

*BRINGING GREENHOUSE GAS BENEFITS TO MARKET:
NUTRIENT MANAGEMENT FOR
NITROUS OXIDE REDUCTION*

Prepared by:



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EXECUTIVE SUMMARY

The round of funding that supported Delta Institute's 2011 Conservation Innovation Grant (CIG), *Bringing Greenhouse Gas Benefits to Market: Nutrient Management for Nitrous Oxide Reduction*, was intended to stimulate the development, adoption, and evaluation of innovative approaches to greenhouse gas (GHG) emissions reductions and carbon sequestration on agricultural lands.

The goal of Delta's CIG was to support farmer implementation of nutrient management practices using GHG emission reduction credits, and to support market design and participation. The Delta CIG team proposed the following objectives to support that goal:

1. Research and analyze existing and planned nutrient management protocols to understand implementation requirements.
2. Analyze different nutrient management models with real producer practices and data to understand variability on GHG credit values.
3. Create an efficient system to enroll, manage, and aggregate producers to earn GHG credits for nutrient management and conservation practices.
4. Enroll producers, register projects, coordinate verification and registration, and complete GHG credit transactions.
5. Evaluate different implementation strategies to understand the most effective enrollment structure for producers.
6. Policy analysis and recommendations.

The primary quantifiable accomplishment of this CIG grant is the award of the world's first fertilizer nitrous oxide (N₂O) emission reduction credits to a farmer in Tuscola County, Michigan, the transaction of those credits on the American Carbon Registry (ACR), and the establishment and development of programmatic infrastructure for Delta's Nitrogen Credit Program (NCP). Ancillary and interim milestones and deliverables are described in greater detail below, and some are included as appendices to the full report. The Delta CIG team has successfully met the goals and objectives of this grant, although some of the deliverables, as originally conceived, were not well-suited to the market landscape during the grant period or were found to not meet an existing need.

In June 2014, Delta received a one-year, no-cost extension of this CIG due to unforeseen challenges encountered during Years 1 and 2 of the grant that significantly impacted the project team's ability to execute the activities put forth in the CIG agreement. Specifically, there were delays in market demand and protocol development that project proponents had initially anticipated to occur early on in the grant period.

To date, the primary beneficiary of Delta's CIG is the Michigan farmer who received payment for N₂O credits. However, there is significant credit delivery potential for corn farmers in the North Central Region as well as retailers and crop advisers seeking to expand their services. The economic result of this CIG is the ongoing opportunity for Midwestern corn producers to generate a new revenue stream for delivering

environmental benefits through N fertilizer rate reductions and the infrastructure that now exists to bring credits to market.

The project team expended all grant dollars; however, the ground-breaking nature of this CIG and shifting partnership dynamics made it necessary to reallocate funds across categories over time. Specifically, bringing GHG credits to market and establishing the infrastructure for scaling NCP required more labor hours than the project proponents initially envisioned. In part, this is due to real barriers to enrollment, which are described in more detail below. However, this team's experience suggests that there are also perceived barriers or perceived risks to enrollment in NCP. Federal, State, or local agencies could support implementation by addressing real and perceived risks to shifting nutrient management systems, akin to recent NRCS educational efforts around cover crops.

Delta's experience administering this project, ranging from direct farmer outreach to capacity building of national associations, has led to the following conclusions and recommendations:

1. Incentives for voluntary programs should be simple and have low barriers to entry.
2. Emphasis on environmental and economic benefits should be framed around issues that resonate with producers.
3. Money is necessary, but not always sufficient to meet the needs of producers.
4. The private sector can play a significant role in delivering conservation outcomes throughout the supply chain.

INTRODUCTION

Delta Institute's 2011 Conservation Innovation Grant, *Bringing Greenhouse Gas Benefits to Market: Nutrient Management for Nitrous Oxide Reductions*, was a unique partnership among business, academic, and nonprofit collaborators working to demonstrate and scale the benefits of nutrient management practices using voluntary, market-based incentives for GHG emissions reductions. The proposed scope involved a three-year project based in Illinois, Michigan, and Oklahoma, with the following objectives:

1. Research and analyze existing and planned nutrient management protocols to understand implementation requirements.
2. Analyze different nutrient management models with real producer practices and data to understand variability on GHG credit values.
3. Create an efficient system to enroll, manage, and aggregate producers to earn GHG credits for nutrient management and conservation practices.
4. Enroll producers, register projects, coordinate verification and registration, and complete GHG credit transactions.
5. Evaluate different implementation strategies to understand the most effective enrollment structure for producers.
6. Policy analysis and recommendations.

Over time, certain deliverables, as originally proposed, were reevaluated or reimagined to ensure that the team's resources continued to support these objectives despite being constrained by: limited availability of field-scale management data; commodity prices; developments in the availability or applicability of crediting protocols and methodologies; shifting perceptions of or interest in GHG credit markets; and budgetary constraints. In June 2014, Delta received a no-cost extension of the project through July 2015. As a result of this CIG, Delta is currently operating its Nitrogen Credit Program (NCP), a voluntary initiative that allows farmers to earn and sell N credits in the voluntary marketplace. NCP is currently available to corn farmers in the North Central Region.¹

Partnerships

The outcomes of this CIG result from the efforts of key players whose scope and length of involvement is described below:

Delta Institute - Delta Institute, a Great Lakes focused nonprofit with deep knowledge in carbon markets and ecosystem services, provided overall project direction and management of grant activities, including protocol and model analysis, project verification

¹ Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin

and registration, implementation of enrollment strategies, and reporting to NRCS. 2011-2015.

National Wildlife Federation (NWF)– NWF, a leading environmental nonprofit, provided co-direction of grant activities including convening project partners and consolidation of reporting. 2011-2012.

American Carbon Registry (ACR)– ACR, a nonprofit subsidiary of Winrock International with a mission of creating a high-quality and robust carbon offset market, provided critical matching funds to support registration of an N credit pilot program. In addition, during the project period, ACR worked with other partners and stakeholders to develop v2.0 of the *Methodology for N₂O Emissions Reductions from Changes in Fertilizer Management*, which incorporates feedback from Delta as well as other partners and stakeholders. 2011-2014.

American Farmland Trust (AFT)– AFT, a national nonprofit focused on protecting farmland and improving farm practices, provided consistent support connecting project implementers to producers, producer networks, and conservation and supply chain initiatives in Illinois and Washington, D.C. 2011-2015.

Conservation Technology Information Center (CTIC)– CTIC, a national public-private partnership working towards environmentally beneficial agriculture, supported producer outreach and engagement efforts through its Indian Creek Watershed Project in Illinois. 2011-2014.

DNDC Applications Research and Training, LLC (DNDC-ART)– DNDC-ART, a for-profit business focused on the technical needs of agricultural data and modeling, worked to improve the role of DNDC in voluntary offset protocols. This included routine conference calls, meetings at conferences, and in-person meetings in Chicago. As specific project deliverables shifted due to changes in the policy and market landscapes, DNDC-ART focused on improving model features to enhance simulation of management practices on N dynamics in soils. Specific management practices include utilization of: slow-release fertilizer, nitrification inhibitor, and urease inhibitor. This work underscores the potential for advanced nitrogen management strategies to impact N₂O emissions. 2011-2014.

EKO Asset Management Partners (now doing business as Encourage Capital)– EKO Asset Management Partners, a for-profit investment venture, agreed to purchase any GHG credits generated through project activities. However, The Climate Trust (TCT), a nonprofit based in Portland, OR, presented a longer-term demand-side opportunity and prevailed as the buyer. EKO's services were not utilized. 2011-2014.

Oklahoma Conservation Commission (OCC)– OCC, a state-based public agency, facilitated outreach and engagement of Oklahoma producers and liaised with conservation districts to communicate project goals and opportunities. 2011-2014.

Oklahoma State University (OSU)– OSU, a leading academic institution in the Great Plains, explored the use of nitrogen-rich strips and the GreenSeeker technology to engage and refer Oklahoma producers to OCC. 2011-2014.

Leverage

The Delta CIG team attracted additional investment from stakeholders interested in supporting our innovative approach to this project. Leveraged support is described below.

Coalition on Agricultural Greenhouse Gases (C-AGG)– C-AGG, a partnership of public, private, and academic organizations, received funding from the David and Lucile Packard Foundation to convene GHG-CIG grantees at stakeholder meetings to advance the development of voluntary mitigation efforts throughout the agricultural sector. C-AGG provided support for two grantees from each CIG team to attend tri-annual meetings in March, July, and November, from November 2011 through March 2014. C-AGG generously provided additional support for an additional attendee in March 2014 to enable full team participation, and continued support in July 2014, November 2014, and March 2015.

Electric Power Research Institute (EPRI)– EPRI, the nonprofit research and development arm of the electric utility sector, provided support to Michigan State University to develop the methodology that Delta utilized for quantification and transaction of N credits. EPRI also provided critical support to this CIG by fully funding verification of Delta's 2014 pilot N₂O emission reduction project, in addition to substantial in-kind support for development of the underlying protocol and project plan for the pilot.

