METHODOLOGY FOR QUANTIFYING N_2O EMISSIONS REDUCTIONS IN US AGRICULTURAL CROPS THROUGH N FERTILIZER RATE REDUCTION ASSESSMENT REPORT (V2)

ENVIRONMENTAL SERVICES, INC.

ANSI ACCREDITED PROGRAM GREENHOUSE GAS VALIDATION AND VERIFICATION 0800

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Summary:

Environmental Services, Inc. (ESI) was contracted by MSU and EPRI to perform the first methodology element assessment of their methodology entitled *Methodology For Quantifying N_2O Emissions Reductions in US Agricultural Crops Through N Fertilizer Rate Reduction*, in accordance to the VCS Methodology Approval Process (v1.1, 21 January 2010), the VCS Standard (2007.1), VCS Program Guide (18 November 2008), and the VCS AFOLU Requirements (18 November 2008).

The methodology quantifies emission reductions of N_2O from agriculture, as brought about by reductions in the rate of nitrogen fertilizer (synthetic or organic) applied to cropland in the United States. The total amount of N added to the soil is multiplied by an emissions factor to determine N_2O emissions.

The purpose and scope of the methodology element first validation was to evaluate whether or not the methodology was prepared in line with VCS program requirements. Our assessment included a detailed review of eligibility criteria, baseline approach, additionality, project boundary, emissions, leakage, monitoring, data and parameters, and adherence to the project level principles of the VCS program (relevance, completeness, consistency, accuracy, transparency and conservativeness). ESI's assessment also included a detailed analysis of the methodology, literature reviews, technical reviews and MSU's responses to all non-conformity reports (NCRs) and clarifications (CLs).

The ESI assessment team identified 35 NCRs/CLs. All were addressed satisfactorily by MSU during the methodology assessment process. These NCRs and CLs provided needed clarity to ensure that the methodology was in compliance with VCS standards and requirements.

ESI confirmed all methodology assessment (validation) activities, including objectives, scope and criteria, level of assurance and the methodology adherence to VCS Program and Standards (Version 2007.1), as documented in our first assessment report (2 February 2011). During the reconciliation process with the second assessment team (DNV), ESI reviewed upgrades to the methodology to be consistent with VCS Version 3.1 (15 July 2011) and all associated updates to supporting guidance documents as well as changes/modifications requested by DNV. As part of the reconciliation process, ESI converted our report format to the required Methodology Assessment Report Template (V3.0) provided by VCS. ESI again confirms all methodology assessment activities and the methodologies adherence to VCS Program and Standards as stated in this report, are complete and concludes without any qualifications or limiting conditions that the *Methodology For Quantifying N_2O Emissions Reductions in US Agricultural Crops Through N Fertilizer Rate Reduction* (Version 1.4.6A, 25-January-2012) meets the requirements of VCS. ESI recommends that VCSA approves this methodology element.

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1 INTRODUCTION

1.1 Objective

The methodology element objective was to assess the likelihood that implementation of the AFOLU methodology element would result in the accurate calculations and appropriate eligibility criteria of the N_2O emission removal methodology as stated by the methodology developer.

1.2 Scope and Criteria

The scope of the methodology element assessment included applicability conditions, project boundary, procedure for demonstrating additionality, procedure for determining baseline scenario, baseline emissions, leakage, quantification of net GHG emission reduction and/or removals, monitoring, data and parameters, adherence to the principles of the VCS Program/Standard and relationship to approved or pending methodologies

The criteria of the methodology element assessment followed the VCS Program guidance documents provided by VCS, located at http://www.v-c-s.org/program-documents/find-program-document. These documents include:

- VCS Methodology Approval Process (v3.2, 19 October 2011)
- VCS Program Guide (v3.1, 19 October 2011)
- VCS Standard (v3.1, 15 July 2011)
- Program Definitions (v3.1. 19 October 2011)
- Agriculture, Forestry and Other Land Use (AFOLU) Requirements (v3.1, 19 October 2011)

Please note that the First Assessment conducted by ESI was originally conducted under VCS 2007.1, but updates to the methodology were addressed during the reconciliation process with the second assessment team.

1.3 Summary Description of the Methodology Element

This methodology quantifies emissions reductions of nitrous oxide (N_2O) from US agriculture, as brought about by reductions in the rate of nitrogen (N) fertilizer (synthetic and organic) applied to cropland. The methodology encourages the application of economically optimum N fertilizer rates that do not harm productivity, and requires the use of verifiable best management practices for N timing, placement, and type. Dependant on the U.S. state, where a project is proposed, the methodology uses either a generally accepted IPCC Tier 1 emission factor or an empirically derived Tier 2 regional emission factor (applicable in the 12 state North Central Region) to aid in calculating N_2O emissions reductions. The approach is straightforward and transparent and is a practical solution to help reduce N_2O emissions and other reactive N pollutants from agriculture. The field research that underpins the methodology is publicly available in the peer-reviewed literature.

2 ASSESSMENT APPROACH

2.1 Method and Criteria

The methodology assessment approach closely followed the system outlined in the following documents: VCS Methodology Approval Process, VCS Program Guide, VCS Standard, Program Definitions, Agriculture, Forestry and Other Land Use (AFOLU) Requirements, ISO 14064-3, ISO 14065, and ESI's Management System and Management System Manual v11. As defined by ISO 14064-3:2006 (E), "validation is the systematic, independent and documented process for the evaluation of a greenhouse gas assertion in a GHG project plan against agreed validation criteria." In the case of a new methodology element assessment (validation), the assessment is the systematic, independent documented process for the evaluation of a methodology element against the VCS program criteria.

The criteria followed are outlined in Section 1.2 of this report.

ESI's assessment included detailed analysis of the methodology, literature review, technical reviews and use of previously approved methodologies. Our assessment/analysis technique is generally broken down into five basic parts:

- Creation of Methodology Assessment (Validation) Plan
- ESI review and assessment,
- Utilization of independent technical experts, including VCS approved AFOLU-ALM Expert,
- Issuance of non-conformity reports (NCRs) and clarifications (CLs)
- Review of methodology developer's explanations, clarifications and insight.

2.2 Document Review

A detailed review of the methodology element documentation was conducted to ensure consistency with, and identify any deviations from, VCS program requirements. The methodology was reviewed by all team members, with some members focusing on the methodology's adherence to VCS program guide, the VCS Standard, VCS AFOLU Requirements and other guidance documents. Others, including VCS-approved AFOLU expert, John Kimble, focused on technical aspects of the methodology and its adherence to currently accepted principles and methods of soil science. The following is the final list of documents received and reviewed by ESI:

- MSU EPRI Methodology v1.4.6A.docx
- VCS Validation Report_MSU_rev1_25Jan2012.pdf

2.3 Interviews

After ESI team members reviewed/assessed the methodology element and compiled a list of NCRs/CLs, the list was presented to the MSU-EPRI methodology authors. Conference calls were scheduled after each Round of NCRs/CLs was issued. During the conference calls the methodology authors were interviewed by the ESI team to reconcile understanding of the NCRs/CLs. The methodology authors were then able to ask questions of the ESI team if they were unclear about a reviewer's comments regarding particular NCRs/CLs.

The MSU-EPRI methodology authors, Neville Millar, G Philip Roberston and Adam Diamant, and ESI team reviewers Shawn McMahon, John Kimble (AFOLU expert), Gordon Smith and Richard Scharf participated in the interviews. Individual reviewers took part when an NCR/CL found by the reviewer was being discussed.

Additional interviews were arranged, as needed, after the authors addressed NCRs/CLs in subsequent versions of the methodology and reviewers required additional clarification on changes in the new version. (See table below.)

Table 1. Meetings/Interviews Schedule

Date	Attendees	Topics Discussed
15-September-2010	Shawn McMahon – ESI Janice McMahon – ESI Neville Millar – MSU Adam Diamant – EPRI	Opening Meeting – Validation Plan
15-November-2010	Shawn McMahon – ESI Richard Scharf – ESI Gordon Smith – ESI/Ecofor John Kimble – ESI/Independent Neville Millar – MSU Phil Robertson – MSU Adam Diamant – EPRI	CAR/CL and responses from round 1
21-January-2011	Shawn McMahon – ESI Neville Millar – MSU Adam Diamant – EPRI Phil Robertson – MSU	Closing Meeting
23- December 2011	Gordon Smith – ESI Edwin Aalders - DNV	Coordination between technical experts on remaining issues. – reconciliation process
26 January 2012	Janice McMahon – ESI Neville Millar - MSU	Final Coordination on updating ESI's report and the reconciliations process with DNV

2.4 Use of VCS-Approved Expert

John Kimble – Team Member/AFOLU Expert
Gordon Smith – Team Member/AFOLU-ALM Expert

2.5 Resolution of Any Material Discrepancy

When potential material discrepancies/non-conformities were identified during the assessment process, a NCR/CL was issued. After review and issuance of each round of NCRs/CLs, the methodology authors were allowed sufficient time to correct or address non-conformities and make clarifications. Changes were reviewed by the ESI team, who either accepted corrected non-conformities and clarifications, or rejected them with explanation. The methodology authors were then able to confer again with the ESI team to discuss and clarify their findings. If the ESI team were satisfied that corrections and clarifications to the methodology bringing it into compliance with VCS program requirements, the NCR/CL was considered resolved.

2.6 Internal Quality Control

The Regional Technical Manager is responsible for the overall performance of the methodology assessment process, and is the main authority for quality assurance and quality control of the validation/verification policy and procedures of the ESI Management System. The methodology element assessment was conducted according to ESI's policies and procedures, their accreditation under ISO 14065:2007, and VCS program requirements.

3 ASSESSMENT FINDINGS

3.1 Applicability Conditions

The methodology's applicability conditions are appropriate and adequate. They are in compliance with VCS Standard (v3.1) by indentifying activities, locations and conditions under which the methodology can be appropriately used and identify which specific methodology modules apply to specific project activities. Further, it is in compliance with VCS AFOLU Requirements (v3.1), identifying specific activity categories covered by the methodology.

3.2 Project Boundary

The methodology addresses the establishment of spatial and temporal project boundaries, including the selection of mandatory carbon pools, i.e., the sources, sinks and reservoirs relevant to the baseline scenario. Due to the nature of the methodology, soil is the only pool considered, and nitrogen fertilizers, both natural and synthetic, are considered emissions sources. For temporal boundaries, the methodology refers to the most recent version of the VCS standard.

3.3 Procedure for Determining the Baseline Scenario

The baseline scenario is the amount of N_2O that would have been released under a "business as usual" (BAU) scenario in the absence of the project. Two approaches are described for determining BAU, depending on whether site-specific N-fertilizer records are available.

