated or Sampled Plots			12	81	80	73	100	100	84	84	52	52	100	101	8	109
Target # of Plots			100		100		100		100		100		100			100

A number of remnant Palouse grasslands in the Reference Region were sampled as reference areas. Conventional Tillage and USDA Conservation Reserve Program fields on participating farms within targeted strata were also sampled. Rigorous quality assurance and quality control

---

[16] Based on INdec_81 (30 year average annual precipitation) >= 16.816878 inches (52nd percentile of precipitation).
[17] (Up slopes (convex features) and Down slopes --valley bottoms (concave features) were defined statistically using Topographic Index (TPI). The statistically defined cut-off points is as follows: DEM10m_TPI>=-1.25525 (24th percentile of the slope position).

requirements in accordance with Appendix C were followed. A required percentage of duplicate samples were collected to test infield measurement consistency (using laboratory blind and split sampling) and to assess laboratory accuracy and precision.

Approximately 800 one-meter length soil core samples were collected using a Giddings hydraulic soil sampler mounted on an ATV; this included the additional samples collected during pre-sampling. Auto-generated stratified random sampling location coordinates were downloaded to a GPS unit on the ATV. At each sampling location a 1 meter (or to a depth of refusal) core sample was collected in a 2" diameter hollow core sample probe with a removable inner plastic sleeve. Prior to inserting the soil probe, biomass litter was brushed away by hand to expose a clean mineral surface. After extraction, the inner plastic sleeves containing the soil core were capped, labeled with a bar code and placed in cool storage until shipped to the University of Missouri (Columbia, MO) Soils Laboratory. Once at the lab, the soil cores were described morphologically, photographed, sub-sampled (a portion archived) by taxonomic strata, and analyzed for soil carbon (total, inorganic and organic) using a LICOR combustion analyzer and for carbon density by measuring bulk density using a standard soil volume dried to constant weight. Bulk density, in grams/cubic centimeter, was used as a multiplier to convert the LICOR soil carbon percentages into carbon mass per unit area, tonnes of soil carbon per hectare.

The analytical results were tabulated in excel spreadsheets and statistically evaluated to determine how the data were distributed (e.g., normal distribution of data, means and variances; homoscedasticity, and independence) and which statistical methods to use (ANOVA, Mean, Linear regression, Correlation, Covariance, etc). Standard transformations were used where skewness or curtosis occurred. The results of the application of statistical methods to the data were used to determine baseline soil carbon accrual rates and erosion loss rates across the Reference Region.

3. Pairing of Tillage/Low Disturbance Cropping for comparison

Robust statistical signals were detected for fields based on the Tillage practice and number of years in Low Disturbance Cropping . The number of years in Low Disturbance Cropping (1-20 years),[18] and the number of years in continuous Tillage were strongly correlated with soil carbon levels.

[18] The lack, pre ~2000, of available commercial Low Disturbance Cropping equipment did not stop industrious farmers from fabricating innovations such as reduced crop residue sweeps that created minimum soil disruption and essentially accomplish the same performance as present day Low Disturbance Cropping equipment. The palouse farmers were influential in informing equipment manufacturers on design innovations necessary to achieve Low Disturbance Cropping.

The number of years that any given field in the Reference Region was in continuous Low Disturbance Cropping varied from 1 to 32 years. However, data were sufficient to statistically evaluate only the first 20 years of continuous Low Disturbance Cropping. These time-equated data, called a "chronosequence data set," were analyzed using linear regression analyses by landscape strata to determine the rate of soil carbon change through the years. These accrual rates were compared with the continuous Tillage data from proximal fields.

Data analyses were evaluated at 95% probabilities around calculated mean total soil carbon levels. The analyses of 0-20 year chronosequence data from upper slope locations in the Wetter Zone indicated robust soil carbon accruals occurring in continuous Low Disturbance Cropping fields and significant carbon losses in paired continuous Tillage fields. In the Drier Zone, statistical detection of soil carbon accrual was only possible when explainable outliers were removed from the data set. Following removal, a positively sloped linear regression indicated a statistically measurable accrual. The analysis, when applied to bottom slope positions in both the Wetter and Drier Zones indicated overall higher carbon stocks in bottom slope positions but no statistically detectable relationship to Low Disturbance Cropping agriculture.