Michigan State University (MSU)– MSU, a leading land grant university, co-developed the *Methodology for Quantifying Nitrous Oxide (N₂O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops* with EPRI, which was subsequently adopted by ACR to provide a credit delivery framework. MSU also provided ongoing labor and technical support through participation in the verification process, co-development of the *GHG Plan* submitted to ACR, and provided general support to Delta as needed.

The David and Lucile Packard Foundation – Delta identified a need for an interface between COMET-Farm and DNDC, two of the models analyzed under the scope of inquiry of this CIG. The Packard Foundation funded development of software tools to transform COMET-Farm outputs into DNDC model inputs as a separate project that further advanced the objectives of this grant.

BACKGROUND

Delta's CIG was developed to support on-farm implementation of nutrient management practices that reduce GHG emissions from fertilizer application. Specifically, this project addresses emissions of N₂O from row crop agriculture. N₂O is a powerful GHG with an atmospheric lifetime of over 100 years and a global warming potential roughly 300 times that of carbon dioxide.² While the agricultural sector - including crop and livestock production - accounts for approximately 9% of total US GHG emissions, agricultural soil management accounts for 74% of US N₂O emissions.³ Field trials at MSU have shown that corn farmers can decrease rates of N fertilizer applications while maintaining yields and decreasing emissions.⁴

To date, the environmental impacts of fertilizer have been addressed by various statutes and legislative initiatives at the federal and state levels. Examples of federal regulations include:

- The Food, Conservation, and Energy Act (2008);
- The Military Munitions Rule (1997);
- The Water Quality Amendment Act (1987);
- The Superfund Amendments and Reauthorization Act (SARA) (1986);
- Resource Conservation and Recovery Act (RCRA) Statute - Solid Waste Disposal, Title 42, Chap. 82, Subchapter III - Hazardous Waste Management (1976);
- The Federal Water Pollution Control Act (1972);
- Hazardous Waste Regulation, 40 CFR, Part 503, Standards for the Use or Disposal of Sewage Sludge; and
- The Occupational Safety and Health Administration (OSHA) Hazard Communication Standard (29 CFR 1910.1200).⁵

Additionally, many states have individual fertilizer regulatory programs or additional regulations based on the Association of American Plant Food Control Officials (AAPFCO) model Uniform State Fertilizer Bill.⁶

² United States Environmental Protection Agency. *Overview of Greenhouse Gases: Nitrous Oxide Emissions*. Available at: <http://epa.gov/climatechange/ghgemissions/gases/n2o.html>

³ United States Environmental Protection Agency. *Sources of Greenhouse Gas Emissions: Agriculture Sector Emissions*. Available at: <http://epa.gov/climatechange/ghgemissions/sources/agriculture.html>

⁴ Hoben, J. P., et al. "Nonlinear nitrous oxide (N₂O) response to nitrogen fertilizer in on-farm corn crops of the US Midwest." *Global Change Biology* 17.2 (2011): 1140-1152.

⁵ Millar, N, G.P. Robertson, A. Diamant, R.J. Gehl, P.R. Grace, and J.P. Hoben. 2012. *Methodology for Quantifying Nitrous Oxide (N₂O) Emissions Reductions by Reducing Nitrogen Fertilizer Use on Agricultural Crops*. American Carbon Registry, Winrock International, Little Rock, Arkansas.

⁶ Ibid.

ACR's *Methodology for Quantifying Nitrous Oxide (N₂O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops* aptly describes how the issue of fertilizer use and efficiency is dealt with today and is quoted below:

"Since the 1970s it has been common practice throughout the NCR and the conterminous US in general for producers to apply rates of N fertilizer based on recommendations derived from yield goal estimates [...]. The agricultural departments of land grant universities and state agricultural organizations have typically endorsed yield-goal N fertilizer rate recommendations. These organizations are the most common source of external information and advice for producers, and this network serves as the foundation for producer BAU practice in the NCR and beyond, constituting a sector-wide approach for calculating baseline N fertilizer rates, and by extension, emissions of N₂O.

Despite concerns that yield goal-based recommendations are too liberal [...], the practice is still widely followed, and recommended, leading to application of N fertilizer in excess of crop requirements, principally as a result of unrealistic yield goal estimates [...]. Furthermore, a producer's tendency is to hedge against a perceived insufficient supply of N from the soil or previous N inputs by applying N fertilizer in excess of the recommendations as compensation [...]. Therefore, reductions in N rate below those determined by yield-goal based calculations (i.e., BAU baseline scenario) can be implemented to reduce the amount of excess N in cropland agriculture, thereby decreasing its N₂O burden without reducing crop productivity."

The prospect of earning N credits for enhancing nutrient use efficiency presents a significant opportunity for farmers, their suppliers, and consumers. As a result, GHG emissions from agricultural management have been the subject of increasing attention from conservation and agriculture groups as well as supply chain initiatives - a growing trend since the outset of this project.

The Nitrogen Credit Program provides a framework for farmers to achieve cost-savings on fertilizer input costs while generating an additional revenue stream from N credit transactions. NCP may also present new business opportunities for farm retailers or other service providers to link their existing services with data tracking or quantification of field-scale management practices. These types of services are also of increasing interest to retailers of value-added products looking to reduce the GHG footprint of their supply chains.

In addition to GHG reductions, enhanced nutrient use efficiency can have significant positive impacts on local and regional water quality. By reducing N application rates,

⁷ Ibid.

farmers can effectively prevent nutrient loading to lakes, streams, and rivers, which can adversely impact drinking water, recreational opportunities, or property values. At a larger scale, nutrient loading to the Mississippi River Basin has created a dead zone in the Gulf of Mexico.

REVIEW OF METHODS

Delta's CIG involved a combination of focused research and implementation activities.

Literature Review: The team conducted a review of literature on nutrient management use and potential for improvement. This analysis focused on annual cropping systems, and a range of nutrient management practices associated with conservation agriculture, including: minimal soil disturbance, cover crops, permanent ground cover, and appropriate timing, placement, quantity, and source of nutrients.

Protocol Analysis: The team compared approved, publicly available protocols for quantifying the GHG benefits of nutrient management. A key trade-off in protocol design is between precision and time; more precise measurements require more information and time from farmers, aggregators, and verifiers. Protocols that demand more information of increasing complexity may produce more precise outputs, but at a greater cost. Delta's protocol analyses are included as Appendix A. The summaries have been shared widely with other CIG teams, USDA agency staff, carbon market stakeholders, and other interested parties.

Model Analysis: The team reviewed a variety of N quantification models and tools to maximize a producer's return on time invested. These include the DNDC (DeNitrification-DeComposition) model, USDA's COMET-Farm tool, the MSU-EPRI methodology, Field to Market's Fieldprint Calculator, Adapt-N, and others. An analysis of data inputs for the first three is included as Appendix B. Similar to the protocol analysis, this deliverable was widely shared, and utilized by many stakeholders nationally.

Producer Outreach: The team utilized multiple outreach and enrollment strategies for NCP: 1) direct outreach at producer-focused events; 2) engagement via key outreach partners who are working with networks of farmers; 3) collaboration with industry, associations, and agribusiness contacts to gauge their (and their constituencies) interest; and 4) indirect publicizing of the program via participation in other conservation events. Additionally, Delta created a website - <http://www.deltanitrogen.org/> - to promote NCP and provide an online data sharing portal. The program's tri-fold brochure, overview, and Initial Screening Form are included as Appendix C. The NCP website and outreach materials have also been promoted through Delta's CIG partners, Environmental Defense Fund, as

well as to agronomic service providers in the Saginaw Bay Watershed Conservation Partnership, led by The Nature Conservancy and Michigan Agri-Business Association.⁸

GHG Credit Transaction and Analysis: The team generated the world's first fertilizer reduction N credits, and transacted those credits on the ACR registry.⁹ These credits are based on records detailing the date, rate, and N content for each product applied to the pilot site's corn crop over baseline and project periods, and calculations of N₂O emissions for each. The full GHG Plan and calculations are included as Appendix D.

Discussion of Methods

As described above, NCP is premised on the concept that corn producers can reduce their rates of N fertilizer application to achieve N₂O reductions, while maintaining their crop yields and receiving an offset payment. Delta's CIG is innovative in its development of a scalable infrastructure that enables Midwestern corn farmers to implement nutrient management activities that generate market-grade GHG credits, which in turn can be sold to generate new sources of revenue. Additionally, because commodity and input prices can be volatile, the methodology supports innovation at the farm enterprise-scale by allowing operators to take advantage of arbitrage opportunities to generate credits when their operational constraints permit, and forgo reductions as needed.

Participating farmers receive payments based on their total Emission Reduction Tons (ERTs), which are calculated based on application rate reductions compared to own their field-specific historic baselines. In addition to any credit payments, farmers also save money on their fertilizer costs. The only cost associated with participation is the time it takes to collect and provide field-scale management data, though there are a variety of initiatives throughout the private and not-for-profit sectors to streamline those costs. The MSU-EPRI methodology is designed to optimize nutrient use efficiency and minimize nutrient loss to soil, air, and water.