The procedures for determining baseline scenario are in accordance with the VCS Standard (v3.1) and VCS AFOLU Requirements (v3.1).

3.4 Procedure for Demonstrating Additionality

The methodology takes the VCS Standard (v3.1) approach to demonstrate additionality, using a regulatory surplus test and a performance standard test. The performance threshold is represented by BAU. The approach to demonstrate additionality is appropriate for this methodology.

3.5 Baseline Emissions

The methodology adequately addresses procedures for calculating baseline emissions, in accordance with VCS AFOLU Requirements (v3.1), specifically section 4.5.8. Two methods, depending on the existence of site-specific N-fertilization records, are supplied.

3.6 Project Emissions

The methodology adequately addresses procedures for calculating baseline emissions, in accordance with VCS AFOLU Requirements (v3.1), specifically section 4.5.8. Two methods, depending on the existence of site-specific N-fertilization records, are supplied.

3.7 Leakage

Leakage is rightly deemed irrelevant in projects under which this methodology is appropriate. No reduction in commodity production will occur as a result of a project developed under this methodology, so there will be no increased pressure on other croplands as a result.

3.8 Quantification of Net GHG Emission Reductions and/or Removals

The methodology provides a procedure for determining net emissions in both the baseline and project scenarios. Procedures are appropriate and in compliance with VCS rules. Significant evidence is supplied as justification for excluding soil C as a source of emissions.

3.9 Monitoring

The methodology establishes the purpose of the monitoring, procedures for measurement, calculation, estimation and modelling, procedures for managing data quality, and determining monitoring frequency. The monitoring plan is in compliance with VCS rules and is appropriate for this methodology.

3.10 Data and Parameters

Data and parameters to be reported are explained, including sources, units of measurement, frequency of reporting, etc. Specifications for all data and parameters are sound and in compliance with VCS rules.

3.11 Use of Tools/Modules

The methodology developers used the default values for calculating direct and indirect emission of N_2O found in the 2006 IPCC Guidelines for National GHG Inventories (v4, ch1) appropriately. No other approved tools or modules were used.

3.12 Adherence to the Project Principles of the VCS Program

The methodology adheres to the principles taken from IOS 14064-2, clause 3, and therefore the VCS standard. In terms of relevance, it addresses a large source of N_2O emissions in US agriculture. In terms of completeness, all relative information to carry out procedures is included. A significant amount of relevant data is expected to be generated in a project using this methodology to meet transparency requirements. The methodology's elements are conservative.

3.13 Relationship to Approved or Pending Methodologies

No pending or approved methodology under the VCS Program or other approved GHG program can be revised to serve the same purpose as the *Methodology For Quantifying N_2O Emissions Reductions in US Agricultural Crops Through N Fertilizer Rate Reduction*.

3.14 Stakeholder Comments

The methodology developers received stakeholder comments from the National Wildlife Federation (NWF), Terra Global Capital (TGC) and The Fertilizer Institute (TFI), and responded in detail (see below).

NWF commented on the methodology being based solely on N applications, and does not include crediting based on management techniques or enhanced efficiency fertilizers, the treating of N sources the same way, even though some may include heavy metals and other contaminants, and using a single leaching factor for all fertilizer types. The methodology developers adequately explained that no techniques or fertilizer types are excluded, and advanced techniques and products can be used as methods for increasing N efficiency to account for N rate reductions in a project. The single leaching factor is in accordance with IPCC guidelines. Language was introduced in the methodology that addresses concerns about environmental contaminants in N sources, like biosolids.

TGC questioned whether the confidence intervals for N_2O emissions constitute a conservative approach for reduction estimates, and asked about the absence of factors that can affect N_2O emissions, like soil texture, drainage class, pH, etc. The methodology developers adequately explained that their model approach is conservative and why inclusion of additional factors will not increase the accuracy of GHG accounting.

TFI's comments, in part, critique VCS's procedures for methodology development, conformance to ISO 14064-2, the completeness of the methodology scope, specifics about the implementation of the different methods within the methodology, the use of leaching and runoff equations, and insufficient guidance. The project developers adequately explained why specific comments are not true or irrelevant, and added language to adequately address the comment regarding leaching and runoff equations.

MSU-EPRI responses to comments can be found in Appendix A.

4 RESOLUTION OF CORRECTIVE ACTION REQUESTS AND CLARIFICATION REQUESTS

The ESI assessment team identified 35 non-conformity reports (NCRs) and clarifications (CLs). All were addressed satisfactorily by MSU-EPRI during the methodology element assessment process. These NCR's and CL's provided needed clarity to ensure technical accuracy and to ensure that the methodology was in compliance with the VCS Standard. All NCRs/CLs are outlined in Appendix B.

5 ASSESSMENT CONCLUSION

ESI confirms all methodology element assessment (validation) activities, including objectives, scope and criteria, level of assurance and the methodology adherence to the VCS Program Guide, VCS Standard, and VCS AFOLU Requirements as documented in this report (v2), are complete and concludes without qualification or limiting conditions that the methodology, *Quantifying* N_2O *Emissions Reductions in US Agricultural Crops through N Fertilizer Rate Reduction* (Version 1.4.6, dated 25 January 2012) meets the requirements of the VCS.

ESI recommends that VCSA approve the methodology element (Quantifying N_2O Emissions Reductions in US Agricultural Crops through N Fertilizer Rate Reduction Version 1.4.6, dated 25 January 2012).

6 REPORT RECONCILIATION

Environmental Services, Inc. (first assessor) – All revisions made during the second assessment of this methodology (version 1.4.6, dated 25 January 2012) were reviewed and are approved.

7 EVIDENCE OF FULFILMENT OF VVB ELIGIBILITY REQUIREMENTS

As set out in the VCS document Methodology Approval Process for Non-ARR AFOLU Methodology Elements:

1) Both validation/verification bodies shall be eligible under the VCS Program to perform validation for sectoral scope 14 (AFOLU); AND
2) At least one of the validation/verification bodies shall use an AFOLU expert (see Section 9) in the assessment; AND
3) At least one of the validation/verification bodies shall have completed at least ten project validations in any sectoral scope. Project validations can be under the VCS Program or an

approved GHG program, with the projects having been registered under the applicable program. A validation of a single project under more than one program (eg, VCS and CDM) counts as one project validation. The validation/ verification body that meets this eligibility requirement may be the same validation/verification body that uses an AFOLU expert

ESI fulfils the eligibility requirements in the following ways:

1) ESI is accredited by the American Standards Institute under ISO 14065:2007 for GHG Validation and Verification Bodied; including validation/verification of assertions related to GHG emission reductions and removals at the project level for Land Use and Forestry (Group 3). VCS accepts this accreditation.
2) ESI added Gordon Smith and John Kimble to our team. Both are VCS AFOLU-ALM Experts and were considered a full team member with their main role being technical review.
3) To date ESI has completed 8 project validations; therefore ESI does not meet this VCS requirement; however we are in the process of completing an additional 10 project validations.

8 SIGNATURE

Signed for and on behalf of:

Name of entity: *Environmental Services, Inc.*

Signature: Janice McMahon

Name of signatory: *Janice McMahon*
Vice President /Regional Technical Manager
Forestry, Carbon, and GHG Services Division

Date: *3 February 2012*

RS/SM/JM MSU Methodology Assessment Report v2.doc
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Appendix A - Public Comment responses

1. **National Wildlife Federation (NWF) Comments**

We appreciate the comments and concerns voiced by the National Wildlife Federation.

General Comment

From our reading of the comments posted by the NWF, we understand that their primary concern relates to the exclusion from the protocol of management factors other than N rate (i.e., N fertilizer type, N fertilizer timing, N fertilizer placement, and tillage practice) that can potentially affect N_2O emissions. The inclusion or disaggregation, of these factors is proposed as being better able to fully account for variation in emissions, and lead to more accurate estimates of N_2O emissions.

Response

Emissions of N_2O from agricultural land are spatially and temporally heterogeneous. We are aware that a host of management and environmental factors can affect emissions of N_2O. We are also aware that evidence to support variation in agricultural N_2O emissions brought about by variation in each of these factors exists in the peer-reviewed literature, as evidenced by specific examples of studies, reviews, and meta-analyses cited by the NWF. Evidence that confounds or contradicts the assertions made in these publications can also be found in the peer-reviewed literature. Notwithstanding the fact that few if any of these practices are sufficiently consistent in their N_2O response to merit consideration for a general N_2O credit protocol, none are directly applicable to our methodology.

For example, there is no special consideration for tillage in our protocol. While there are many studies in the literature documenting how tillage practices affect N_2O emissions, there is no clear evidence that a particular practice affects fluxes in a consistent and quantifiable manner.

To date the vast majority of evidence supports nitrogen input (annual N rate) as the most robust and reliable default proxy for calculating N_2O emissions. It is consistent and straightforward to quantify as a metric for determining N_2O emissions. Its use is substantiated by the IPCC (IPCC 2007), which uses annual N input as the default factor for calculating annual N_2O emissions from managed land in national greenhouse gas inventories. In our protocol, we have taken a conservative approach that is consistent with the IPCC default (Tier 1) approach. We have additionally proposed a Tier 2 approach in geographic areas where we are confident of its applicability. The Tier 2 approach was derived from empirical field emissions measurements taken on commercial farms (Hoben et al. 2010).

Variation in emissions observed in the Hoben et al. (2010) study does indeed indicate that factors other than N application rate have an effect on N_2O emissions. However, we are unaware of any evidence that our proposed methodology will produce biased estimates of N_2O emissions because of factors left out of the estimation calculations.

With regard to the ‘exclusion’ of other N management practices (i.e., N fertilizer type, timing, and placement), our protocol specifically requires the adoption (or continuance), during the project crediting period on the project site, of “Best Management Practices” (BMPs) for the management of N fertilizer. This stipulation inherently includes mandatory adherence to the aforementioned practices for the crop(s) and site specific environmental conditions under consideration within the project boundary. Therefore, a project developer may under certain circumstances need to alter one or more of the four N management criteria to qualify for project acceptance. However, in accordance with conservative principles demanded by carbon standard organizations like the VCSA, only the reduction in N rate below the baseline N rate estimate is proposed to be rewarded with carbon equivalent offset credits.

For example, fall applied N fertilizer typically is assumed to result in higher emissions of N_2O when compared to spring applied N fertilizer (although there is a dearth of peer reviewed literature from studies in the US investigating this assertion). Our approach in the protocol is to treat this potential conservatively, i.e. effectively ignore the additional savings that might accrue from reducing fall fertilizer vs. spring fertilizer, and instead treat both similarly. This is conservative because our empirical work and consequent equations are based on spring fertilizer application; such that if anything our method will underestimate the additional savings that would presumably occur were fertilizer instead applied in the fall.