4. **Observed/Calculated Average Soil Carbon Content (Stocks) on Low Disturbance Cropping and Tillage Fields (2012 average)**

To evaluate baselines, data were sorted by Up Slope and Down Slope position as well as by Wetter Zone and Drier Zone. This analysis compared soil carbon stocks present in continuous Low Disturbance Cropping (period 15 years prior up through the 2012 soil sampling event – linear regression was used conservatively only for the 15-year Low Disturbance Cropping record instead of the 20-year record because two outliers in the 20-year cohort skewed overall accrual rates toward higher rates) and developed carbon stock measuremens for the continuous Tillage during this same period (Table 1). Paired samples (same soil type and strata) were compared through time based on the event of start date for the Low Disturbance Cropping practice, which was defined to have occurred over a 15 year period prior to the 2012 baseline sampling year. Table 1 shows the differences between the averaged carbon stocks measured in paired Low Disturbance Cropping and conventional Tillage fields indicated differences in the accrual rates for the Wetter and Drier Zones and for slope positions (lowest (toe slope) and all other up-slope positions).

Table 1A. Summary soil carbon stocks analysis in primary landscape strata in Tillage and Low Disturbance Cropping fields sampled in the Palouse, 2012. Soil stock data is in Tonnes C/ha. Rates are in Tonnes/C-ha per year. In Table 1B. rates have been converted to mtCO2e/ha and mtCO2e/ha/yr.

Table 1A.	Soil carbon Stock Analysis (MTC/ha) in primary landscape strata sampled in Palouse, 2012.					
	Low Disturbance Cropping	Tillage	Difference	Average Annual Accruals (MTC/ha-yr)	Accrual Rate based on regression analysis (MTC/ha-yr)	Average accrual minus baseline stocking decline rate from tillage (MTC/ha-yr)
Drier Down Slope	88.69	82.23	6.46	0.43	0.92	0.46
Drier Up Slope	78.56	74.81	3.75	0.25	1.10	0.65
AVERAGE DRY	83.62	78.52	5.10	0.34	1.01	0.56
Wetter Down Slope	133.07	121.10	11.97	0.80	0.55	-0.25
Wetter Up Slope	100.47	80.33	20.13	1.34	1.35	0.01
AVERAGE WET	116.77	100.72	16.05	1.07	1.23	0.16

Table 1B. Summary soil carbon stocks analysis in primary landscape strata in Tillage and Low Disturbance Cropping fields sampled in the Palouse, 2012. Soil stock data is in mtCO2e/ha and rates are in mtCO2e/ha/per year.

Table 1B.	Soil carbon Stock Analysis (MTCo2e/ha) in primary landscape strata sampled in Palouse, 2012.					
	Low Disturbance Cropping	Tillage	Difference	Average Annual Accruals (MTCo2e/ha-yr)	Accrual Rate based on regression analysis (MTCo2e/ha-yr)	Average accrual minus baseline stocking decline rate from tillage (MTCo2e/ha-yr)
Drier Down Slope	325.50	301.80	23.70	1.58	3.37	1.71
Drier Up Slope	288.30	274.54	13.76	0.92	4.04	2.37
AVERAGE DRY	306.90	288.17	18.73	1.25	3.71	2.04
Wetter Down Slope	488.37	444.44	43.94	2.93	2.03	-0.90
Wetter Up Slope	368.71	294.83	73.88	4.93	4.95	0.03
AVERAGE WET	428.54	369.63	58.91	3.93	4.50	0.58

5. Observed/Calculated Average Soil Carbon Loss Rates on Tillage Fields

Estimated soil carbon losses in the Tillage fields due to erosion were back-calculated using a two step process. First, we subtracted carbon stock measurements for conventional Tillage fields from Low Disturbance Cropping fields for each strata. Second, we subtracted this difference from the regressional analysis accrual rates for for each primary strata position. Table 2 shows the calculated averaged rates of erosion loss for each strata that were determined to be statistically similar in the Wetter and Drier Zones. This analysis suggested, for combined Wetter and Drier Zones, that with conventional continuous Tillage, erosion losses of measured total soil carbon were 2.02 mtCO_2e/ha-yr.

Table 2: Tillage Total Soil Carbon Baseline Loss Rates by Climatic Zone (mtCO2e/ha/yr).