Participating farmers are required to provide three years of baseline N rate data for corn grown in rotation with other crops. Although Delta's CIG was awarded in 2011, data for the pilot baseline calculations was tracked beginning in 2003. Baseline years for the first credit vintage are 2003, 2007, and 2009, with a project year of 2011.

⁸ Available publicly through The Nature Conservancy's Conservation Gateway at:

<http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/michigan/projects/Pages/Regional-Conservation-Partnership-Program.aspx>

⁹ The public ACR project listing and related documents are available online through the APX platform:

<https://acr2.apx.com/mymodule/reg/TabDocuments.asp?r=111&ad=Prpt&act=update&type=PRO&aProj=pub&tablename=doc&id1=171>

In summer 2013, Delta was presented with an exciting opportunity when The Climate Trust, an Oregon-based leader in carbon markets, released a Request for Proposals for Verified Emission Reduction Projects. This RFP offered presented the Delta CIG team with the opportunity to secure a contracted purchaser for N credits, thereby providing a clear market signal and driver for producer enrollment in an aggregated credit structure for the entire North Central Region. In February 2014, Delta and TCT executed an Emissions Reduction Purchase Agreement (ERPA), and Delta began developing programmatic infrastructure including a website with online data sharing and enrollment capabilities. The program's underlying methodology and data collection guidance was based on EPRI's whitepaper, *Developing Greenhouse Gas Emissions Offsets by Reducing Nitrous Oxide (N₂O) Emissions in Agricultural Crop Production: Experience in Validating a New GHG Offset Protocol*.¹⁰

Based on Delta's credit aggregation experience in the Chicago Climate Exchange offset program and additional stakeholder feedback, the team created the following flowchart for the enrollment process:

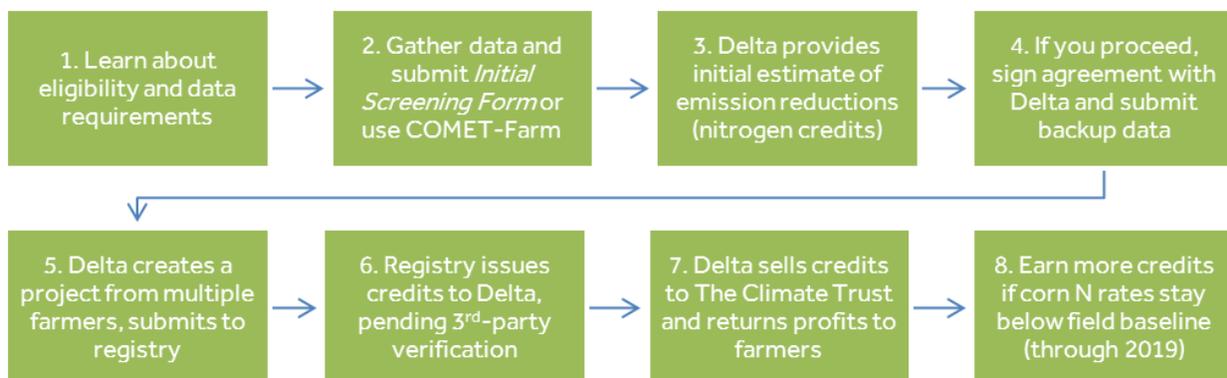


Figure 1: Nitrogen Credit Program Enrollment Process

Delta made a one-page Initial Screening Form available to potential participants in print (see Appendix C) and as a Google Form that 7 independent growers submitted for review and many others accessed, but none made it beyond the third estimation step in Figure 1 above. The team also developed a custom walkthrough of COMET-Farm for the NCP website and presented it to several commodity groups and agronomic service providers.

To date, both engagement with and participation in NCP have been limited for reasons that are described in more detail below. However, several circumstantial barriers also impacted the team's ability to advance project objectives or produce deliverables as originally

¹⁰ Electric Power Research Institute: Developing Greenhouse Gas Emissions Offsets by Reducing Nitrous Oxide (N₂O) Emissions in Agricultural Crop Production: Experience in Validating a New GHG Offset Protocol. <http://eea.epri.com/pdf/highlights/00000000001023669.pdf>

envisioned. For example, the California Air Resources Board, which administers the nation's only compliance-driven offsets program, has not developed a fertilizer N₂O protocol, which the Delta team initially anticipated by 2013, and which prolonged the absence of market demand for compliance-based credits. Additionally, the Midwest drought of 2012 impacted NCP programmatic development in two significant ways: first, it created extreme risk-aversion among farmers as it negatively impacted crop yields; and secondly, the lack of supply from the drought year increased commodity values the following year, causing reluctance to reduce N rates while prices were high. From fall 2013 through spring 2015, commodity prices subsided, while input costs continued to rise.

Though Delta's outreach partners suggested that an extended period of lower commodity prices would lead to increased interest in NCP by farmers, the project team did not see a significant response beyond the first few months following the NCP launch in February 2014. Later in 2014, Delta joined two large-scale water quality partnerships—the EPRI Ohio River Basin Trading Project and the Saginaw Bay Watershed Conservation Partnership—that directly reference and promote NCP. In 2015 and moving forward, Delta will provide substantial in-kind technical and programmatic support to these USDA-funded projects.

DISCUSSION OF QUALITY ASSURANCE

The Delta CIG team and its partners implemented robust quality assurance practices and submitted a pilot project under NCP for validation and verification by Environmental Services, Inc. (ESI), an ACR-approved verifier. Detailed information regarding site description, data records and collection procedures, quantification, and analytical procedures are included in Appendix D. A Verification Report is included as Appendix E.

While the data and emission quantifications were closely scrutinized by ESI verifiers, no sampling was required at the project site location, because the emissions avoided from N fertilizer rate reductions are permanent and irreversible. The data farmers provide to Delta is proprietary to them, which means that Delta will not share that data except for the purpose of credit delivery and with entities involved in that process. Additionally, with regard to data storage, Delta adheres to the QA/QC procedures as outlined in ISO 14064-2:2006 Section A3.6 "Managing Data Quality." These include: establishing and maintaining a complete GHG information system; regular accuracy checks for technical errors; periodic internal audits and technical review; appropriate training for team members; and uncertainty assessments. Project data is securely stored on a file server requiring user authentication; the server is copied to cloud-based storage for disaster recovery purposes. Delta's QA/QC procedures were also informed by the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (2003).

Despite the quality of data provided and controls implemented to ensure accuracy, limits remain on the extent to which models and calculations truly represent nutrient fluxes in dynamic biological systems. Under the MSU-EPRI methodology used for quantification, a regionally derived North Central Region emission factor is used in calculations of direct emissions of N₂O for baseline and project scenarios. So while N fertilizer rate is the best single predictor of N₂O emissions in row crop agriculture in the Midwest and provides the basis for a transparent and scientifically robust protocol,¹¹ N remains highly reactive, mobile, and hard to contain; its fate and transport are impacted by localized conditions, including soil type, temperature, and moisture. The Delta project team continues to explore a variety of other models and tools for N management under the scope of this CIG project. However, while the team developed familiarity with several such models and tools, they are beyond the purview of this report due to their limited applicability in generating GHG credits.

FINDINGS

The learnings from this CIG grant can be summarized as follows:

1. Reductions of N fertilizer rate can reduce N₂O emissions while maintaining yields. The practical experience of the Delta CIG team, through establishment of NCP, applied MSU's research on N rate reduction, and it demonstrates the validity of the MSU-EPRI protocol as a mechanism for reducing N₂O emissions and generating revenue for participating farmers.
2. Apart from rate reduction on corn in the North Central Region, project developers do not have a clear pathway to develop projects around "4R" N management practices. The updated ACR methodology for using the DNDC model provides an important starting point for prospective project developers, but there does not appear to be sufficient scientific consensus around any other crops, practices, or regions for the proponent to undertake the associated risks.
3. There remains a lack of a driver for "4R" N management activities. Over the course of this grant, the Delta CIG team explored a variety of opportunities to align NCP with existing or emerging conservation initiatives. However, these attempts were not successful for a variety of reasons, including unaligned timeframes and partners more focused on research than implementation.
4. The price signal is weak. Delta is prohibited from disclosing the price of N₂O per emission reduction ton under the terms of its ERPA with TCT. However, despite being a highly competitive price, Delta's experience to date suggests it is insufficient to incentivize behavior change on a significant scale. For example,

¹¹ Millar, Neville, et al. "Nitrogen fertilizer management for nitrous oxide (N₂O) mitigation in intensive corn (Maize) production: an emissions reduction protocol for US Midwest agriculture." *Mitigation and Adaptation Strategies for Global Change* 15.2 (2010): 185-204.

when the credit value is translated on a per-acre basis, its benefits are far surpassed by cost-savings on fertilizer inputs.