Specific comments

1. NWF: "A recent meta-analysis of 35 studies found that nitrification inhibitors reduced nitrous oxide emissions by an average of 38%. Polymer coated fertilizers (controlled release fertilizers) reduced nitrous oxide emissions by an average of 58%."

Response: We thank the NWF for directing us to this recent publication (Akiyama et al. 2010) on enhanced efficiency fertilizers (EEFs). We were aware of the majority of the studies that constituted this analysis and also further recent studies on inhibitors, and polymer coated urea products in, for example, Halvorson et al. 2010.

From Akiyama et al. (2010):

"*It should be noted that the number of datasets for Nis [nitrification inhibitors] was limited, except studies of the effect of DCD on N_2O emissions. Therefore, more field studies are needed to evaluate the effectiveness of each NI;*"….. "*However, the effect of PCFs [polymer coated fertilizers] on N_2O mitigation showed contrasting results among land uses and soil types. PCFs were very effective on imperfectly drained Gleysol grassland, but they were not effective for well-drained Andosol upland fields.*"

Previous and ongoing work on evaluating long-term effects of EEFs could offer exciting opportunities for reducing agricultural N_2O emissions and other N pollutants. However, we believe at this time predictions of their quantitative efficacy across a wide range of environmental conditions for reducing N_2O emissions and generating agricultural offset credits are premature.

NWF and other interested parties are certainly welcome to develop and submit proposed new AFOLU offset methodologies that could be used to provide offset credit for activities that are designed to reduce N_2O emissions through utilization of EEFs. The MSU-EPRI protocol does not in any way preclude use of EEFs by project proponents or the development of additional protocols designed to credit alternative methods of reducing N_2O and generating offset credits. In fact, were EEFs (or other technology, such as site-specific fertilizer application) used to reduce N fertilizer use from baseline levels, that reduction is creditable under the MSU-EPRI protocol.

2. NWF: "Projects seeking to use these range of technologies (enhanced efficiency fertilizers) will be unfairly excluded."

Response: As noted, our protocol does not exclude the use or deployment of enhanced efficiency fertilizers - their use is allowed in projects, as with all other N sources outlined in the protocol. Any N_2O reduction will be credited if their use leads to a reduction in the total N rate applied during the credited project period, when compared to the baseline (pre-project) period. However, the use of EEFs during a project period compared to, for example, the use of a traditional readily soluble N fertilizer during the pre-project period, with both being applied at the same rate, is not sufficient by itself to qualify for N_2O reduction credits under the MSU-EPRI protocol.

3. NWF: "There are clear and obvious chemical differences between manure, compost and sewage sludge". "Compost and manure are both amendments with a diverse, complex mix of nutrients including nitrogen, carbon and micronutrients."

Response: This is true, but carbon and nutrient inputs other than nitrogen are not considered in this protocol. All eligible N inputs on a mass basis are considered equal irrespective of their source - N from an organic source is treated identically to N from a synthetic fertilizer. Of course specific organic amendments may confer additional co-benefits to the soil, crop or environment as a whole, following their addition, but this has no bearing on the method of calculation of baseline and project N_2O emissions used in this protocol.

4. NWF: "Sewage sludge often includes toxic heavy metals and various biologically active wastes such as hormones or medicines."

Response: As stated in Annex D, project developers must conduct a complete evaluation of federal, state and local regulations applicable to fertilizer (and other N containing organic amendments) use in the selected project location as part of the additionality assessment. This includes regulations relating to the application of toxic heavy metals or other possible harmful constituents in organic amendments, that if applied to cropland exceed (any) legal thresholds.

In response to questions raised by Environmental Strategies Incorporated (ESI), as part of the VCS program's First Validation of the EPRI-MSU protocol, we have revised the protocol to incorporate the following statement:

"To the best of our knowledge, implementation of project activities associated with this protocol, with or without being registered as an AFOLU project, shall not lead to violation of any applicable law even if the law is not enforced."

5. NWF: "The proposed exclusion of fertilizer N from crop residues and cover crops fails to include a significant source of nitrous oxide affected by the project and within the project boundaries."

Response: Nitrogen from crop residues and cover crops will not be excluded from the protocol. Our protocol requirement is in effect 'rotation agnostic'. The protocol stipulates a requirement for records stretching back at least five years (i.e., a monoculture of corn) or more (e.g., six years for three rotations of corn-soybean, or two rotations of corn-soybean-winter wheat). During this pre-project period the producer will have taken account of any 'N credits' provided by leguminous crops or cover crops in the rotation, and reduced his N application to, for example corn, accordingly. In using the yield goal approach for determining N fertilizer rate recommendations, factors for legume N credits will have been included, and management records during the baseline period will reflect this. The records detailing N rate in effect 'integrate' any N credit from leguminous and / or cover crops within the baseline N rate estimation for the farmer, from which subsequent project N rates must be reduced. The N credit is therefore included. Also, any N from crops grown outside the project site, but applied to the crop at the project site will be included in the protocol as an external source of N and calculated along with other synthetic and organic N applications.

6.NWF: "The protocol proposes one leaching factor "$Frac_{LEACH-(H)}$" for all fertilizers, dependent solely on precipitation and evapo-transpiration. This ignores what can be significant losses of nitrogen to ecosystems, depending on fertilizer types."

Response: The factors used for leaching and run-off (0.3 and zero) are identical to the default (Tier 1) values recommended by the 2007 IPCC Guidelines for National Greenhouse Gas Inventories, and therefore consistent with the approach of our protocol. We acknowledge that future research may provide an effective refinement of this approach.

2. Terra Global Capital (TGC) Comments

We appreciate the in-depth comments posted by TGC.

General Comment

From our understanding of the comments submitted, we have divided our response into two sections below: 1) Confidence intervals for N_2O emissions and conservative approach for reduction estimations; and 2) Omitted factors (e.g., texture, drainage class, pH) and representative conditions for extrapolation to NCR.

1) First, we want to provide an important clarification regarding the graphics displayed in our protocol and the associated appendixes. Figure G4 in the protocol was redrawn from an earlier Figure 6a in Hoben et al. (2010; http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2486.2010.02349.x/abstract and attached. Figure G4 shows the model curve for the average daily flux, with 95% confidence intervals. Figure 6a shows the model curve for the average daily flux, with 95% confidence intervals, and also the observed "raw averages" for each N rate.

As pointed out by TGC, there is variation in N_2O emissions at each of the investigated N rates. Greater variation and therefore increasing confidence intervals (decreased confidence) around the model curve occur at increasing N rates (Figure 6a). This variation is to be expected and is a result of the inherent heterogeneity of N_2O emissions, both temporally and spatially, as discussed throughout the literature. It is also common for environmental properties everywhere for variance to increase with the mean.

Notwithstanding, our approach for calculating N_2O emissions and emissions factors is conservative and unbiased:

a) The best-fit exponential model response curve (observed flux, equation G3), from which the emissions factor relationship (equation G5) is derived calculates lower values for N_2O fluxes, as compared to the "raw average" N_2O fluxes at each N rate (diamonds in Figure 6a). For example the raw average flux from all site years for the highest N rate investigated (225 kg N ha^{-1} yr^{-1}) is ~ 26 g N_2O-N ha^{-1} day^{-1}, whereas the actual model data used to help determine the emissions factor (EF_{BDM2} and EF_{PDM2} in the protocol) is ~ 18 N_2O-N ha^{-1} day^{-1}, a "reduction" of ~ 30%. The higher the N rate, the larger this reduction in N_2O emissions calculated using the model when compared to the raw field data. This systematic "underestimation" in using the model data constitutes a conservative approach.

b) The calculation for estimating annual N_2O emissions at each N rate from which the emission factor (EF_D) is calculated is conservative for the following reasons:

i) The calculation uses the lowest daily N_2O flux measured over all sites and years from the relevant period, as the daily flux from which the cumulative emissions for early spring (March-April) and late fall (October – November) are calculated. The use of this lowest flux to calculate cumulative emissions during these periods very likely underestimates the actual emissions over these times; and,

ii) The calculation also assumes that there are no (zero) fluxes of N_2O from frozen soils, and during soil freeze–thaw cycles during the winter period (December – February). Again, this assumption almost certainly underestimates the actual fluxes that will have occurred during this time, and constitutes a very conservative approach. Please see page 11 of Hoben et al. (2010) for further discussion.

We believe that our conservative underestimation of daily and annual N_2O fluxes, and by extension the emission factors used in our protocol is cautious and justified with regard to the requirements of new methodologies in the AFOLU sector that are under intense scrutiny. We also view this approach as a fully compensatory emissions reduction mechanism for the increasing variability of N_2O emissions at higher N rates and the decreasing confidence in N_2O emissions at these rates.

Furthermore, at the highest investigated N rate (225 kg N ha^{-1} yr^{-1}) the lowest and highest N_2O emissions represented by the 95% confidence interval, are ~6 and ~30 g N_2O-N ha^{-1} day^{-1}, respectively, i.e., a five-fold variation. This variation is relatively low, when for example compared to the upper and lower N_2O emissions (~1.8 and ~18 g N_2O-N ha^{-1} day^{-1}, respectively – a 10-fold variation) calculated from the same N rate using the uncertainty range for the IPCC default emission factor of 0.3 – 3.0 %.

TGC suggests that our protocol should adhere to the draft VCS guidance documents' specific criteria for acceptable confidence interval values. As far as we are aware, the VCS 2011 draft guidance documentation currently posted on the VCS website (http://www.v-c-s.org/vcs2011.html) was not in effect at the time of our protocol submission, and currently remains in draft form pending future implementation by the VCS sometime next year. While we appreciate the need for VCS to continue to refine and clarify VCS protocol standards and requirements for projects in the AFOLU arena, the proposed criteria associated with confidence levels contained in these documents are draft criteria that have not yet been adopted formally by the VCS. Since the criteria were not in place at the time we submitted our protocol we did not address them explicitly.

2) Emissions of N_2O from agricultural land are inherently spatially and temporally heterogeneous, and we are aware that a host of management, soil, and environmental factors can affect emissions of N_2O. Evidence for and against the relative merits of soil properties such as texture, drainage class and pH and their effect on N_2O emissions can be cited from the peer-reviewed literature.

Our protocol is consistent with IPCC Tier 1 and Tier 2 methods, and is based upon empirical data derived from representative commercial farm land experiencing a wide range of environmental conditions throughout the growing season. It is not an attempt to fully quantify all (or even a large number) of the factors that can contribute to altering N_2O emissions, or an effort to impose a complex biogeochemical model on project developers that has not been fully tested on appropriate systems. There is no evidence to show that the introduction of a larger number of parameters will improve the accuracy of estimates of N_2O emissions from these systems. Our approach is conservative in that the overall relationship determined between N rate and N_2O emissions (Hoben et al. 2010) is an "integrator" of the variability of soil and environmental conditions encountered at the study sites. Moreover, we would not expect parameters such as soil texture, drainage class and pH in the project period to differ from those during the baseline period as a result of the reduction of N fertilizer rate.