	Wetter Zone	Drier Zone	Combined Zones
Up Slope	2.02	2.03	2.02
Down Slope	2.37	1.70	n/a

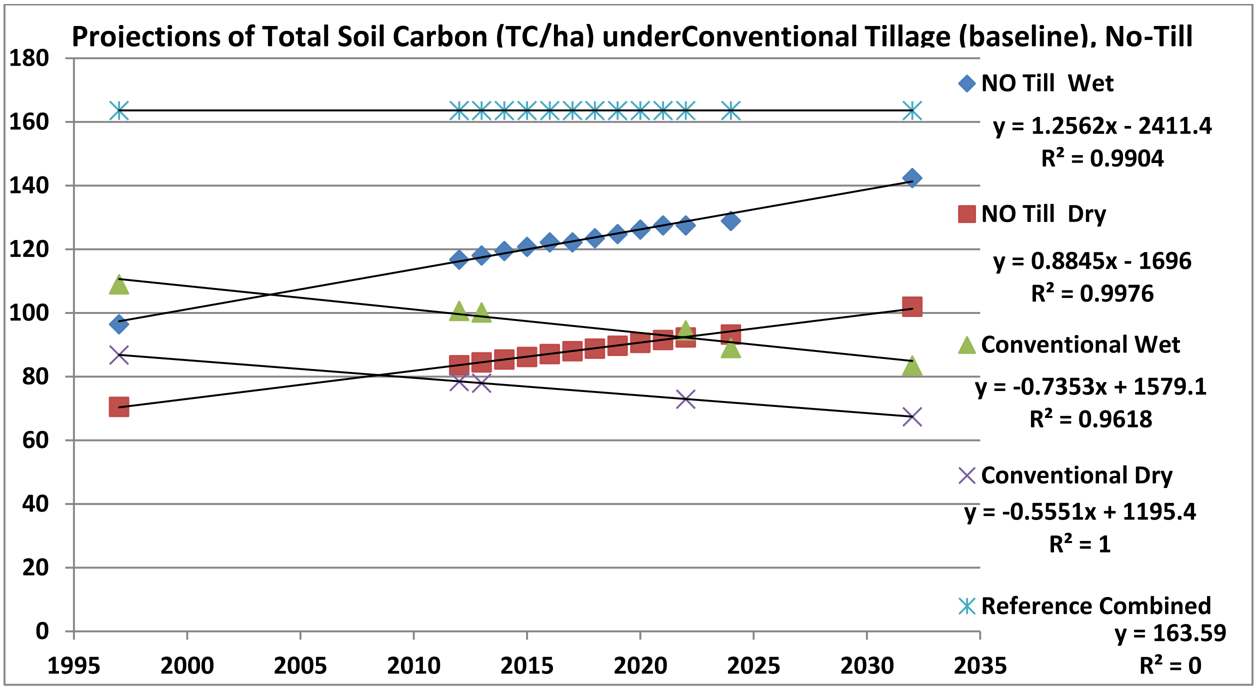
6. Applicable Baselines

Baselines have been computed by analyzing the differences between paired continuous Low Disturbance Cropping and continuous Tillage carbon stock data. Table 3 shows the results of the soil carbon accrual rates from the linear regression analyses from the Low Disturbance Cropping chronosequence used to develop carbon loss rates under continuous Tillage agriculture for Wetter and Drier Zone Up Slope and Down Slope positions. Figure 2 summarizes the measured accrual rates and computed loss rates that were used to predict past soil carbon stocks present in 1997 (15 years prior to the 2012 data collection event); actual measured stocks in 2012; and predicted baseline declining soil carbons stocks with continuous Tillage. The 2012 averaged total carbon stocks were used as the datum for back calculations to project 1997 stocks in each stratum. As a reference point for what are thought to be achievable future soil carbon stock levels, the upper ten percentile of soil carbon stock levels in reference Palouse grassland remnants were used to estimate the likely point when soil carbon saturation occurs. This analysis suggests the wetter slope locations will achieve saturation in ~77 years; the dry slopes will saturate in ~68 years.

Table 3: Low Disturbance Cropping Total Soil Carbon Accrual Rates by Slope Position and Climatic Zone (mtCO2e/ha/yr). ** Averages are derived from the slope of linear regressions, not from the calculations using carbon stock analyses in Table 1.