5. *There are significant barriers to entry in the marketplace.* Despite the comparative ease of using the MSU-EPRI methodology to DNDC, bringing credits to the marketplace remains a complex and costly undertaking, owing primarily to the validation-verification process. For example, according to internal estimates, the Delta project team would have to enroll tens of thousands of acres just to cover the verification costs of an aggregated project before any revenue can be returned to participating farmers.
6. *Federal cost-share programs, such as EQIP and CSP - as currently structured - do not serve as an on-ramp for producers to participate in environmental markets.* During the special EQIP GHG round in FY14, the team's ability to enroll producers was significantly impacted by limited USDA state and county office capacity and restrictive data access policies created by the 2008 Farm Bill.
7. *Market signals have not demonstrated effectiveness at delivery of conservation outcomes.* Until some of the structural issues are addressed, market mechanisms are unlikely to deliver conservation outcomes based singularly on the value of credits in the marketplace. However, the analytical rigor and discipline involved in credit generation provides a framework for quantifying the impacts of conservation practices incentivized by non-market values.

CONCLUSIONS AND RECOMMENDATIONS

Delta's experience with its 2011 CIG award, *Bringing Greenhouse Gas Benefits to Market: Nutrient Management for Nitrous Oxide Reduction*, has led the project team to the following conclusions:

Incentives for voluntary programs should be simple, and have low barriers for attaining incentives. Much of the front-end work on this project emphasized the importance of utilizing protocols and models that generate market-grade credits while overcoming barriers to participation, specifically the investment of time required by participants. While NCP is a streamlined credit generation opportunity, the barriers to entry to the marketplace are high enough that they preclude the value of N credits before it reaches producers.

Emphasis on environmental and economic benefits should be framed around issues that resonate with producers. This project was conceived and implemented at a moment in time when GHG credits presented a viable, market-based alternative to a command-and-control climate policy. That moment appears to have passed, and with it the specter of a comprehensive climate policy. Presently, the appeal of GHG credits is somewhat diminished. However, throughout much of the North Central Region, water quality is a salient, observable issue impacting the daily lives of farmers and non-farmers alike.

Examples include a lawsuit brought recently by the Des Moines Waterworks against three county boards of supervisors for alleged violations of the Safe Drinking Water Act resulting from agricultural runoff, or the toxic algal bloom that left nearly half a million residents of the Toledo, Ohio area without access to drinking water in August 2014. High-profile events may indicate real or perceived risk that can be addressed through incentive program design, similar to NCP, as supported by NRCS and broad-based partnership.

Money is necessary, but not always sufficient to meet the needs of producers: A back-of-the-envelope calculation would suggest that NCP may be a very attractive program for producers who have not optimized N management practices. A modest credit value, combined with more significant cost-savings from fertilizer input costs, creates a clear financial incentive. However, the Delta team's experience suggests that participation would be more robust if the data required for quantification existed in a readily accessible format. This suggests there is an important role for agronomic service providers or other private sector consultants interested in automating data collection or exploring credit delivery as an additional service.

The private sector can play a significant role in delivering conservation outcomes throughout the supply chain: The private sector is becoming increasingly involved in agricultural GHG reductions, but opportunities remain to increase involvement. From data management services to prescriptive management practices for value-added producers, opportunities exist at every level of the supply chain to incentivize good stewardship of soil, air, and water.

Next Steps and Ongoing Work

The Delta Institute continues to run the Nitrogen Credit Program and maintain the website (<http://www.deltanitrogen.org>) to promote the reduction of nitrous oxide emissions by managing fertilizer application on corn. As the science and quantification tools allow, additional crops and practices will be considered where they can be used in the U.S. and particularly within the North Central Region. Additionally, Delta continues to work with its partners to incorporate the NCP framework into pilot programs and supply chain initiatives led by American Farmland Trust, Electric Power Research Institute, The Nature Conservancy, Environmental Defense Fund, and other national organizations.

In addition to expanding our reach through the partnerships above, Delta intends to stay involved in the Coalition on Agricultural Greenhouse Gases to apply our learnings from this grant to emerging policy opportunities and broad-based conservation initiatives, such as the USDA Building Blocks for Climate Smart Agriculture and Forestry. To that end, Delta is currently exploring opportunities to generate additional GHG reductions and performance-based incentives for farmers by leveraging the growing interest in water quality credit trading and impact investing.

APPENDICES

A: GHG Credit Protocol Analyses

B: MSU-EPRI Method, COMET-Farm, and DNDC Model Input Analysis

C: Nitrogen Credit Program Outreach Materials

D: ACR Project GHG Plan

E: ACR Project Validation and Verification Report

American Carbon Registry (ACR) - *Methodology for N₂O Emission Reductions through Changes in Fertilizer Management*

Version 2.0 (published January 2014), originally adopted November 2010

Project Eligibility Requirements

Cropping Systems and Geographic Location – The DeNitrification-DeComposition (DNDC) model is designed to quantify greenhouse gas (GHG) emission reductions resulting from changes in fertilizer management. It is broadly applicable across cropping systems and geographies.

DNDC may be used to predict crop growth, soil temperature and moisture, soil carbon dynamics, nitrogen leaching, and emissions of gases including nitrous oxide (N₂O), nitric oxide (NO), dinitrogen (N₂), ammonia (NH₃), methane (CH₄), and carbon dioxide (CO₂). Eligible projects will use the latest version of the model. DNDC may not be used where cultivation occurs on histosols.

Proponents must propose Project Activities in valid Reference Regions, or geographic areas in which “broad climatic and soil conditions are relatively homogenous,” and justify this to validation/verification bodies. Proposed Reference Regions must be recognized by the “USDA, extension service specialists, or agricultural commissioners.”

This methodology is only applicable to those crops, management systems and Land Resource Regions (http://www.soilinfo.psu.edu/soil_lrr/) where the DNDC model has been sufficiently independently validated to statistically quantify model structural uncertainty.

Management Practices – This methodology is applicable to projects that involve a change in fertilizer rate, type, placement, timing, use of time-released fertilizers, use of nitrification inhibitors, and other technologies and/or practices. These changes must be implemented for one year or longer.

Conditions – Projects must incorporate a minimum of five fields, and must not lead to significant decrease in crop yields (>5%) as a result of implementation. Fertilizer increases on any owned or managed lands that are not part of the project are prohibited. This methodology is only applicable to crops, management systems, and regions where the model has been sufficiently validated to statistically quantify model structural uncertainty. Fertilizer must not be increased on all crops under same ownership/management that are not part of the project.

Start Date and Crediting Period – Project activities must be implemented for one year or longer. For agricultural projects, ACR generally defines the start date as the date project activity began on project lands. For projects with start dates that precede submission of a GHG project plan, project proponents must provide evidence that: 1) the start date is after November 1, 1997; and 2) if using Baseline Approach 2 (described below), that the sale of Emission Reduction Tons provided a financial incentive to proceed with project activity (as determined by documentation available to third parties at the time of or prior to the start date of project activity, including official, legal, and/or other corporate documents).

Data Needs

Producers must have records of applications rates and yields for at least five years prior to start of project. DNDC model inputs require the location of crop fields, crops grown, local climate data, and soils and agricultural management practices. Project proponents must describe legal title to the land, and right of access to avoided emissions, and that during the project lifetime, each discrete are of land is expected to be subject to a change in fertilizer management through activities under control of project participants.

See table at the end of the document describing which data inputs are modeled, measured, look-ups, or defaults.

Establishing Baseline Scenario – Baseline scenario will be determined by historical emissions, or common practice, using one of three approaches:

- Approach 1: Projects that reduce application rate, without changing any other aspect of fertilizer management (e.g. implementing variable rate technology, changing timing/placement/source), must use a Field Specific Historical Baseline.
- Approach 2: projects that go beyond application rate, and where the Project Activity has an adoption rate of 5% or less within the Reference Region, must use a Common Practice Baseline.
- Approach 3: projects that go beyond application rate, and where the Project Activity has an adoption rate greater than 5% in the Reference Region must use a Field Specific Historical Baseline.

Current adoption rates will be determined using survey data or expert opinion. Project Proponents relying on expert opinion must obtain assessments by three independent experts with at least ten years of experience in agronomy, and who are associated with an academic institution, government institution, or is a certified crop advisor with experience in the Reference Region.

Alternatively, Project Proponents may access relevant survey data through the USDA Economic Research Service Agricultural Resource Management Survey (ARMS).¹ To view survey data, go to the homepage and select “Tailored Reports.” For the ‘Survey’ field, select ‘Crop production practices.’

- For **adoption rate** data: for the ‘Subject’ field, select your crop (e.g. corn/soybeans/wheat). For the ‘Report’ field, select ‘Nutrient Use and Management,’ and filter by state.
- For **N inhibitor** data: For the ‘Report’ field, select ‘Nutrient Use and Management,’ and filter by state.
- For **N incorporation** data: For the ‘Report’ field, select ‘Nutrient Use by Application Method,’ and filter by state.
- For **spring application** data (before/during/after planting): For the ‘Report’ field, select ‘Nutrient Use by Application Timing,’ and filter by state.
- For **variable rate** data: For the ‘Report’ field, select ‘Precision Agriculture Report,’ and filter by state.