The soil properties and environmental conditions at each of the study sites are shown in Table 1 and the supporting information of Hoben et al. (2010). The sites detailed in this study were specifically chosen to ensure a wide range of soil type, texture, and grain yield that is comparable to that found across the NCR. The sites used in the development of the nonlinear N_2O flux model for Michigan are broadly representative of crop rotations and conditions throughout the Midwest; during years with normal precipitation, crop yields at these sites are typical of the region as a whole (Smith et al. 2007). The N rates employed in Hoben et al. (2010) also are within the range commonly required for optimum corn grain production and recommended for the US Midwest (Sawyer et al., 2006; Vitosh et al., 1995). For these reasons, we consider our empirical results from Michigan to be representative of the NCR, as did reviewers of Millar et al. (2010), and Hoben et al. (2010).

External, third-party review of similar N_2O studies suggest that at recommended fertilizer application rates, there is no evidence to show that soil and climate variations of typical crop fields across the NCR results in greater variation of N_2O emission rates than weather variations and the site specifics of, for example, fertilizer N type or timing. Furthermore, there is no evidence that the soil and climate variations across the NCR region are different from the study sites in any way that is likely to lead to the methodology's resulting in biased estimates of N_2O emissions or emissions reductions. We are not aware of any evidence that the proposed methodology will produce biased estimates of N_2O emissions because of any factors not included in the N_2O emissions estimation calculations included in the protocol.

3. The Fertilizer Institute (TFI) Comments

We thank the TFI for posting their concerns.

For clarity our responses chronologically follow (exclusive of TFI pre-amble) the section titles as posted by the TFI:

1) Development process; 2) Conformance to ISO 14064-2; 3) Completeness of posted methodology scope; 4) Implementation of Method I — Tier I Approach; 5) Derivation and implementation of Method 2 — Tier II Approach; 6) Justification for equations to determine if leaching and runoff occur; and 7) Guidance for implementation of methodology.

1) Development process

We agree with TFI that "*publication of components of the protocol does not constitute the use of a consensus-based, structured, and transparent process of development."* and that *"publication of the N_2O method used does not necessarily mean that the method represents a consensus of scientific opinion."*

Our protocol was developed to be in conformance with the VCSA's requirements for the development of a new AFOLU offset methodology. Please also refer to our comments under response 2 below.

We do not make the explicit claims described above in the protocol or in our publications. While we believe publication of peer-reviewed research in the scientific literature is preferable as a component of the validation of a particular approach, we understand that it is independent of the protocol validation process. The integrity of our protocol does not rest solely on the fact that research related to the protocol has undergone peer-review.

Under the aegis of the VCS, there is no requirement to develop a protocol using extensive stakeholder engagement to arrive at a 'scientific and political consensus.' The merits of this approach for achieving 'validity' or 'equity' for a protocol that aims to reduce agricultural greenhouse gas emissions can be debated in any case.

Irrespective of this, we certainly appreciate the value of involving expertise from multiple disciplines in developing our methodology. As such, during the development process, we have collaborated and continue to work with various and numerous researchers and stakeholder groups, including social scientists, economists, aggregators, and producers.

Please also note that alongside our protocol we will be submitting associated project documents that will bring practical implementation of our protocol to farmer fields in the Midwest. Our submitted protocol therefore does not represent an *ad hoc* attempt to promote our methodology via the carbon market, but is rather a component of ongoing research that aims to mitigate reactive nitrogen in the environment, while fairly rewarding good land stewardship that contributes to this goal.

TFI further note, that "…*the protocol for comment differs substantively from the published version (Millar et al. 2010…), but no description is given of the process of decision-making which led to these changes.*

As noted above, while Millar et al. (2010) validates our approach, it is not sufficiently detailed or specific to constitute a protocol. The submitted protocol is a stand-alone document that must be evaluated on its own merits, underwritten by studies such as Millar et al. (2010) and others, but ultimately different in ways that put the approach into practical terms.

Notwithstanding, it may be worth noting that the fundamental accounting methodology in both the published manuscript (Millar et al. 2010) and the submitted protocol is entirely consistent – in both cases N fertilizer rate is used as a proxy for N_2O emissions during the baseline and project periods, with the same formulas used to generate credits, and in both cases there is a requirement that Best Management Practices for N management be adhered to prior to project acceptance.

2) Conformance to ISO 14064-2

Our understanding, recently verified with VCS and consultants, is that the VCS program, standards, and methodology validation process (including public consultation, as participated in by TFI), are all consistent with applicable ISO standards. Since our protocol is being developed in a manner consistent with the VCS program and offset methodology development standards, it is in fact compliant with all relevant ISO 14064-2 standards.

3) Completeness of posted methodology scope

Aside from the issue relating to ISO 14064-2 conformance addressed in response 2), the TFI statement that "*quantification and monitoring of the nitrogen derived from crop residue*.." are excluded is false, and rests on a misunderstanding of the methodology from which the baseline and project emissions are calculated. Subsequent TFI comments and justification for inclusion of crop residues as a nitrogen input are thereby moot.

Our protocol is in effect 'rotation agnostic.' It stipulates a requirement for baseline estimation of N_2O emissions, for management records stretching back at least five years for monocultures or six years for 2- or 3-crop rotations (e.g.

three rotations of corn-soybean or two rotations of corn-soybean-winter wheat). During this pre-project period the producer will have taken account of any N credits provided by crop residues (i.e., from leguminous and non-leguminous crops, including cover crops) in the rotation, and reduced his N application to the fertilized crop accordingly. In using the yield goal approach for determining N fertilizer rate recommendations, factors for crop residue N credits will have been included, and management records during the baseline period will reflect this. These records detailing N rate in effect integrate any N credit from leguminous and / or cover crops within the baseline N rate estimation for the farmer, from which subsequent project N rates must be reduced. The N credit from crop residues is therefore included.

Please also note that any N from crops grown outside the project site, but that are applied to the crop at the project site (e.g. as compost) will be included in the protocol as an external source of N and calculated along with other synthetic and organic N applications.

4) Implementation of Method I — Tier I Approach

TFI states that:

Tier 1 approach is designed for use in developing nations, or in regions where no better data is available;

It seems inappropriate that a Tier 1 approach would be considered a science-based approach for a sophisticated region within a developed country;

The protocol is designed for use in a region with more data than most developed nations. USA National Inventory Report method is Tier 3;

The developers propose the Tier 1 and derived "Tier 2" approach is more transparent than a Tier 3 approach.

Response

We are unaware of a requirement that protocols developed for projects use the same accounting methods used for their country's greenhouse gas inventory. There are good scientific reasons for the absence of such a requirement – first among them a scaling issue, second among them a field-scale validation issue. Notwithstanding, in fact the US uses a combination of Tier 1 and 3 approaches (US EPA 2010, Annex 3.11, A-224 – A 242), and most of the other Annex 1 countries (56%) use a Tier 1 approach with the remainder using either Tier 2 (26%) or not reporting N_2O emissions from agricultural soils (18%; Lokupitiya and Paustian 2006). All of these approaches are science-based.

5) Derivation and implementation of Method 2 — Tier II Approach

If we understand their comments correctly, TFI are unfavorably comparing our approach, in developing an N_2O emission factor from empirical field work in Michigan, to the development of a country-specific (Canada) methodology to calculate the inventory of N_2O emissions from all agricultural soils, as detailed in Rochette et al. (2008).

We believe comparison (negative or positive) between our derivation of a regionally appropriate fertilizer induced emission factor for the USA and methods used to calculate the country-wide inventory of N_2O emissions from agricultural soils in Canada may be useful from a research and discussion perspective but has little bearing on the process of protocol validation for the NCR. Our protocol does not preclude the adoption and use of a TFI-preferred protocol in Canada or elsewhere, and we welcome any verifiable approach that reduces N_2O emissions. Moreover, as we note in response to earlier comments, our protocol allows for credits generated by N-fertilizer reductions using the Canadian 4R framework or any other methods for doing so.

More specifically, TFI comments express concerns with:

a) the non-linear relationship between N rate and N_2O emissions;

b) the exclusion of modifying factors for N_2O emission e.g., climate and soil texture, and;

c) the geographical scope of our work and its extrapolation to the North Central Region.

a) Non-linear N_2O response. The publication by Hoben et al. (2010) includes a detailed statistical analysis of the data collected from our field sites, showing the derivation of the best-fit non-linear N_2O response function to increasing N fertilizer rate. Non-linearity is not common in the literature because there have been few studies of N_2O-response against more than two fertilizer rates at individual research sites. Meta-analyses, such as those used to determine fertilizer induced emissions factors in Canadian regions, by their very nature confound numerous factors along with N rate in their goal to generate a simple relationship with N_2O emissions. A number of more recent site studies have reported non-linear response curves and these include a number of row-crop sites in Canada (e.g., Grant et al. 2006; Zebarth et al. 2008; Ma et al. 2009).

The reality that a non-linear relationship between N rate and N_2O emissions can in effect 'generate' more carbon offsets when N rates are reduced, when compared to a linear relationship using the same N rate reduction, is not a serendipitous artifact of our methodology, but rather is predicted by biogeochemical theory. The greater incentive that this scenario affords, with respect to potential financial remuneration for a producer, is a major driver of our desire to implement the protocol.

b) Exclusion of modifying factors. Emissions of N_2O from agricultural land are inherently spatially and temporally heterogeneous, and we are aware that a host of management, soil, and environmental factors can affect emissions. In line with the stringent requirements of carbon standards, our approach is conservative: we can view the overall relationship determined between N rate and N_2O emissions (Hoben et al. 2010) as an "integrator" of the variability of soil and environmental conditions encountered at the study sites. There is also no evidence to show that the introduction of a larger number of 'modifying parameters' will improve the accuracy of estimates of N_2O emissions from cropping systems. Moreover, we would not expect parameters such as soil texture and topography in the project period to differ from those during the baseline period as a result of the reduction of N fertilizer rate.

Finally, we are not aware of any evidence that the proposed methodology will produce biased estimates of N_2O emissions because of any factors not included in the N_2O emissions estimation calculations included in the protocol.

c) Geographical scope. Our protocol is consistent with IPCC Tier 1 and Tier 2 methods, and is based upon empirical data derived from representative commercial farmland experiencing a wide range of environmental conditions throughout the growing season.