	Wetter Zone	Drier Zone
Up Slope	4.77	2.34
Down Slope	2.89	1.68

Figure 2. Projections of Total Soil Carbon (TC/ha) under Tillage (baseline), Low Disturbance Cropping Treatment and Reference Conditions, Palouse agro-eco-region, based on sampled soil carbon stocks in 2012. The average soil carbon stocks measured in the region remnant Palouse grasslands is provided for reference on this projection. In Figure 2, “No-Till” is intended to mean Low Disturbance Cropping in the terminology of this methodology, and “conventional” is intended to mean Tillage as defined in this Appendix E.



<u>The following summarizes these accrual rates, and the carbon stocks projected changes for each zone.</u>

Wetter Zone Slope Position Carbon Stock Projections against Baseline of Continuous Conventional Tillage:

Wetter Zone:

The analysis projects the rate of increase of soil carbon stocks under continuous Low Disturbance Cropping l for Wetter Zone slope locations.

Projected Stock Changes on Up Slopes

Based on 2012 measured carbon stocks, in the Wetter Zone Up Slope, under continuous Low Disturbance Cropping, the carbon stocks averaged 100 MTC/ha or 367 MTCO2e/ha and are projected to increase by 1.3 TC/ha or 4.77 MTCO2e/ha/yr, or by a deemed 6.79 MTCO2e/ha/yr relative to a baseline decline, net of expected Tillage losses, of 2.02 MTCO2e/ha/yr.

Projected Stock Changes Down Slopes

Based on the 2012 measured carbon stocks, in the wetter zone, toe of slope locations, under continuous Low Disturbance Cropping, the carbon stocks averaged 133 TC-ha or 488 MTCO2e/ha and are expected to increase by 0.79 TC/ha-yr or 2.89 MTCO2e/ha/yr, or by a deemed 4.91 MTCO2e/he/yr relative to a baseline decline, net of expected Tillage losses, of 2.02 MTCO2e/ha/yr.

Dry Meteorological Zone Slope Position Carbon Stock Projections against Baseline of Continuous Conventional Tillage:

The analysis projects the rate of increase of soil carbon stocks under continuous Low Disturbance Cropping for Drier Zone slope locations.

Projected Stock Changes Up Slopes

Based on 2012 measured carbon stocks, in the Dry zone, slope locations, under continuous Low Disturbance Cropping, the carbon stocks averaged 78 MTC/ha or 286.26 MTCO2e/ha and are anticipated to increase by 0.64 TC/ha or 2.34 MTCO2e/ha/yr, or by a deemed 4.71 MTCO2e/ha/yr relative to a baseline decline, net of expected Tillage losses, of 2.37 MTCO2e/ha/yr.

Projected Stock Changes Down Slopes

Based on the 2012 measured carbon stocks, in the Dry zone, toe of slope locations, under continuous Low Disturbance Cropping, the carbon stocks averaged 88 TC-ha or 322.96 MTCO2e/ha and are expected to increase by 0.46 TC/ha-yr or 1.68 MTCO2e/ha/yr, or by a deemed 3.38 MTCO2e/ha/yr relative to a baseline decline, net of expected Tillage losses, of 1.70 MTCO2e/ha/yr.

Full Carbon and GHG Accounting and Baseline Considerations

The baseline and project scenario soil carbon levels were evaluated and quantified using Appendix C, Appendix D, and used the ACR Methodology for N_2O Emissions Reductions from Changes in Fertilizer Management v1.0 for evaluating the baseline and project scenario N_2O emissions. The estimated atmospheric GHG flux associated within the project area were summed using measured carbons stocks per hectare for both the baseline, and for the project scenario for a period of 40 years. Statistics from the actual measured carbon stocks during the 2012 sampling event were computed and the variance around the computed means was used to understand the uncertainty of the projections and baseline scenario carbon stock and emission calculations. Because of very low to immeasurable GHG (N20 and CH4) emissions in this semiarid region, and because of archeological evidence suggesting impermanence risk is also immeasurably very low, absent reversion to Tillage, the soil carbon stocks and the variance around mean stock measurements were calculated and used as an estimator of the atmospheric GHG benefit and confirms that Low Disturbance Cropping agriculture soil carbon accruals are greater than the Tillage baselines.