For Project Proponents that claim the implementation of the project activity is more than one year before the submission of a GHG Project Plan, proponents must provide evidence that the incentive from the sale of ERTs was considered to the decision to proceed with the Project, preferably as shown by official/legal, and/or other corporate documentation available to third parties at or prior to the start of the Project Activity.

Under Approaches 1 and 3 Project proponents must identify realistic agricultural land use scenarios that would have occurred within the proposed project boundary in the absence of project activity, accounting for national and/or sectoral policies and circumstances such as historical practices and economic trends. If Project Activity adoption rate is greater than 5%, possible land use scenarios must include:

- Continuation of pre-Project historical baseline
- Fertilizer management as modeled under the Project but in the absence of registration as a Project Activity
- Adoption of precision agriculture
- Shift to crops with lower fertilizer use

Sources for identifying management scenarios may include field surveys, data and feedback from stakeholders, and information from other appropriate sources.

Each of the baseline scenarios will be subject to the following tests:

¹ <http://www.ers.usda.gov/data-products/arms-farm-financial-and-crop-production-practices.aspx>

1. Investment analysis to determine that the Project Activity neither a) the most economically or financially attractive, nor b) economically or financially feasible;
2. Barriers Analysis; and
3. Common practice analysis.

Each scenario that does not meet at least one of these three tests will be excluded.

Calculating Emissions – The DNDC model is a computer simulation of carbon and nitrogen biogeochemistry in agro-ecosystems that was developed at the University of New Hampshire. Under this protocol, it is used to calculate and model emissions from fertilizer management practices. The model must be parameterized for specific project conditions. More information, including links to the latest software and user guide, can be accessed here: <http://www.dndc.sr.unh.edu/>.

Additionality

Projects using Approach 1 or 3 will test additionality of the project using ACR's three-pronged additionality test. This requires project proponents to demonstrate that they exceed: current laws and regulations; common practice in the agricultural sector; and that projects face either financial, technological, or institutional barriers to implementation. (Note this alternative test of additionality to the performance standard test used in ACR's corn methodology.)

If a project is not excluded through a financial analysis or demonstration of barriers, then it is considered non-additional. Proponents are recommended to show additionality through an additionality tool, such as the [CDM Tool for the Demonstration and Assessment of Additionality](#).

Aggregation

Aggregation is permitted under the DNDC protocol, which treats aggregated areas of a single project area. Over the project lifetime, each discrete area of land should be subject to a change in fertilizer management through activities under the control of project participants.

Verification

Per ACR requirements, credits may be issued annually or at other intervals based on project proponent request. Proponents must undergo verification at each request for issuance for ERTs, and must submit to a full audit at least once every five years.

Exclusionary Criteria

- Producers with fewer than five years of fertilizer and yield history
- Producers unable to incorporate at least five fields
- Projects that involve drainage or flooding of wetlands

Table of Required Inputs for the DNDC Model (adapted from pp. 18-19)

Input Category	Code	Input	Units	Project records	Measured	Look-up	Default
Location	L1	GPS location of stratum	decimal °			X	
Climate	C1	Atmospheric NH ₃ concentration	µg N/m ³				X
	C2	Atmospheric CO ₂ concentration	ppm				X
	C3	N concentration in rainfall	mg N/l or ppm			X	
	C4	Daily meteorology	multiple		X	X	
Soils**	S1	Land-use type	type	X			
	S2	Clay content	0-1		X	X	
	S3	Bulk density	g/cm ³		X	X	
	S4	Soil pH	value		X	X	
	S5	SOC at surface soil	kg C/kg		X	X	
	S6	Soil texture	type		X	X	
	S7	Slope	%		X		
	S8	Depth of water retention layer	cm		X	X	
	S9	High groundwater table	cm		X	X	
	S10	Field capacity	0-1		X		X
	S11	Wilting point	0-1		X		X
Cropping system	CR1	Crop type	type	X			
	CR2	Planting date	date	X			
	CR3	Harvest date	date	X			
	CR4	C/N ratio of the grain	ratio		X	X	
	CR5	C/N ratio of the leaf + stem tissue	ratio		X	X	
	CR6	C/N ratio of the root tissue	ratio		X	X	
	CR7	Fraction of leaves + stems left in field after harvest	0-1		X		
	CR8	Maximum yield	kg dry matter/ha	X			
Tillage system	T1	Number of tillage events	number	X			
	T2	Date of tillage events	date	X			
	T3	Depth of tillage event	6 depths†	X			
N fertilizer	F1	Number of fertilizer applications	number	X			
	F2	Date of each fertilizer application	date	X			
	F3	Application method and depth	surface/injection, cm	X			
	F4	Type of fertilizer	type*	X			
	F5	Fertilizer application rate	lb N/acre	X			
	F6	Time-release fertilizer	# days for full release	X			
	F7	Nitrification and/or urease inhibitors	efficiency (0-1), # days duration	X			
Organic fertilizer	O1	Number of organic applications	number per year	X			
	O2	Date of application	date	X			
	O3	Type of organic amendment	type	X			
	O4	Application rate	lb C/ac	X			
	O5	Amendment C/N ratio	ratio		X		
Irrigation system	I1	Number of irrigation events	number	X			
	I2	Date of irrigation	date	X			
	I3	Irrigation type	3 types‡	X			
	I4	Irrigation application rate	mm	X			

† Tillage: Mulching (0 cm), plowing slightly (5), plowing with disk/chisel (10), moldboard (20), deep (30), litter-burying (50)

* Fertilizers: Urea, anhydrous ammonia, ammonium nitrate, nitrate, ammonium bicarbonate, ammonium sulfate, ammonium phosphate

‡ Irrigation: Flood, sprinkler or surface drip tape

** Soil parameters for DNDC are for the properties of the top layer of the soil profile.

American Carbon Registry (ACR) - Methodology for Quantifying Nitrous Oxide (N₂O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops

Version 1.0, adopted July 2012

Project Eligibility Requirements

Project Categories – Projects are eligible in all countries, and are divided into 3 categories. Projects in the U.S. are eligible in all categories; Projects outside the U.S. are eligible in Categories 2 and 3 only, both of which require expert review of the submitted data:

- Category 1: Projects located in the North Central Region of the U.S., or NCR (IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, and WI), that involve corn in row-crop corn rotations will use equations based on a regionally derived, IPCC Tier 2 emissions factor. These equations, referred to below as Method 1, are used to calculate both baseline and project emissions.
- Category 2: Non-corn projects in the NCR or any projects outside the NCR may use the default IPCC Tier 1 emission factor, which currently assumes that 1% of nitrogen (N) applied is released as N₂O, for calculating emissions at the project site(s). The equations used to calculate project-specific emission factors are referred to as Method 2. Proponents must be able to demonstrate that the Tier 1 emissions factor is conservative for calculating emissions for the project site(s).
- Category 3: Non-corn projects in the NCR or any projects outside the NCR may use project-specific calculations provided that proponents can demonstrate that the use of a new Tier 2 emissions factor is conservative for the project site(s). Category 2 projects may be reassigned based on available data.

Start Date and Crediting Period – The project calculations cover a period of time covering 12 months from the first application of N fertilizer to a particular crop. Activities that lead to a reduction in the rate of N fertilizer may be implemented for one year or longer, and may generate emission reductions against the baseline scenario for 7 years. Projects that maintain compliance with ACR standards may be renewed.

Cropping Systems – Eligible crops include corn in row-crop systems (e.g. continuous corn and rotations of corn-soybean or corn-soybean-wheat), though only the corn component of a rotation is eligible. Crops must have been cultivated for at least 5 years (e.g. equivalent to 5 annual cropping seasons) prior to the project start date. All soil types are eligible with the exception of histosols, such as peat or organic soils.

Management Practices – This protocol addresses synthetic and organic nitrogen inputs to soil during the project crediting period, which are compared to a baseline using the same crop types on the same land area. Fertilizer application to a single crop during a single growing season is eligible for determination of annual application rate, regardless of when it is applied during the calendar year, or whether it is split between calendar years for the same crop.

Conditions – During crediting period, project proponents must adhere to BMPs for dates, rates, and methods of nitrogen fertilizer application. BMPs are available from state agricultural agencies, federal agencies, or as described in the Global 4R Framework (Right Source-Rate-Time-Place).

Data Needs

Establishing Baseline Scenario – Baseline N₂O emissions are calculated using one of two approaches:

- Approach 1 (default): Requires management records for years 5-6 year prior to project implementation, such as fertilizer purchase and application rate records, as well as manure application rate and manure nitrogen content data. Five years are required for monoculture, or 6 years for crop rotations (3 cycles of two crop rotation, or 2 cycles of 3 crop rotation). Baseline emissions are based on the average previous application rate to the same crop and land parcel as the project.