The soil properties and environmental conditions at each of the study sites are shown in Hoben et al. (2010; Table 1 and the supporting information). The sites detailed in this study were specifically chosen to ensure a wide range of soil type, texture, and grain yield that is comparable to that found across the NCR. The sites used in the development of the non-linear N_2O flux model for Michigan are broadly representative of crop rotations and conditions throughout the North Central Region; during years with normal precipitation, crop yields at these sites are typical of the region as a whole (Smith et al. 2007). The N rates employed in Hoben et al. (2010) are also within the range commonly required for optimum corn grain production and recommended for the US Midwest (Sawyer et al., 2006; Vitosh et al., 1995). For these reasons, we consider our empirical results from Michigan (in particular the N_2O response curves) to be representative of the North Central Region. This view was supported by reviewers of Millar et al. (2010) and Hoben et al. (2010).

6) Justification for equations to determine if leaching and runoff occur

TFI state that:

"It is not clear how the $Frac_{LEACH}$ derivation is consistent with IPCC (2006) and Rochette et al. (2008)."

"As the methods used in the references provided do not align exactly with the EPRI method, it would be helpful for the developers to describe fully the derivation of their approach to calculation of $Frac_{LEACH}$."

We agree that the text is unsuitable when referring to equations A1 and A2 in Annex A, and their relationship with equations used in IPCC 2006 and Rochette et al. (2008). We propose to alter the text to read:

"The approach presented here uses default (Tier 1) values for leaching and run-off from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, and the ratio of growing season values of precipitation to potential evapotranspiration."

Potential evapotranspiration is a measure of the climatic demand for water from a saturated soil volume. Available energy (often expressed in terms of potential evaporation) and precipitation, largely determine evapotranspiration and runoff rates at a site.

We also propose to alter the term '$Frac_{LEACH-(H)}$' as used in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, to '$Frac_{LEACH}$'. This reflects the fact that the term as now used is consistent with the 1996 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 3, Chapter 4) and that it does not only apply to regions where soil water-holding capacity is exceeded, as a result of rainfall and / or irrigation.

For sites where the ratio of growing season values of precipitation to potential evapotranspiration is greater than or equal to 1.0, the maximum $Frac_{LEACH}$ value recommended by the IPCC (2006) of 0.30 was assigned. For other regions, the default $Frac_{LEACH}$ value is set to zero, as recommended by IPCC (2006). The use of IPCC default (Tier 1) factors is consistent with the approach of the protocol.

7) Guidance for implementation of methodology

From our understanding of the comments posted, we assume that TFI have interpreted that in order for projects that use the protocol to be accepted, project proponents need only reduce the project N rate when compared to the baseline N rate, and need not adhere to other N best management practices. As noted on page 3 of the protocol, project proponents are required to follow Best Management Practices" (BMPs) for the management of N fertilizer. This stipulation inherently includes mandatory adherence to these practices for the crop(s) and site-specific environmental conditions under consideration within the project boundary. Therefore, a project developer, under certain circumstances may need to alter all four of the N management criteria to qualify for project acceptance.

The TFI's list of 4R endorsements has no direct bearing on the validity of our approach, and whether our protocol '*needs to more closely conform to 4R*'. Growers are free to more finely tune any part of the 4R equation (source, rate, time, place) to achieve better nitrogen use efficiency and provide creditable fertilizer savings.

However, unlike the 4R approach, in accordance with conservative principles demanded by carbon standard organizations like the VCSA, only the verifiable reduction in N rate below the baseline N rate estimate is proposed to be rewarded with carbon equivalent offset credits in our approach.

For example, fall applied N fertilizer typically is assumed to result in higher emissions of N_2O when compared to spring applied N fertilizer (although there is a dearth of peer reviewed literature from studies in the USA documenting this assertion). Our approach in the protocol is to treat this potential conservatively, i.e. effectively ignore the additional savings that might accrue from reducing fall fertilizer vs. spring fertilizer, and instead treat both similarly.

This is conservative because our empirical work and consequent equations are based on spring fertilizer application; such that if anything our method will underestimate the additional savings that would presumably occur were fertilizer instead applied in the fall.

As well as being a VCSA requirement, the major reason for this 'conservative' approach, is the lack of consistent, non-confounded, and reliable evidence, across a wide range of environmental conditions in the USA, that alteration of any of the N management practices discussed above, other than N rate, will have a predictable directional bias on N_2O emissions. Moreover, quantification of the effect of these N management practices on N_2O emissions, based upon literature, peer-reviewed or otherwise, is we believe premature.

To date the vast majority of evidence supports nitrogen input (annual N rate) as the most robust and reliable default proxy for calculating N_2O emissions. It is consistent and straightforward to quantify as a metric for determining N_2O emissions. Its use is substantiated by the IPCC (IPCC 2007), which uses annual N input as the default factor for calculating annual N_2O emissions from managed land.

The claim by TFI that "*the protocol does not provide detailed guidance*" in regard to conformance with 4R principles is correct, insofar as the protocol documentation does not provide an exhaustive, and prohibitively extensive, list of publications and documentation from each state and / or region in the USA. We believe that this is unnecessary, and credit the project developers with the ability to retrieve this readily available documentation (from the NRCS, Farm Service Agency, and state departments of agriculture) to ascertain which BMPs are in place for their project site. From the protocol (slightly amended at the suggestion of the validators: "Details of fertilizer BMPs are readily available for each US state via State Departments of Agriculture and from federal agencies such as the Natural Resources Conservation Service. More generally these BMPs are described in the Global 4R Nutrient (Fertilizer) Stewardship Framework (Right Source–Rate–Time–Place), published by the International Plant Nutrition Institute (IPNI)."

We are uncertain why TFI think that, "*Without this detailed guidance, it is expected it will be difficult to ensure projects are implemented to simultaneously minimize N_2O emissions while maintaining crop yield, soil quality, and environmental integrity.*"

As mentioned above this guidance is readily available, and indirectly referenced in the protocol.

TFI: "*there is essentially no guidance given concerning the documentation needed to provide verifiable evidence that projects have been implemented according to the posted Methodology.*"

By design our protocol does not mandate a specific list of documents required to determine the baseline. Rather the protocol language is in accordance with VCS guidelines as detailed in their Tool for AFOLU Methodological Issues, i.e., "the baseline fertilizer N rate is determined from the project proponents' management records for at least the previous five years…."

In Annex C we provide a description of the types of management records that are deemed suitable: "Examples of these include synthetic fertilizer purchase and application rate records, as well as manure application rate and manure N content history." We also specify that "management records from which baseline fertilizer N rate can be directly determined are required." The protocol thus provides guidance that we believe sufficient about information with which a project developer can determine a baseline N rate. The protocol also describes a 'contingency' if site-specific records are considered insufficient or inappropriate, in the form of our Approach 2. A detailed worked example of this approach is available (Annex C) that provides guidance on the mechanism and documentation required to determine baseline N rate. Also, again, as mentioned above, the expectation is that expert project validators will be in place to determine whether a project conforms to the protocol or not.

We are very aware of the concept of 'gaming' and understand some project developers may attempt to 'unfairly' optimize their financial and business opportunities. With this in mind, one of the major aims of the language included in the protocol is to minimize the potential for gaming. We believe the protocol as written accomplishes this important goal. However, we also believe that neither this nor any other offsets protocol can be written in such a way as to predict each, and every possible scenario that may result from the protocol entering the public domain.

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9 Appendix B - Corrective Action Requests, Clarifications – Technical