To address the full accounting needs under the baseline, and to understand the effects of soil carbon sequestration, erosion, and GHG emissions on these baseline projections, regional data (Purakayastha, T.J., D.R. Huggins) on GHG emissions were used. J.L. Smith. 2008; USDA 1978; Eagle et al 2011. For purposes of this analysis the assumptions included no change from baseline in fertilizer use and no change in GHG emissions from petroleum use because both assumptions are conservative baseline scenarios. For example, as soil carbon improves with No-Till agriculture the need for fertilizer, irrigation, and herbicides are typically reduced. In addition, the conversion from conventional Tillage to Low Disturbance Cropping reduces the number of passes from 5-pass to 1 or 2-pass farming operations (where Low Disturbance Cropping seed and any weed control occurs in one pass compared to conventional Tillage which often requires a separate pass for plowing, discing, harrowing, seeding, and weed management by cultivation or herbicide use. Further, datasets created by Huggins found when comparing Low Disturbance Cropping and continuous conventional Tillage with comparable fertilizer uses (formulations, rates and timing), that in the semi-arid portions of the Palouse, exhibit negligible measurable N20 and Methane emissions annually.

The soil carbon stocks, rates of erosion, and soil carbon accrual rates measured in this project fall in line with similar measurements in the limited number of the strata others have sampled in test plots and demonstration field studies in limited locations in the Palouse landscape (Purakayastha, T.J., D.R. Huggins, J.L. Smith. 2008; USDA 1978; Eagle et al 2011). In contrast to other projects that have measured various expressions of "conservation Tillage" and various "residue management" strategies, this project appears to be one of the first where continuous No-Till has actually been measured across the diversity of landscape strata and to a meter in soil depth. In this project residues were left in place in the fields and continuous Low Disturbance Cropping practices have been ongoing. Typically, other studies that averaged "landscape" carbon accrual rates under unspecified types and durations of "conservation Tillage practices" nationally averaged 0.63 $tCO_2e\ ha^{-1}yr^{-1}$ with a mean range nationally across the USA (-0.43-1.53) while strict continuous No-Till[19] averages 1.26 $tCO_2e\ ha^{-1}yr^{-1}$ with a mean range nationally across the USA (-0.43-3.62) (Eagle A.J. et al., 2011). The rates of soil carbon accrual under strict continuous No-Till nearly double those rates measured in studies based on unspecified types and durations of "conservation Tillage" practices.

[19] In this and the subsequent two paragraphs, we use the study authors' chosen terminology, with the understanding that "continuous No-Till" represents activities that constitute or approximate Low Disturbance Croppin.

Purakayastha, T.J., D.R. Huggins, J.L. Smith. (2008) sampled various No-Till fields (continuous for 4, 10, and 28 years, and the reversion to No-Till following ten continuous years with a three year conventional Tillage production interlude, followed by an additional 1 year of No-Till), conservation Tillage fields, conventional Tillage fields, and reference native Palouse prairies. Unfortunately, they only sampled soil carbon to a 20 centimeter depth, but the relative quantities of soil carbon they found aligned with our findings. They found the native prairie remnants to have the highest carbon stocks (63.7 MtC/ha or 233.77 MtCo2e/ha); followed by the No-Till for 10 years with the conventional Tillage interlude (58.4 TonnesC/ha or 214.38 MtCo2e/ha), then the No-Till for 4 years (50 MtC/ha or 183.5 MtCo2e/ha, and lastly conventional Tillage for over 100 years with 27.9 MtC/ha, or 102.39 MtCo2e/ha.). Similarly, switches from conventional Tillage to No-Till farming nationally in the USA have been found to typically sequester an additional 2 to 4 tons of carbon per acre per year (Willey and Chameides 2007) .

Soil carbon losses from the literature as result of erosion are nearly identical to the measurements and averages predicted under this project under conventional Tillage (0.5 T MTC/ha-yr (1.8 MTCO2e/ha-yr)). Documented soil carbon erosion loss rates in the Palouse of 50-70% , have increased SOC variability on the land. “Since late 1800’s mouldboard plowing in Palouse has been associated with loss of 25 Tg/ha of SOC (USDA 1978)”, which equates to 0.325 MTC/ha-year or 1.19 MTCo2e/ha-yr. Similar statistics have been documented globally on soil carbon erosion rates of 0.8-1.2 Pg C $^{yr-1}$, rates of SOC sequestration through conversion to No-Till farming ranges from 100-1000 kg ha^{-1} yr^{-1} (Lal, Ratan. 2007).