- Approach 2: If Approach 1 is not viable, baseline emissions may be calculated from county-level crop yield data from USDA-NASS, and equations for determining N rate recommendations based on yield goal estimates found in state departments of agriculture and agricultural extension documents. Approach 2 is not applicable to the rate of baseline organic fertilizer, which is assigned a default rate of 0.

Calculating Emissions – Baseline and project activity emissions, both direct and indirect, are calculated using a series of equations applicable to Method 1 or 2.

Additionality

For projects to be considered additional, they must pass a dual component performance test:

- Regulatory Surplus Test: Project developers must pass this test in the absence of any federal, state, or local legal mandate, or other regulatory framework, requiring producers to reduce N fertilizer input rates below the business-as-usual or common-practice scenario.
- Performance Standard Test (PST): project developers pass this test by exceeding a performance threshold that represents business-as-usual.

Aggregation

Under the ACR's *Forest Carbon Project Standard Guidelines for Aggregated Projects*, aggregated projects share features and targets including inventories and project baselines. Monitoring and verification are conducted at the aggregate level, whether they are comprised of a single large landholding or distributed project parcels, and there is no minimum number of monitoring plots per participating landholding as long as aggregated targets are achieved. Similarly, the issue of permanence is considered for the aggregate, and requires project aggregators to correct for any reversal, which reduces risk to participating landowners¹.

Verification

Verification must be conducted for each reporting year prior to the issuance of credits (emission reduction tons, or ERTs). Each year, the proponent must submit an attestation that: confirms project activities; confirms ownership is uncontested; discloses negative or community impacts and plans to remediate those impacts; and addresses significant changes in external conditions that would affect the quality or integrity of the project. At each request for ERTs, project proponents must, at a minimum, submit statements from approved verifiers based on a desk audit. To comply with ACR requirements, proponents must submit statements from verifiers based on full verification (e.g. site visit) at least every five years.

¹ Weisberg et al. *Benefits, existing methods and key challenges to aggregating greenhouse gas emissions: Background paper for the EPRI greenhouse gas emissions offset policy dialogue workshop #12*. Electric Power Research Institute. March 2012.

Climate Action Reserve (CAR)- Nitrogen Management Project Protocol (NMPP)

Version 1.1 (published January 2013), originally adopted June 2012

Project Eligibility Requirements

Cropping Systems – Eligible crops include crops or corn component of crop rotations. Five eligible crop years may occur over a period of up to ten years. All soil types are eligible with the exception of histosols. Both tile-drained and non-tile drained fields are eligible.

Geographic Location – Projects must be located in the North Central Region of the U.S. (IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, and WI), in counties where annual precipitation is between 600 and 1200 mm.

Management Practices – The NMPP addresses synthetic and organic nitrogen inputs to the soil during a complete cultivation cycle, generally defined as the period beginning immediately after the harvest of one primary crop and ending after the next primary planted crop is harvested the following calendar year. May be further defined as 365 days.

Conditions – During the project period, total application of synthetic N must decrease below baseline levels.

Start Date and Crediting Period – Eligible crops do not need to be consecutive, but project reporting must be continuous. Multi-year rotations that alternate between eligible and non-eligible crops must report data for all time periods, including ineligible crop years to maintain continuous reporting throughout the crediting period. Projects are eligible after June 27, 2010.

Data Needs

Establishing Baseline Scenario – The baseline is calculated after establishing a look-back period, defined as all eligible crop years occurring over the 5 year period prior to a project start date. If less than 3 eligible crop years were planted in 5 year period prior to start date, the look-back period will be extended until at least 3 eligible crop years are included. The baseline must be calculated for each crop year in the look-back period, and then averaged to ensure project meets applicability conditions.

For both eligible and ineligible crop years project developers must provide: planting date; begin and end date of harvesting; and date(s) when emergency irrigation is used. In addition, for eligible crop years project developers must provide: crop yield; fertilizer types, rates, and application dates, disaggregated by type for organic and synthetic, including purchase records and information on N concentration; field monitoring parameters resulting from Corn Stalk Nitrate Test; fertilizer application and placement; and type of equipment used for application. Additional data is required if irrigation is used for eligible years, including a justification of why it was necessary, type of system used, dates, and volumes.

Calculating Emissions – CAR's calculations rely on categories of greenhouse gas sources, sinks, and reservoirs (SSRs), detailed in the protocol. Total emissions reductions are equal to combined total emissions from SSR 1 (soil dynamics) and SSR 2 (leaching, volatilization, and runoff, or LVRO), minus the increase in emissions from all other SSRs resulting from project activity.

Baseline and project direct emissions from soils are calculated based on average baseline application rate and the MSU-EPRI Tier 2 emissions factor (SSR 1). Baseline and project emissions from LVRO (SSR 2) are calculated using IPCC Tier 1 emissions factors. Projects may result in unintended increases in

emissions in other SSRs, such as cultivation equipment or leakage, so project proponents must consider how that may affect crediting.

Additionality

For projects to be considered additional, they must pass a dual component performance test:

- Performance Standard Test: Project developers must show that their rate of Removed-to-Available (RtA) exceeds the state average. RtA is a general measure of N use efficiency, which occurs after completion of reporting period.
- Legal Requirement Test: Project developers must show there are no legally binding mandates that require adoption or use of nitrogen management activities, and that rates are reduced beyond what would have occurred in the absence of the project.

Aggregation

Under the NMPP, project developers may aggregate fields located on one farm or disturbed among different farms and producers. Fields may be added to or removed from existing aggregates. Aggregates are subject to Aggregate Monitoring Plans for verifiers to confirm that tracking requirements are met.

Verification

It is the responsibility of the project developer to coordinate verification for a single project or aggregate for each reporting period. Projects must report annually, and undergo verification for each eligible crop year. For single field projects, the requirements for conducting site verification and desktop verification are the same, though a verifier may elect to visit any site at its discretion. Projects have three verification options to allow for flexibility. Aggregates are sub-divided into “small aggregates,” “large single-participant aggregates,” and “large multi-participant aggregates,” and in all cases verifiers rely on a combination of risk-based and random sampling.

Exclusionary Criteria

- Any project which does not result in a reduction in the rate of synthetic N fertilizer applied
- Projects located on highly erodible lands (HEL) or wetlands
- Sites that cannot provide five years of history for eligible crops
- Project fields receiving NRCS payments for conservation practice 590 *if* the NRCS contract was signed prior to project start date. (Fields may receive payment for conservation practice 590 if the project is submitted to CAR concurrent to pursuing NRCS payment.)

Verified Carbon Standard (VCS) - *Quantifying N₂O Emissions Reductions in Agricultural Crops through Nitrogen Fertilizer Rate Reduction* (VM0022)

Version 1.1 (published September 2013), originally adopted March 2013

Project Eligibility Requirements

Cropping Systems – Eligible crops include corn-row crop systems including continuous corn, and rotations that include a corn component, in particular corn-soybean. Eligible crops must have been cultivated on the project site for at least ten years prior to implementation. All soil types eligible with the exception of histosols.

Geographic Location – Projects must be located in the U.S. and will use one of two calculation methods depending on location.

- Method 1 (Tier 1) projects may be located in contiguous U.S., AK and HI.
- Method 2 (Tier 2) projects may be located in the North Central Region of the U.S. (IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, and WI).

Management Practices – The VCS protocol addresses synthetic and organic nitrogen inputs to the soil during the whole crop cycle, even if split between calendar years for a single crop.

Conditions – During crediting period, project proponents must adhere to BMPs as described by state agricultural agencies, federal agencies, or as described in [Global 4R Framework](#) (Right Source-Rate-Time-Place)

Start Date and Crediting Period – The project calculations cover a 12 month period following the first application of N fertilizer to a particular crop. For Agricultural Land Management (ALM) projects focusing exclusively on emissions reductions of N₂O, CH₄ and/or fossil-derived CO₂, the VCS Program allows a maximum Project Crediting Period of ten years, with the possibility to renew two times.¹

Data Needs

Establishing Baseline Scenario – Baseline emissions can be calculated in one of two ways:

- Approach 1 (default): Uses management records for 5-6 years prior to project implementation to calculate baseline N₂O emissions, such as fertilizer purchase and application rate records, as well as manure application rate and manure N content data. Five years required for monoculture, or 6 years for crop rotations (3 cycles of two crop rotation, or 2 cycles of 3 crop rotation). Baseline emissions will be based on average of previous application rate for specific crop(s).
- Approach 2: If Approach 1 is not viable, baseline emissions may be calculated from county-level crop yield data from USDA NASS, and equations for determining N rate recommendations based on yield goal estimates found in state departments of agriculture and agricultural extension documents.

Calculating Emissions – Baseline and project activity emissions, both direct and indirect, are calculated using a series of equations applicable to Method 1 or Method 2. Method 2 uses a regionally derived NCR emission factor in calculations of direct emissions for baseline and project emissions.