Question No.	Page No.	Line No.	ESI Comment /Question/Clarification	MSU Answer	Addressed	ESI Comment /Question/Clarification
Technical Questions						
1	3	93-94	The agencies of state governments that document or develop BMPs have a variety of names. Why mention 'DNR' without an exhaustive list? Why not include NRCS?	These organizations were used as examples. Line 93-94 reads 'Details of fertilizer BMPs are readily available for each state in the US in documentation from, for example, the Environmental Protection Agency (EPA), the Department of Natural Resources (DNR) and Cooperative Extension Services (e.g., University Extension).' We agree that it might be better to substitute the wording below: Details of fertilizer BMPs are readily available for each US state via State Departments of Agriculture and from federal agencies such as the Natural Resources Conservation Service.	Yes.	The revisions suggested by MSU were made in the final version of the methodology, satisfactorily addressing the question raised.
2	3	122	What is the reasoning for selecting the North Central Region as the area where method 2 is applicable?	The sites detailed in Hoben et al. 2010 were specifically chosen to ensure a wide range of soil type, texture, and grain yield generally found across the NCR. The results from the Michigan study can be considered representative of the NCR. This claim has not been challenged during the peer review process as noted below, where we extract passages from published and accepted manuscripts that have undergone peer review. Millar et al. 2010: a. 'To the best of our knowledge, the Michigan field studies are the only Midwest studies to specifically investigate long-term N_2O emission responses to a large number of fertilizer N rate treatments in corn cropping systems. The sites used in the development of the nonlinear N_2O flux model for Michigan (Hoben et al. 2010) are broadly representative of crop rotations and conditions throughout the Midwest. During years with normal precipitation, crop yields at these sites are typical of the region as a whole (Smith et al. 2007)1.' b. 'these gradient studies provide the only detailed information of their kind, and the non-linearity of N_2O emissions has significant consequences when comparing N_2O emissions reductions with the very general IPCC Tier 1 approach.' c. 'In the absence of evidence to the contrary we assume that these N gradient experiments are representative of the soil and corn cropping systems throughout the Midwest.' Hoben et al. 2010 (In press, see question #14 below for access): a) Title is "Non-linear Nitrous Oxide (N_2O) Response to Nitrogen Fertilizer in On-Farm Corn Crops of the US Midwest" b) "The objectives of the present study are to determine the relationship between N fertilizer rate and N_2O emissions for corn grown on production fields in the US Midwest." c) "Our results suggest a nonlinear exponentially increasing N_2O response to N rate that may be typical for corn-soybean rotations in the US Midwest." Grace et al 2010. (Accepted in Agricultural Systems - Version AGSY1866R2). a. 'Detailed experimental data linking annual climate variability, crop yield, a range in N application rates and soil types, and N_2O emissions is extremely limited in the Midwest. The N rates employed in Hoben (2010) were within the range commonly required for optimum corn grain production and recommended for the US Midwest (Sawyer et al., 2006; Vitosh et al., 1995). The sites were specifically chosen to ensure a wide range of soil types, textures, and grain yields generally found across the NCR.' 1Smith, R.G., Menalled, F.D., and Robertson, G.P. 2007. Temporal yield variability under conventional and alternative management systems. Agronomy Journal 99:1629-1634.	Yes.	MSU responded that the application the emission prediction equation to the north central region has not been challenged in the peer review process. This response does not provide evidence that it is appropriate to extrapolate from the 8 measured field-year combinations in southern Michigan to the 12 state north central region. We have reviewed of other studies of soil N_2O emissions and the dynamics of soil N_2O emissions. Our review suggests that, at recommended fertilizer application rates, there is no evidence that the soil and climate variations of typical crop fields across the 12 state region will lead to any greater variation in N_2O emission rates than weather variations and the specifics of type of N applied, timing of N application, and crop vigor. Further, we have no evidence that the the soil and climate variations across the 12 state region are different from the study sites in any way that is likely to lead to the methodology making biased estimates of emissions. Our conclusion is that known soil N_2O emission dynamics do not suggest that the the methodology is biased, and we accept application of the methodology to the 12 state region.
3	4	144-147	Why use WRD in place of US Soil Taxonomy? WRD is not used in US soil surveys.	Refers to the definition of organic soil type. Lines 46-47: 'Proposed projects on sites with organic soils, as defined by the World Reference Base for Soil Resources (FAO 1998), will be considered ineligible. See Annex F for organic soil definition.' Good point. We can swap WRD (FAO) definition as used in IPCC documentation with the US Soil Taxonomy definition of organic (histosol) soils.	Yes.	The revisions suggested by MSU were made in the final version of the methodology, satisfactorily addressing the question raised.
4	5	195 & table	Is there evidence that CH_4 emissions are negligible, even though numerous soils in the NRC are hydric and significant CH_4 emissions have been documented as occurring after drains are closed to bring up the water table outside the cropping season?	Refers to Table 1, in which changes in CH_4 are 'Assumed negligible. Yes, it is true that CH_4 emissions occur in hydric soils intermittently flooded. However there is no evidence in the literature to indicate that CH_4 flux is affected by N fertilizer change in fields already farmed. And while hydric soils in the NCR that are seasonally flooded may show significant emissions of CH_4, there is nothing in the protocol that would affect this practice, and / or increase project emissions above pre-project emissions.	Yes.	None.
5	6	220-221	The statement that the baseline is equivalent to common practice appears to contract the rest of the baseline section, lines 209-257. The baseline section describes two methods for setting the baseline, with a preference for data on historic application rates (baseline approach 1), but lines 220-221 appear to say that baseline approach 2 (lines 247-257) shall be used. Which is intended to apply, lines 220-221 or the rest of the baseline section lines 209-257?	Lines 219-220. 'For this protocol the baseline scenario is considered equivalent to 'common practice' for the project developer (see Assessment of Additionality section below).' Lines 222-227. 'The determination of baseline N_2O emissions is carried out using one of two Approaches. Both Approaches initially generate a baseline fertilizer N application rate, from which emissions of N_2O are calculated. Approach 1 is used preferentially due to its finer spatial resolution, (site specificity). Approach 2 (county scale data) is used if relevant records are not available or verifiable for Approach 1.' There may some ambiguity in the way that we've used the term common practice here. The business-as-usual practice, that is inferred from N rate recommendations that follow the yield goal approach are common practice for both Approach 1 and Approach 2. They are simply derived differently - Approach 1 derives baseline N rates from producer specific N fertilizer management records and Approach 2 derives baseline N rates from USDA crop yield data plus readily available equations for calculating N rates from these yields. To avoid ambiguity it may be preferable to replace the term 'common practice' with "business-as-usual" (please also see further discussion in Q. 25).	Yes.	The revisions suggested by MSU were made in the final version of the methodology, satisfactorily addressing the question raised.

6	6	237-239	Why not use soil test data to determine baseline amounts? Why not include date of N application in equations, since this is known to have a major effect on N volitization?	a). The relationship between N2O emissions and N rate is independent of soil N test data, therefore soil N test data isn't relevant for calculating N2O flux. The protocol depends on the knowledge of previous N rates applied, and soil N test data cannot reliably be used to determine soil N fertilizer rate. b). We assume volatization here refers to N2O rather than NH3. We are aware that the timing of N applications, and a host of other management and environmental factors, can affect N2O emissions. For example, fall applied N fertilizer is typically assumed to result in higher emissions of N2O when compared to spring applied N fertilizer. Our approach in the protocol is to treat this potential conservatively, i.e. ignore the additional savings that might accrue from reducing fall fertilizer vs. spring fertilizer, and instead treat both similarly. This is consistent with the Tier 1 and Tier 2 approaches of the IPCC (IPCC 2007). This is conservative because our empirical work and consequent equations are based on spring fertilizer application; such that if anything our method will underestimate the additional savings that would presumably occur were fertilizer instead applied in the fall.	Yes.	None.
7	7	266-268	Why not include the needed information here, rather than refer to another set of material?	Lines 266-268. 'Project developers pass the Regulatory Surplus Test if there is no mandatory law, statute or other regulatory framework in place at the local, state, or federal level, requiring producers to reduce fertilizer N input rate below that of a business–as–usual or common–practice scenario.' This suggestion refers to the placement of information on laws and regulations within the protocol text itself, rather than in a separate Annex (D). We could include the needed information in the main protocol but it seems more reasonable, given its length (Line 911-993, approximately one and a half pages of text) to place in a separate annex.	Yes.	None.
8	7	282-287	The language is not clear. Do the project proponents mean that for the project to be additional, the with-project N application rate must be less than the common practice N application rate?	Lines 281-287 read 'For this protocol a common practice threshold is used. The common practice threshold value is identical to the baseline calculation value for fertilizer N rate application irrespective of whether Approach 1 or 2 is used. Reductions in fertilizer N rate, and therefore N2O emissions, beyond the threshold value at the project site (Approach 1), or beyond the calculated value in the county where the project will be conducted (Approach 2), will result in project additionality. Annex E details information on common practice for fertilizer N rate application.' Yes, the N rate during the project period must be less than the baseline N rate, which is defined as common practice (business as usual) for the baseline period. Justification for common practice being equivalent to the calculated baseline is given in Annex E. Please also see discussion for Q. 25.	Yes	The revisions suggested by MSU were made in the final version of the methodology, satisfactorily addressing the question raised.
9	7	290-292	Defining CO2 equivalents would make things easier for the user.	Lines 290-292 read 'All emissions of N2O (baseline and project, direct and indirect) are reported in units of Megagram of carbon dioxide equivalents (Mg CO2e). One (1) Mg is equivalent to 1 × 106g or one (1) metric Ton or one (1) tonne.' We define CO2 equivalents in Annex F (lines 1096-1106, extracted below). We agree it would be helpful to either refer to the definition in Annex F here or define it here. From Annex F: 'The GWP value of 298 for N2O used in the protocol is the 100-year value proposed in the 2007 Intergovernmental Panel on Climate Change Fourth Assessment. The value of 298 is the direct GWP for one molecule of N2O on a mass basis for a 100 year time horizon, relative to one molecule of CO2, which is ascribed a value of 1 by convention. This means that a molecule of contemporary N2O released to the atmosphere will have 298 times the radiative impact of a molecule of CO2 released at the same time. The conversion, as stated in IPCC (2007), can be represented as: N2OGWP = 298, Mg CO2e (Mg N2O)-1	Yes.	None.
10	8	304+	How is N taken up by crops handled? Stover removed for feed or bedding would lead to indirect emissions off site.	The fate of material such as corn stover used as feed or bedding is handled in separate IPCC calculations relating to manure management (2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4. Agriculture, Forestry and Other Land Use. Chapter 10: Emissions from Livestock and Manure Management). This factor is not addressed in this protocol except insofar as manure may be returned to the field as fertilizer. See also Q. 17 for comments on legume N contribution.	Yes.	None.
11	9	340+	How does the methodology account for a wide range in N content of organic materials?	The range of N contents for organic materials is explicitly covered in the calculations (term NCB OF), extracted from the protocol: Direct emissions (Baseline) for Method 1 and Method 2. Eqn. 4 FB ON, t = MB OF, t * NCB OF * (1 - FracLEACH–(H)) NCB OF Nitrogen content of baseline organic fertilizer applied g N (100g fertilizer)-1;	Yes.	None.
12	9	360-363, 384-385 and other places.	What about losses due to wind erosion, which can be high in many areas?	This refers to lines 360-361, 384-385 etc., which reads: 'At project sites where leaching and runoff do not occur (see Annex A), the direct N2O emissions are calculated by removing the FracLEACH–(H) component (considered zero) from equations 3 and 4.' Wind and other forms of soil erosion are not included in the protocol calculations as N removal mechanisms, although they can be important. It is reasonable to assume that wind erosion would not be different during the project period when compared to the non- project period. Moreover, the alteration of N fertilizer rate will not affect erosion due to wind.	Yes.	None.
13	9, 12 & 39	376, 523, 1311	How can this equation omit the rate of N application per unit area? Equation G3 as graphed in fig. G4 clearly shows that the emission rate is nonlinearly related to the rate.	This refers to the Emissions factor equation(s) for the non-linear relationship EFB(P)DM2 = 0.0072 * exp [5.2 * (FB SN, t + FB ON, t)] EFB(P)DM2 Emission factor for baseline (project) direct N2O emissions from N inputs Mg N2O–N (Mg N input)-1. See Annex G for full description of emission factor calculation. There may be a misunderstanding here. Equation G3 as graphed in Figure G4 relates to the changes in N2O-N emissions in response to changes in N rate: 'Figure G4. Relationship between fertilizer N rate (kg N ha-1 yr-1) and daily N2O fluxes (g N2O–N ha-1 day-1) across five Michigan sites in 2007–2008.' The equations in the protocol calculations (6 and 15) refer to changes in the Emissions Factor with N rate, and not changes in the N2O-N emissions rate per unit area. The changes in the emissions factor are calculated from the changes in the emissions rate, but are independent of unit area.	Yes.	MSU is correct that we misunderstood the equation. At a point several steps earlier in the chain of equations, area is included. As a result, the equation in question is in a per-hectare basis.