Lastly, on the Washington State University and USDA/ARS 57 ha research farm, sampling to a 1.5 meter depth documented nearly identical ranges of soil carbon stocks as we have found in this project (David R. Huggins and David P. Uberuaga, Undated) with stocks ranging from 54 to 272 MtC/ha, or 198-998.24 MtCo2e/ha. In the 57 ha study site the lowest stocks were measured on the driest south and west facing ridge tops and slopes (comparable to our findings in the Drier Zone) and that the highest stocks were present in the cooler moister north slopes, and in the toe of slopes in drainageways.

APPENDIX F
ADOPTION RATE OF LOW DISTURBANCE CROPPING PRACTICES

Introduction

To understand the acreages and percentages of land subject to tillage using Low Disturbance Cropping we have relied on three sources of information: 1) USDA National Statistical Services analysts and USDA data base, 2) Expert opinion from agency leaders who administer USDA farm bill programs, and 3) National Equipment Manufacturing Equipment data on the sales of no-till drills. We sought the most recent assessment and defensible data and expert opinion with a focus on trying to understand the answer to this question in the year 2012, when the baseline sampling of soil carbon for this Palouse project was conducted by our team.

We asked the following question during this inquiry:

What percentage of tillable land is farmed using Low Disturbance Cropping in the Palouse region?

This document reports on the findings and conclusions we have reached through this evaluation.

1) USDA National Statistical Services analysts and USDA data base

Working with statisticians from USDA, NASS, our question resulted in them mining two national databases maintained by USDA NASS from the 2012 Agriculture Census: (a) the Summary of Tillage Practices database, which enables one to sub-classify acreage based on the kind of tillage practiced on it; and (b) the Land in Farms database, which enables one to sub-classify acreage based on the kind of crop(s) grown on it.[20] We immediately learned that they had no measurement of the percentage of no-till farmed land that was continuously being farmed as one- or two pass no-till with the equipment required for Low Disturbance Cropping. They suggested the methods section behind their data might provide some procedures for addressing how to estimate the question of continuous use of any practices.

[20] Both provided statewide data, as the relevant data were not available by county. County data would have allowed us to focus on only those counties within, or including portions of, the Reference Region. However, most of the Reference Region is located in Washington, so where appropriate, we will focus on Washington data as well as the three-state data.

The data records were acknowledged to be a "snapshot," not an annual field-based accounting of changing practices over time on a farm.

We first looked at the actual 2012 acreages from the Summary of Tillage Practices database and summed the acreage for each of the 3 tillage types reported: conventional tillage, conservation tillage and no-till agriculture. Across the three states (WA, OR and ID) the total acres in one of these three tillage practices was reported as 10.302 million acres, with 1.985 million acres, or 19%, reported as in no-till in 2012 across the three states, with 18% in no-till in Washington. See Figure 1.

To confirm that the land reported as in no-till did not include land that was reported as in no-till due simply to the fact that it was not tilled, where it would never be based on the crop grown, we worked with the NASS statistician to separate the data in the Land in Farms database into: (a) land in farms that is not subject to tillage (e.g. native rangeland and forest tree crops) ("Untillable Land"); and (b) land in farms that is subject to tillage (e.g. such as a corn field) ("Tillable Land"). In our discussions, several gray areas became clear and we worked with the statistician to further refine the national classification in the interest of accuracy. For example, they had excluded alfalfa and planted grass/clover forage fields from the Tillable Land category. We suggested from our discussions with Palouse farmers, that on average, alfalfa land is re-tilled and re-planted on average every 3-4 years, and that apple orchards were also tilled and replanted on an ~ 15 year rotation. With these modest refinements, using the USDA acreages, the portions tillable and untillable by state were used to compute a total acreage of Tillable Land for each tillage crop category. From these data, it appears that of the approximately 14.75 million acres of land in farms in the three states, approximately 10.375 million acres is Tillable Land. See Figure 2. As this roughly compared with the 10.302 million acres reported as in conventional tillage, conservation tillage or no-till in the Summary of Tillage Practices database, we concluded that such over-reporting was unlikely.