¹ VCS Standard v3.4. [http://www.v-c-s.org/sites/v-c-s.org/files/VCS Standard, v3.4.pdf](http://www.v-c-s.org/sites/v-c-s.org/files/VCS%20Standard,%20v3.4.pdf).

Additionality

For projects to be considered additional, they must pass a dual component performance test:

- Regulatory Surplus Test: Project developers pass this test in the absence of any federal, state, or local legal mandate, or other regulatory framework, requiring producers to reduce N fertilizer input rates below the business-as-usual or common-practice scenario.
- Performance Standard Test (PST): project developers pass this test by exceeding a performance threshold that represents business-as-usual.

Aggregation

Under the VCS protocol, projects expanded after validation are referred to as grouped projects. Proponents of group projects provide descriptions of the project area, baseline scenario, demonstrations of additionality, eligibility criteria, and description of the GHG information system on controls associated with the project. Groups are confined to geographic areas in which all future projects must be implemented in order to ensure common baseline scenarios and demonstrations of additionality. Under this protocol, groups that do not share a baseline, or for groups that cannot demonstrate additionality for the entirety of a geographic area, must be redefined or divided.

These requirements may limit applicability of the VCS protocol to grouped agricultural projects, which may need to be implemented at different times and in different regions.²

Verification

Validation of the project and verification of its offsets are prerequisite to program registration and issuance of credits, and may be conducted by a single body. To verify a project, proponents submit documentation to a validation body and the project is assessed, and once validated that body provides the proponent with a written report and representation. The report is submitted to a validation/verification body that assesses GHG reductions, and that body then provides a verification report. Verification deadlines vary by project start date, and can be found in the latest *VCS Standard* (linked in note 1 above). For AFOLU projects starting on or after March 8, 2008, validation must be completed within five years of the start date. For crediting period renewals, a revised project description, validation report, and validation representation will be provided to registry administrator.

Exclusionary Criteria

- Projects must not be at sites that have been cleared of native ecosystems for at least ten years prior to the start date.

² Weisberg et al. *Benefits, existing methods and key challenges to aggregating greenhouse gas emissions: Background paper for the EPRI greenhouse gas emissions offset policy dialogue workshop #12*. Electric Power Research Institute. March 2012.

	DNDC v2.0	COMET Farm	MSU-EPRI v1.0
Personal Information			
Name	not specified in model	Via Registration	not specified in protocol
FSA Farm Number	not specified in model	n	not specified in protocol
FSA Tract Number	not specified in model	n	not specified in protocol
FSA Field Number	not specified in model	n	not specified in protocol
Field Acreage	not specified in model	Via Map Tool	y
Field State	not specified in model	Via Map Tool	y
Field County	not specified in model	Via Map Tool	only needed for Approach 2
Field Township	not specified in model	May be loaded, unknown	y - needed for site/legal description
Field Numerical Range	not specified in model	May be loaded, unknown	y - needed for site/legal description
Field Section	not specified in model	May be loaded, unknown	y - needed for site/legal description
Field Quarter	not specified in model	May be loaded, unknown	y - needed for site/legal description
Field Coordinates	y - degrees of latitude required	May be loaded, unknown	y - needed for site/legal description
Field Slope	y - degrees	May be loaded, unknown	not specified in protocol
Soil Test (Y/N)?	y - not specified in model	n (not able to input data)	not specified in protocol
Field History			
Pre-1980 Management Type	n	y - upland/lowland/livestock	n
Pre-1980 Tillage Type	n	y - intensive/reduced/no-till	n
Pre-2000 CRP Enrollment (y/n)	n	y	n
1980-2000 Management Type	n	y - see historic mgmt types below	n
1980-2000 Tillage Type	n	y - intensive/reduced/no-till	n
<i>Yearly Practices</i>	5 years if only N rate reduced or if rate+other change w/ >5% adoption; Common Practice Baseline if rate+other	2000-2012 required, but annual inputs can be copied then modified (for different dates, rates, etc.)	5+ years for continuous corn or 6 for rotation
Crop Type	y	y	y
Planting Date	y	y	n
Tillage Type	y - litter-burying till, deep plowing, moldboard, disk or chisel, plowing slightly, only mulching	y - intensive, reduced, mulch, ridge, strip, no-till	n
Tillage Season	y - date required	y - spring/summer/fall/winter	n
Fertilizer Type	y	y	y - required for % N content
N Inhibitor?	y	y	n
Fertilizer App Season	y - date required	y	y - date required for project start
Fertilizer lbs/acre	y	y	y
Fertilizer App Method	y	y	y - required for BMP attestation
Manure App Season	y - date required	y	y - required for BMP attestation
Manure total applied (tons)	y	y	y
Manure C:N Ratio (default 5)	y	y	y
Irrigation # Applications	y	y	n
Irrigation Gross Applications	y - cm of water applied	y - acre-inches water per acre	n
Irrigation Method	y - flood/sprinkler/drip	n	n
Harvest Date	y	y	n
Grain (y/n)	y - specific "crop type" for silage	y	protocol assumes grain harvest
Straw/Stover/Hay %	n	y	n
Burn Season	n	y - checkboxes for each season	n
Future Management Scenario	possible with climate simulations or projections	y	input as project year calculation
Soil Data			
Land Use Type	y - upland crop/rice paddy/moist or dry grassland-pasture/wetland	Via map tool	n
Texture	y - input or lookup	Via map tool	n
Clay Fraction	y - input or lookup	Via map tool	n
pH	y - input or lookup	Via map tool	n
SOC (% at surface)	y - input or lookup	Via map tool	n
Bulk Density (g/cm ³)	y - input or lookup	Via map tool	n
Crop Data			
# of Sequential Cropping Systems	y - includes rotation duration	n	n
Crop Type	y - multiple crops per yr possible	y - single crop	y
Planting Date	y	y	n - might be needed in verification
Harvest Date	y	y	n - might be needed in verification

	DNDC v2.0	COMET Farm	MSU-EPRI v1.0
Harvest mode	y - current or next year	n	n
Yield (bushels/acre)	y - converted from kg C/ha	n	n - might be needed in verification
Perennial (y/n)	y	n	n
Portion Left on Field (%)	y - leaves + stems	n	n
Cover Crop (y/n)	y	y - input as non-harvested 2nd crop	n
Tillage			
How Many Times	y	n	n
Date of Tillage events	y	spring/summer/fall/winter	n
Tillage Implement	y - litter-burying till, deep plowing, moldboard, disk or chisel, plowing slightly, only mulching	intensive/reduced/NT only	n
Nitrogen Fertilizer			
Fertilizer applied (y/n)	y	y	y
Times applied	y - by date	y - by season	y
Fertilizer application Date	y	spring/summer/fall/winter	y
Quantity applied (lbs/acre)	y	y	y
Injection or surface (Application method)	y - including depth in inches/cm	y - surface broadcast, surface band/sidedress, incorporation/ inject, fertigation, none	y - required for BMP attestation
Fertilizer Type	y - Amm. Nitrate, Anhydrous Amm., Amm. Sulf, Urea, Amm. Bicarbonate, Nitrate, Amm HPO4	y - Amm Nitrate, Anhydrous Amm, Amm Sulf, Urea, UAN, compost, mixed blends, MAP, DAP, none	y - required for % N content
Controlled Rlse/Inhib used (y/n)	y	y - "enh. eff. product"/nitrification	n - possibly required for BMP attestation
Inhibitor Type	y	n	n
Controlled Release Timing	y	n	n
N Inhibitor Efficiency	y	n	n
N Inhibitor Effective Duration	y	n	n
Urease Inhibitor Efficiency	y	n	n
Urease Inhibitor Eff Duration	y	n	n
Organic Fertilizer			
Oranic Ammendments (y/n)	y	y	y
Times OA applied	y	y	y
OA application date	y	spring/summer/fall/winter	y
OA type	y - farmyard manure, green manure, straw, slurry animal waste, compost, bean cake, human waste, poultry waste, sewage sludge	manure only, compost listed under "nitrogen application"	manure only
OA C:N ratio	y	y	y
OA quantity applied (lbs/acre)	y - amount of product and nitrogen	tons total	y
OA application type	y - surface spread or incorporation	n	n
Irrigation			
Irrigation # Applications	y	y	n
Irrigation Gross Applications	y - cm of water applied	y - acre-inches water per acre	n
Irrigation Method	y - flood/sprinkler/drip	n	n
Flooding			
Water table control method	y - irrigation, rainfed, observed water table data, empirical parameters	n	n
Irrigation - # of times flooded	y - times per year	n	n
Irrigation - flooding timing	event	n	n
Irrigation - conventional/marginal	y - choose conventional (10cm) or marginal (-5cm, 5cm) flooding	n	n
Irrigation - N received with flood water	n - appears to have been deprecated between DNDC 9.3 and 9.5	n	n
Irrigation - leaking rate/day	n - appears to have been deprecated between DNDC 9.3 and 9.5	n	n