14	9	380-381	Are the recent Hoben and Millar articles available?	Hoben et al. 2010 is available from the publisher of Global Change Biology at the link (password protected): http://onlinelibrary.wiley.com.proxy1.cl.msu.edu/doi/10.1111/j.1365-2486.2010.02349.x/pdf Accepted Article; doi: 10.1111/j.1365-2486.2010.02349.x We also attach a typescript pdf version here. Millar et al 2010b about non-linear N2O emissions from winter wheat will be submitted to Journal of Environmental Quality before the end of October. A preprint can be made available at that time.	Yes.	None.
15	20	702-704	Total precipitation can give poor results, since leaching is affected by storm intensity and duration. It also occurs outside the growing season. How is this handled?	From Annex A. A project site is considered to have a FracLEACH-(H) default value of 0.30 kg N (kg N additions)-1) when: PrecipGS / PETGS ≥ 1.00 (A1) A project site is considered to have a FracLEACH-(H) default value of 0.00 kg N (kg N additions)-1) when: PrecipGS / PETGS < 1.00 (A2) PrecipGS = Precipitation during the growing season, mm; PETGS = Potential evapotranspiration during the growing season, mm. The growing season is considered to occur from May – September inclusive, unless otherwise verifiable. As discussed earlier, we understand that N2O emissions may be affected by a range of environmental factors, including rainfall intensity and timing throughout the year. However in this protocol we have taken a conservative approach consistent with IPCC Tier 1 and Tier 2 methods, and Rochette et al. (2008), and used a simple ratio to determine whether leaching occurs or not. Our approach is based upon empirical data derived from representative farm land experiencing a wide range of environmental conditions throughout the growing season. Moreover we don't expect precipitation patterns in the project period to differ significantly from patterns during the baseline period, so nitrogen leaching will differ mainly as a function of N-rate where leaching occurs.	Yes.	None.
16	21	Annex B	How do you deal with no-till and the use of soil testing to apply N? On the Morrow plots excessive N was applied and this changed the C:N ratios where as lower rates of application may not have had the same effect.	a) There is no special consideration for tillage in our protocol. While there are many studies in the literature documenting how tillage practices affect N2O emissions, there is no clear evidence that a particular practice affects fluxes in a consistent manner. Farmers who have used soil tests to determine their N fertilizer needs during the baseline period may still do so during the project period, but the MRTN approach explicitly avoids the need for soil test results as soil N tests (e.g. PSNT) have not been found to be consistently useful across wide geographic areas. b) A reduction in N rate in accordance with the MRTN approach will not reduce yield (or total net primary productivity), and therefore will not affect the amount of crop residue entering the soil carbon pool. Results from the Morrow Plots (Khan et al. 2007) suggest that irrespective of residue amounts, excess N-fertilizer can accelerate residue decomposition (presumably via C:N change) and thereby impede C sequestration. It may thus be that our protocol will potentially increase C sequestration by reducing excess N fertilization. However, without additional evidence we believe it is premature to make this co-benefit claim and instead adopt the more conservative approach that a reduction in N rate will have no effect on C sequestration. Line 202-206. 'In this protocol, reductions in fertilizer N rate resulting from project implementation will not result in significant (> 5% of the total CO2e benefits from reduction in N2O emissions) decreases in soil C stock. Evidence presented in Annex B shows that this pool can be omitted from the protocol as its exclusion will lead to a conservative estimate of the number of credits generated by the proposed project.'	Yes.	None.
17	22-23	773-841	Ignoring the N added by legume crops does not seem conservative. Shouldn't N credits derived from including a legume crop in a rotation be treated like the synthetic and organic N additions?	Refers to Annex C and the worked examples for establishing baseline N inputs using either farmers' records or county level data. Our protocol requirement is in effect 'rotation agnostic'. The protocol stipulates a requirement for records stretching back at least five years (i.e., monoculture of corn) or more (e.g., six years for three rotations of corn-soybean, or two rotations of corn, soybean, winter wheat). During this pre-project period the producer will have taken account of any 'N credits' provided by leguminous crops in the rotation, and reduced his N application accordingly. In using the yield goal approach for determining N fertilizer rate recommendations, factors for legume N credits will have been included, and management records during the baseline period will reflect this. The records detailing N rate in effect 'integrate' any N credit within the baseline N rate estimation for the farmer, from which subsequent project N rates must be reduced. The N credit is therefore included.	Yes.	None.
18	35	1190-1202	How can we be assured that the timing of soil N2O sampling within the diurnal cycle did not bias results? The sampling appears to have been done in the middle of days. Is there data showing that N2O emission rates do not vary significantly through the diurnal cycle (in the absence of precipitation events)? Is there data showing that precipitation events are evenly distributed through the diurnal cycle?	In the literature, N2O fluxes are typically sampled at consistent and specific times on each sampling day throughout a measurement period, as most static-chamber protocols dictate. This regime was followed by Hoben et al. (2010). Irrespective of rainfall or other time dependant environmental or management variables, we are not aware of any peer reviewed literature that reports consistent diurnal variation in N2O fluxes. Even using high temporal resolution methodologies (4-8 N2O flux measurements per day) we do not see consistent diurnal N2O flux variations at N fertilizer rates typical of the NCR (Millar et al, unpublished data), nor have we seen other automated-chamber studies report consistent diurnal differences for field crops. As discussed in response to Q. 15, inclusion of daily and sub-daily events are inconsistent with our approach. Both Tier 1 and Tier 2 IPCC methodologies are agnostic with respect to time of sampling during the day.	Yes.	We are satisfied that if there are diurnal variations in N2O emissions, the sampling does not bias estimates of cumulative emissions because of any diurnal variation in emissions.

19	37, 39	1271, 1311	Please explain the transformations to get to Eq. G5 from Eq. G3.	This refers to how the variable emissions factor for the region was derived from the non-linear emissions equation. N2OADF, t = 4.46 * exp [0.0062 * (F N, t)] (G3) EFD = 0.0072 * exp [5.2 * (F N, t)] (G5) Equation G3 is taken from Hoben et al. 2010 (Figure 6a – observed flux) Lines 1284-1288: 'Emission factors for the fraction of N2O–N emissions induced by fertilization at each N rate were derived from conservative estimates of the annual flux at each N rate. For late fall and early spring periods, an average representative daily flux across all sites was used to estimate a daily flux rate for this period. For the winter months of December, January, and February, when soils were frozen and fluxes not measured, flux was assumed to be zero.' Equation for calculating conservative annual N2O flux (g ha-1 d-1). = (Daily N2O flux*153)+(1.493*122)+(0*90) Where: Daily N2O flux is the mean daily N2O-N flux over the flux measurement period for each N rate at each site in each study year (g N ha-1 d-1); 153 is the average period for all site years, in number of days that N2O fluxes were measured over the growing season. 1.493 is the average representative daily flux across all sites for late fall and early spring (g N ha-1 d-1). 122 is the number of days represented by the late fall and early spring period (March-April and October-November). 0 is the zero N2O flux assumed for the winter months. See Hoben et al. 2010 for conservative approach to annual fluxes Pg. 27, lines 5-17. 90 is the number of days represented by the winter months December – February. The emission factor for each N rate at each site in each year was then calculated as in equation G4. EF(+N), t = N2OAYE (+N), t - N2OAYE (0N), t / F N, t (G4)	Yes.	The response shows the steps in the transformations. We accept that the spring/fall emission rate of 1.493 g N2O-N/ha-day is sufficiently below the growing season emission rate as to be plausible.
20	38	1279	Please show the underlying data used to generate the relationship, either in spreadsheet form or as points on a scatter plot chart.	Please see Hoben et al. (2010) Figure 5.	Yes.	MSU provided the Hoben 2010 paper as its response to this question. The Hoben paper shows that, across the 8 combinations of fields and years where emissions were measured, at the application rate of 135 kgN/ha-yr, growing season emission rates varied from less than 6 to greater than 30 g N2O-N/ha-day. Also, the paper shows that a the application rate of 180 kgN/ha-yr, growing season emission rates varied from less than 8 to about 55 g N2O-N/ha-day. This seven-fold variation in emissions observed in this study (where variation is limited) indicates that factors other than N application rate have a significant effect on actual N2O emissions. However, we are not aware of any evidence that the proposed methodology will produce biased estimates of N2O emissions because of factors left out of the estimation calculations.
Programmatic Questions						
21		n/a	As required under Section 3.4 of the VCS 2007.1, please discuss the potential negative environmental and socioeconomic impacts of the methodology and if they exist, discuss how they are to be addressed by project developers.	Text from Section 3.4. 'AFOLU projects shall identify potential negative environmental and socio-economic impacts and shall take steps to mitigate them prior to generating Voluntary Carbon Units (VCUs).' We are not aware of any negative social or environmental impacts brought about by a reduction in N fertilizer rate. On the contrary, the reduction of reactive N in the environment can be viewed as a positive development from both environmental and socioeconomic standpoints. For example, reduced nitrogen use will likely improve water quality by reducing nitrate loadings.	Yes.	None.
22		n/a	As required under the applicability conditions of the Tool for AFOLU Methodological Issues, our team could not locate any statement that implementation of the project activities, with or without being registered as an AFOLU project, shall not lead to violation of any applicable law even if the law is not enforced.	Yes, this was omitted by oversight. A statement reflecting this requirement will be inserted in the amended protocol document. Implementation will not lead to violation of any laws of which we are aware.	Yes.	The revisions suggested by MSU were made in the final version of the methodology, satisfactorily addressing the question raised.