The second issue is the degree to which the land reported as in no-till represents land on which Low Disturbance Cropping was conducted, or the degree to which it included land on which practices were conducted that result in significant soil disturbance, and would not meet the definition of Low Disturbance Cropping in this methodology. Neither the USDA, NASS database nor the statisticians had continuous 1-2 pass no-till agriculture estimates. For this we used personal observations and discussions with farmers and agency personnel during our 2012 field sampling. From this process we conservatively believe over 90% of the land we observed during our field sampling that was called "no-till" (and so likely would have been reported as such in the NASS data) did not meet the definition of Low Disturbance Cropping. Our 2012 field sampling was focused on sampling what were truly 1-2 pass continuous no-till farm fields. We also did side by side sampling of Low Disturbance

Cropping with 3+ pass direct seeding land and visually could easily detect the latter, where ~30% residue remained instead of far greater percentages found in Low Disturbance Cropping farmed fields. We had conversations with the Low Disturbance Cropping farms we sampled about what the neighbors were using for planting and tillage and confirmed in all cases where we observed 30% or less residue, the neighbors were using other "conservation tillage," techniques, not Low Disturbance Cropping.

Based on our observations and discussions with farmers during the field sampling, and on the opinions of the experts set forth below, we believe that the portion of the land reported as in no-till on which Low Disturbance Cropping was conducted is approximately 10%.[21] With this adjustment it suggests the percentage of Low Disturbance Cropping is 1.36, 1.80 and 3.00 percent by state (respectively, ID, WA, OR) in the Reference Region. The average across the three states is 1.93%. We believe this is the correct percentage of land classified as no-till in the USDA, NASS data that is actually in Low Disturbance Cropping.

Using this first USDA NASS data base we attempted to bracket our findings, with some level of sensitivity analysis, assuming a 100% error in our discount factor (this would suggest that only 80% of no tilled acreage in the NASS data base was in multi-pass direct seeding) thus using a discount factor of 0.20, this suggests an estimate of 2.72, 3.60 and 6.00% by state, or a regional averaged percentage of 3.85% is in Low Disturbance Cropping.

Figure 1. USDA NASS Database summary of Tillage Acreages by State for 2012.				
	ID	**OR**	**WA**	**Total**
Cropped tilled acres				
no-till	467,634	712,518	805,517	1,985,669
conservation	700,590	660,376	1,621,309	2,982,275
conventional Tillage	2,273,369	1,004,157	2,056,630	5,334,156
	3,441,593	2,377,051	4,483,456	10,302,100
AES Summary % no till as a percent of total acres in farms in each state				
	ID	**OR**	**WA**	**Total**
Total Reported on Tillage Practices	3,441,593	2,377,051	4,483,456	10,302,100
Reported No-till as a percent of Total Reported	14%	30%	18%	19%
Estimated % in Low Disturbance Cropping	**1.36%**	**3.00%**	**1.80%**	

2) Expert Opinion from agency leaders who administer USDA farm bill programs.

We asked this question of the key farm bill program managers with the state and federal agencies who also were field personnel very knowledgeable about the practices in the field. We were

[21] Based on our experience in the field sampling, we have no reason to believe that continuous 1-2 pass no-till is more prevalent in the Reference Region than on a state-wide basis in the three states.

informed by agency administrators at the federal and state level to talk to the local representatives within their respective agencies to get the most accurate expert opinion. The opinion from the discussions with over a dozen agency personnel was remarkably consistent with all persons decisively asserting that the percentage of farmed lands in the entire Palouse region in which Low Disturbance Cropping was occurring in was between 1-3%. Attachment 1 to this Appendix F contains agency personnel expert opinions.

3) National Equipment Manufacturing Association data on the point of sales and geography of delivery of no till drills.

Specialty drills that support true Low Disturbance Cropping are necessary. Nothing else that is commercially available is adequate. Early drills called "no-till" drills were inadequate to support Low Disturbance Cropping because they could not drill through moderate to high levels of crop residues and this required shovels on the drills that moved the residue out of the way of the slit where the seed was inserted. Or, it required separate passes to windrow the extra residue and then harvest it with bailers. Also, the shovels that were added to the manufactured drills (because the manufactured drills were completely inadequate) did considerable soil damage, often to 50-70% or more of the soil surface, and to a depth of several inches or more. While the manufacturers called these early drills "no-till" drills, their use did not meet the USDA, NRCS definition of no-till farming equipment.