23		n/a	As required under VCS 2007.1 Section 6.1, please provide a discussion of implementation barriers potential project developers may face.	Text from Section 6.1. ‘Methodologies shall be informed by a comparative assessment of the project and its alternatives in order to identify the baseline scenario. Such an analysis shall include, at a minimum, a comparative assessment of the implementation barriers and net benefits faced by the project and its alternatives.’ We neglected to include this discussion and propose to correct the oversight with the following: There are a number of barriers that prevent farmers from implementing N-rate reductions now, and that would need to be overcome by project developers. These include the fact that MRTN recommendations are not common practice; they are new and counter to historical recommendations based on yield-goal approaches. Moreover, N fertilizer remains inexpensive relative to the price of corn and wheat, so there is little financial incentive (absent a project based on this protocol) to reduce N fertilizer levels. This situation is not expected to change in the near future because corn prices are now tightly linked to the price of petroleum via the ethanol industry – and since petroleum (natural gas) is used to produce fertilizer, corn and fertilizer prices are likewise linked. Tradition is another factor affecting a producer’s N rate decision. If a producer has been applying a specific N rate for a number of years and has become satisfied with this rate, it is likely they will continue applying that same rate unless they are convinced from results from comparison trials or other research that their N rate may be too high. In other words the producer has developed a high comfort level with his / her traditional N rate even though it may be too high based on the MRTN approach (see Annex E, Babcock references, line 1035-1036). In addition, the fertilizer supplier also has a greater comfort level with applying traditional N rates. These social and economic barriers are significant and must be overcome in order to implement projects based on this protocol.	Yes.	The revisions suggested by MSU were made in the final version of the methodology, satisfactorily addressing the question raised.
24	7	278-287	This methodology creates a new performance standard to be used for assessing a methodology. Does VCS allow methodolgies undergoing the double validation process to establish performance standards?	From our reading and understanding of the currently operational VCS documentation, there is no language that prohibits developers of methodology elements from establishing performance standards for a project. We believe this is a question for the VCSA. We are not creating a new performance standard to assess a methodology, rather we have developed a performance standard to be used as part of the implementation of our methodology, to compare project performance against a baseline.	Yes.	The MSU response to question 5 and ESI's investigation of VCS rules appear to address this question.
25	7	278-287	Assuming the methodology can create a new performance standard, using historical emissions from project lands ("approach 1") to determine additionality would not be consistent with the performance standard (separate from the issue of whether approach 1 might be used to set the baseline). Also, the text states that to be additional the project must "exceed" the performance standard. The text would be clearer if it stated that the project must have lower emissions than the performance standard, and the performance standard is defined as emissions under common practice manangement as determined using the methods described in Annex C.	a) Our protocol aims to create a new Performance Standard for the application of N fertilizer that is not based upon historical N fertilizer rates and N2O emissions per se, but rather from the country / regional wide ‘information system’ based upon crop yield goals that has been in place since the 1970s and that recommends producers to apply N at rates that are now known to be in excess of crop needs. Hence the performance standard can be viewed as a common practice standard that results in systematic over application of N fertilizer. The term ‘common practice’ may be misleading as it also refers to Step 3 in the separate Project Test for additionality. As noted earlier, it might be less ambiguous to replace ‘common practice’ with ‘business as usual’. With regards to baseline establishment using historical N rates (approach 1) - in previously using the yield goal approach as a guideline to applying N fertilizer rates, a producer would in effect have been adopting the performance standard or business as usual approach to N fertilizer application. That same historical data (5+ years of N rate management records) is used to define the baseline N rate and by extension baseline N2O emissions. Therefore the performance standard across the agriculture sector as it relates to N rate management is equivalent to the baseline determination for a project. Please also note that Annex E (particularly lines 1021-1038), justifies this Performance Test approach: Text extracted below. ‘It is common agricultural practice throughout the NCR and the conterminous US in general, for producers to apply rates of fertilizer N based on recommendations derived from yield goal estimates (e.g., Fixen, 2006; Shapiro et al. 2003; Warncke et al. 2004). Recommendations based on yield goal have also been incorporated into Federal technical standards (e.g., USDA–NRCS, 1999). The agricultural extension departments of State universities and State agricultural organizations typically endorse yield goal based fertilizer N rate recommendations, and are the most common source of external information and advice for producers. This network serves as the foundation for producer common practice in the NCR and beyond, and constitutes a sector wide approach for calculating project baseline fertilizer N rates, and by extension, emissions of N2O. Despite concerns regarding yield goal based recommendations (Sawyer et al. 2006) the practice is still widely followed, leading to application of fertilizer N in excess of crop requirements (Table E1 and E2), principally as a result of unrealistic yield goal estimates (e.g., Vanotti and Bundy 1994). Furthermore, a producer’s tendency is to hedge against a perceived insufficient supply of N from the soil or previous N inputs by applying fertilizer N in excess of the recommendations as compensation (e.g., Babcock, 1992; Babcock and Blackmer, 1994). Reductions in N rate below the baseline (common practice) scenario can therefore be implemented, which reduce the amount of excess N in cropland agriculture without reducing crop productivity.’ b) We agree that ‘exceed’ is, in context, a poor choice of words. The suggested wording is better and could be included in a revision (lines 278 -287).	Yes.	The MSU response to question 5 and ESI's investigation of VCS rules appear to address this question.
26		n/a	As required under VCS 2007.1 Section 6.5.2, please discuss risk of reversal (permanence).	From the AFOLU Guidance document: Such ALM emissions reductions projects are not subject to non-permanence risk (or buffer withholding). Based upon our N fertilizer rate reduction approach, avoided emissions of N2O occur immediately and are irreversible and thus permanent.	Yes.	None.
27		n/a	Though the CDM tools and procedures are listed as documents for the basis of the protocol, they are not referenced anywhere else in the document. Please clarify how these were used.	We agree that the CDM tools and procedures are irrelevant in this context and should be removed.	Yes.	The revisions suggested by MSU were made in the final version of the methodology, satisfactorily addressing the question raised.

28		n/a	As stated in lines 146-147 organic soils are considered ineligible. Though appendix F defines what an organic soil is, the protocol does not appear to specify how the soils will be located in the field (i.e. soil survey, soil maps, field sampling, etc.). How would this be verified?	Refer also to Q. 3 and the replacement of FAO definition with US soil taxonomy definition of organic soil (order Histosol). Histosols are rare in agricultural cropland and easy to identify. Agronomically they are used primarily for vegetable production. We could readily refer developers to soil survey maps for their location.	Yes.	None.
29	5	187-188	Within the methodology is states that the crediting period is renewable, however it does not include the requirement within the VCS Guidance for AFOLU Projects that it is only renewable at most 2 times. Please discuss.	From AFOLU Guidance document. 'The project crediting period for ALM projects focusing exclusively on emissions reductions of N2O, CH4 and/or fossil-derived CO2 shall not exceed 10 years, renewable at most two times*. Such ALM emissions reductions projects are not subject to non-permanence risk (or buffer withholding), and therefore shall follow the VCS Program rules governing non-AFOLU projects in terms of an acceptable crediting period (i.e., a maximum of 10 years which may be renewed at most two times.). This omission can be re-instated in the amended protocol	Yes.	The revisions suggested by MSU were made in the final version of the methodology, satisfactorily addressing the question raised.
30	7	249-257	Though the proposed approach 2 for estimating baseline emissions appears consistent with IPCC guidelines, it also appears to be in conflict with the VCS Tool for AFOLU Methodological Issues Step 4. number 13. which states "Minimum baseline estimates for N2O and CH4 emissions shall be based on verifiable management records (e.g., fertilizer purchase records, manure production estimates, livestock data, etc.) averaged over the 5 years prior to project establishment." Is there another provision in the VCS standards and guidelines that provides for performance standard baselines?	Protocol Approach 2, Lines 246-256: 'With Approach 2, the baseline fertilizer N rate is calculated from crop yield data at the county level (available from USDA – NASS) and equations for determining fertilizer N rate recommendations based on yield goal estimates (found in e.g., state department of agriculture and university agricultural extension documents).' We are unaware of provisions in the VCS documentation other than Step 4, note 13, which specifically relate to N2O emissions reductions and performance standard baselines. We believe that our approach for estimating baseline emissions is consistent with VCS guidelines. Both approaches use project-level data for the baseline period. Approach 1 uses field-level management records collected by the farmer. Approach 2 uses county-level management records collected and verified by the USDA's National Agricultural Statistics Service (NASS). More specifically, Approach 2 uses 5 years of county-level yield data that can be used to back-out fertilizer rates based on recommended rates during the baseline period.	Yes.	None.
31	13	595-599	The VCS Guidance for AFOLU Project states that "the leakage risks are **likely** to be negligible because the land **is being** actively maintained for commodity production." However, the methodology states that "the leakage risks associated with project activity **are** negligible as cropland **will have been** actively maintained for commodity production for at least 10 years". As the VCS guidance states that leakage risks are likely to be negligible, and not definitively negligible, please provide further reference/justification for stating that the leakage risks associated with methodology are negligible.	Leakage in relation to ALM project (VCS AFOLU Guidance document Pg 25). 'Leakage potential should be assessed for all project activities using full GHG accounting principles and, where significant, estimated leakage must be deducted from the net CO2 benefits generated by the project. Potential sources of leakage for ALM projects are listed below: As discussed in Millar et al. 2010 (e.g., Section 3 and 5.5) and lines 1062-1069. Reduced N rates and the adoption of N rates based on the Maximum Return to N (MRTN) will not result in average crop yield reductions. Therefore, with no reduction in productivity within the project boundary, there will be no associated requirement for increased production outside of the project boundary, which might then result in increased N fertilizer use and N2O emissions. The leakage potential is therefore negligible. Moreover, although accounting for 'positive leakage' is not eligible, less available N in the soil will result in a reduction in other gaseous and hydrologic N pollutants (e.g., NH3, NOx, and NO3-). Line 1040-1042.	Yes.	None.
32	13	599	To support this conclusion, please describe the logic and add a reference to VCS Guidance for AFOLU Projects.	The VCS Tool for AFOLU Methodological Issues (Step 5, note 18) states that 'Leakage is defined as any increase in greenhouse gas emissions that occurs outside a project's boundary (but within the same country), but is measurable and attributable to the project activities.' See 31 for logic. Reference to VCS AFOLU documentation can be included in the amended protocol.	Yes.	The revisions suggested by MSU were made in the final version of the methodology, satisfactorily addressing the question raised.

33	15	648	Under the monitoring procedures section the methodology outlines the data and parameters to be/not to be monitored, however it does not discuss the length of monitoring required, the frequency, etc. Please discuss.	In all cases the data and parameters monitored (below) are derived from project proponent records, so only desk verification is required. See Monitoring section, Lines 667-675. a) Mass of project synthetic N containing fertilizer applied. b) Mass of project organic N containing fertilizer applied. c) Nitrogen content of project synthetic fertilizer applied. d) Nitrogen content of project organic fertilizer applied. e) Crop yield. f) Area of crop(s) planted.	Yes.	None.
34	20	709	The methodology states that "The growing season is considered to occur from May – September inclusive, unless otherwise verifiable." What would qualify as sufficient evidence to demonstrate that the growing season is "otherwise"?	Growing season is used to determine the likelihood that significant leaching occurs. Planting and harvesting or frost records could be used to demonstrate that the growing season is other than May-September. While May – September is appropriate for corn over most of the corn belt, in southern parts of the U.S. corn can be planted weeks prior to May 1. For winter annual crops such as winter wheat and fall canola, October – July would be a more appropriate growing season.	Yes.	The revisions suggested by MSU were made in the final version of the methodology, satisfactorily addressing the question raised.
35	26	887 Table C2	Though it is not critical to the outcome of the methodology, on table C2 we cannot replicate the production bushels from the harvested acres and the yield bushel acres. Doe this discrepancy possibly result from a difference in rounding?	All data in Table C2 are directly downloaded from the USDA NASS website. This table was replicated on 19 October, 2010 using the same criteria as outlined in Annex C. It is correct that the production (bushel) values for the county are not consistent with the bushel yields (per acre) multiplied by harvested acres for the crop (corn for grain) for the county (Tuscola), as downloaded. For example in 2004: 83,300 harvested acres * 145 bushels per acre = 12,078,500, whereas the downloaded USDA-NASS value is given as 12,050,000. This discrepancy is not a result of rounding by the MSU / EPRI team, rather likely an artifact of 'internal rounding' in USDA NASS database calculations. As observed by the validation team, given that the yield goal value calculated in Annex C is not dependent on the total production value (bushel) from the county - rather it is derived from the average yield (bushes per acre), then this inconsistency is not critical to the outcome of the N rate recommendation value.	Yes.	None.