Not until 1999-2000 were the coulter disks improved on no till drills such that the disk could cut through the residue to insert the seed. Most drills plugged up in this process and didn't function for very long before farmers had to stop the operation, lift the drill off the ground and sometimes spend hours unplugging the soil, seed, and compacted crop residue from the "no-till" drill. Now, the latest no-till drills able to truly do 1-2 pass drilling, have rotary saw blades that reliably slice through the residue and cut the slot for seed introduction into the soil. These refinements have been absolutely necessary to allow farmers to successfully conduct Low Disturbance Cropping.

Unfortunately, many drills including the most recent innovations that can actually do Low Disturbance Cropping, are called "no-till" drills. With this caveat, we sought to understand the number of drills manufactured, purchased and delivered within our Palouse study area that are capable of Low Disturbance Cropping ("Low Disturbance Drills"). Because each manufacturer over the years has created different types of innovations and many of the innovations also have the same name, it is virtually impossible to really understand the number of the actual Low Disturbance Cropping drills in operation. It is certain, however, that most drills being used that are called "no-till" drills are not capable of Low Disturbance Cropping.

With the above caveat, we asked from the National Equipment Manufacturing Association data on the point of sales and geography of delivery of Low Disturbance Drills through time in the

USA. A USDA, NASS statistician suggested that we seek records on drill sales and delivery in the Palouse region. We sought the actual sales records of Low Disturbance Drills as another indicator of adoption trends. Ultimately, the association CEO and Board committed to providing us with the national sales volume and Washington State sales volume. However, we were only given permission to disclose the Washington State sales volumes trends expressed as a percentage of total national sales volumes. The normalized values of sales, expressed as percentages within Washington, have been plotted (Attachment 2). We have been given permission to disclose the number of Low Disturbance Drills sold/delivered in Washington, and over the period of record (1999 to 2014) this number is 72 drills. Using simply the percentage of total point of sale and delivery of Low Disturbance Drills in Washington for the period of record, this suggests far less than 1% of the Palouse land is being farmed with Low Disturbance Cropping.

As a check on these numbers, we attempted to estimate how many acreages might be farmed with 72 Low Disturbance Drills. While the average farm in Washington State is ~ 396 acres,[22] the average size of the farms we sampled in the Palouse was ~5000 acres. Using the 5000 acre average farm size (i.e., 72 drills times 5,000 acres), this suggests that ~360,000 acres of the 15 - 18 million acres of Tillable Land (of the 30 million acre Palouse region) is being farmed with Low Disturbance Drills, which is 2-3% of the study region.

This analysis is very conservative and still doesn't answer the question about how much of this Tillable Land is in continuous Low Disturbance Cropping. But, as a conservative estimate, both approaches using the drill sales/delivery data used in this inquiry support a very low percentage (<1 to 3%) of the Tillable Land being farmed with Low Disturbance Cropping.

Summary and Conclusion

We have used three independent methods to address our question:

"What ***percentage of tillable land is farmed using Low Disturbance Cropping in the Palouse region?"***

Each method of inquiry suggests conservatively that the percentage of Tillable Land in the Reference Region being continuously farmed in Low Disturbance Cropping is between 1-3 %. Expert opinion corroborates the analysis provided using USDA NASS data and equipment

---

[22] For context, the average crop farm size in the U.S. in 2011 was 234 acres. See http://www.ers.usda.gov/media/1156726/err152.pdf at page 4. Further, the average size of all farms in Washington State in 2012 was 396 acres. See http://www.ers.usda.gov/data-products/state-fact-sheets/state-data.aspx?StateFIPS=53&StateName=Washington#P15b8d444638b4afeafc8ed00cc9eae80_2_428iT15C0x0. Among the limited class of farms in Washington that reported average annual sales of >$500,000 in 2002, the average farm size was 2,674 acres. See http://agr.wa.gov/fof/docs/LandStats.pdf at page 5. From these data, the assumption of 3,000 acres for the average Tillable Land per farm in the Reference Region is quite conservative.

manufacturers' drill sales volume. At this time, we believe the percentage of Tillable Land in the Reference Region that was in Low Disturbance Cropping in 2012 is between 1-3 percent.

ATTACHMENT I
TO APPENDIX F