	DNDC v2.0	COMET Farm	MSU-EPRI v1.0
Geography	Global	US	North Central Region
Crops	alfalfa	alfalfa	
	barley	barley	
		clover	
	corn	corn	corn
	cotton	cotton	
	beans	dryland beans	
	perennial grass	grass	
	grassland	grass-cover pasture	
	millet	millet	
	oats	oats	
	peanut	peanut	
		peas	
	potato	potato	
	sorghum	sorghum	
	soybean	soybean	
	spring wheat (6)	spring wheat	
	beet	sugar beets	
	sugarcane	sugar cane	
	sunflower	sunflower	
	tobacco	tobacco	
	winter wheat (2)	wheat	
	upland rice	upland rice	
		windbreak 3-row	
	Paddy Rice		
Historic Management Types		alley cropping	
		apple orchard	
		farm woodlot	
		grape orchard	
		heavy utilization, seasonal	
		heavy utilization, year round	
		moderate utilization, seasonal	
		non-irrigated: corn-soy	
		non-irrigated: corn-soy-w.wheat	
		other	
		peach	
		pear	
		pecan	
		riparian buffer	
		windbreak 3-row	
		windbreak 5-row	
Cover Crops	Alfalfa		
	Rye		
	Radish		
	Annual Grass		
	Legume Hay		
	Non-Legume Hay		
	Oats		
	Rapeseed/Canola		
	Cover_Crop (47)		

Program Overview

Midwestern farmers are longtime stewards of our productive region. They are uniquely positioned to solve the environmental and financial challenge of profitably and sustainably feeding a growing population while protecting the soil, air and water, on which our businesses, communities, and families all rely. As previous generations of farmers overcame the limitations of nutrient availability to feed more people on fewer acres, today's farmers are called to manage those nutrients to maximize input efficiency and optimize yield potential while minimizing environmental impacts.

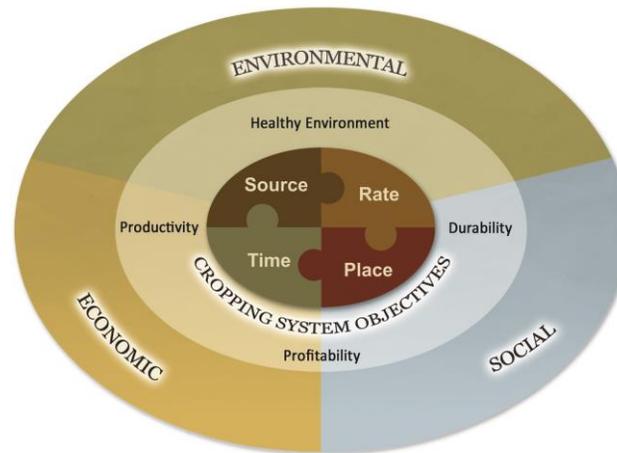
One of these impacts is increased emissions of nitrous oxide (N₂O) from nitrogen (N) fertilizer management. Delta Institute's Nitrogen Credit Program (NCP) offers farmers financial incentives for reducing N₂O emissions from synthetic and organic N fertilizers applied to their fields through a "4R" nutrient stewardship strategy. By implementing certain N management activities, farmers can earn emission reduction credits. NCP will pool eligible projects on a yearly basis, submit them for third-party verification, sell the verified N credits, and return any revenue from the sale (less transaction and verification costs) to participating farmers. This voluntary and market-based approach pays landowners, or renters by agreement, for the environmental benefits of their activities—all without government intervention.

This program is based on field trials conducted by Michigan State University (MSU) and MSU Extension. With support from the Electric Power Research Institute, data from that research was translated into a formula-based credit methodology endorsed by the American Carbon Registry.

The Nitrogen Credit Program works with farmers across the Midwest to encourage voluntary changes to fertilizer applications to reduce N losses and on-farm emissions of nitrous oxide, while maintaining crop yields and enhancing profitability.

About 4R Nutrient Stewardship

According to the International Plant Nutrition Institute (IPNI), the "4R" approach is defined as applying "the right source of nutrient, at the right rate, at the right time, and in the right place." To determine the right rate, IPNI recommends a site-specific assessment based on soil nutrient supply and plant demand. To learn more, visit www.nutrientstewardship.com.

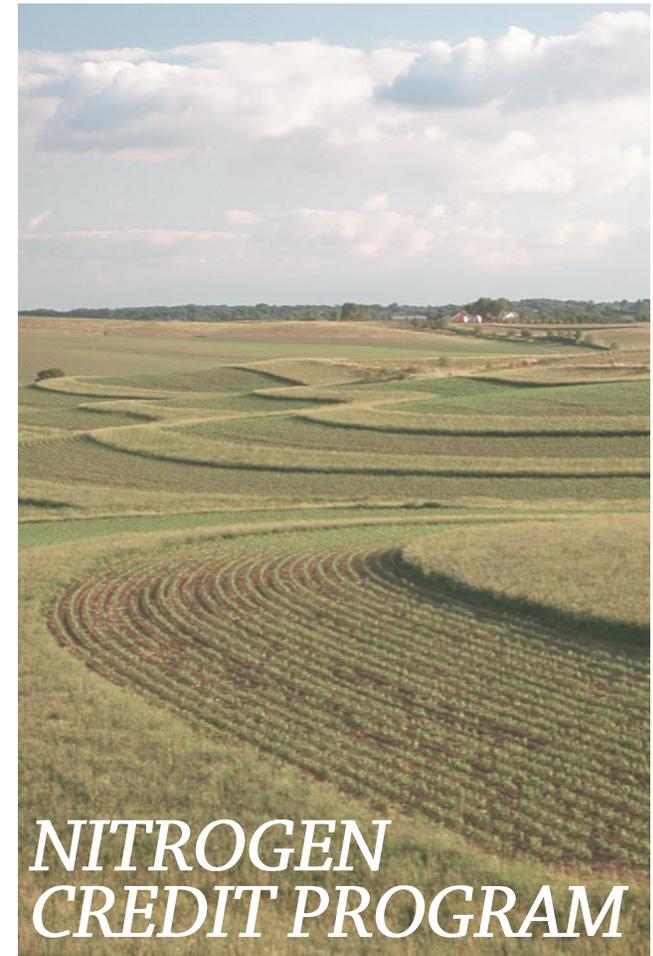


Graphic Source: <http://www.ipni.net/article/IPNI-3323>

About Delta Institute

For fifteen years, Delta has served as a catalyst for environmental sustainability and economic development across the Great Lakes region. Delta has experience working with farmers and other private landowners to design and implement economic programs that create incentives for conservation activities. Through previous work in soil carbon credits, Delta enrolled 1,385 farmers and forest owners representing nearly 400,000 acres across 18 states. From 2006 to 2010, the program generated over \$2 million in additional revenue for participants.

Delta has a track record of tackling some of our region's toughest environmental challenges, driving systems change, and promoting economic development.



NITROGEN CREDIT PROGRAM

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Photo Source: USDA NRCS

Who is eligible for generating credit and which practices qualify?

Eligible participants are corn farmers in the North Central Region (as shown on the map below) who are interested in improving N use efficiency and can document that they have reduced, or are willing to reduce N fertilizer applications to the corn component of their crop rotation. Other practices—such as changing fertilizer timing or placement and using slow-release or inhibitor products—can also reduce N₂O emissions and may qualify for credit under a separate, model-based American Carbon Registry methodology. To date, however, only N rate adjustments on corn crops have been accepted in this region.



How much does it pay and how much will it cost me?

Individual revenues will be based on the number of N credits you generate through increased N use efficiency, less costs of verification and sale. The only cost to you is the time it takes to provide the data.

How frequently will I be paid?

Credits will be pooled in the winter after the harvest; they will then be verified, and payments will be issued on an annual basis.

What data or documentation do I need to provide?

- **Application dates, rates, and N content for each product applied**, for each field you enroll. If you have access to those same data points for the same field(s) for recent years, providing that information may help you generate more N credits. Your retailer or service provider may be able to provide recent historical data to NCP directly with your consent.
- **Field coordinates**;
- **Ownership and lease agreements** (in order to establish custody of any credits generated, you must document control of your land);
- **Fertilizer application records** (receipts, load sheets, or other documentation from your retailer/service provider);
- **Attestation of voluntary “4R” nutrient stewardship practice adoption**, depending on your state and cropping system. Links to relevant state agency, land grant university, and fertilizer industry resources are available through the NCP website.

What do I do next?

The first step is to engage in a screening process that will help you determine your farm’s N credit potential. Printable and electronic options for signing up can be found on the NCP website. After receiving your initial information, NCP will calculate your credit potential and follow up with you. If you decide you would like to proceed beyond the screening phase, your participation will be formalized by signing an agreement with NCP. After signing, you will then need to provide the data and documentation listed above for the fields you wish to enroll. All personal identification and farm operation information will be kept confidential.

www.deltanitrogen.org

nitrogen@delta-institute.org

(312) 651-4363

Once enrolled, will I need to submit any forms or documentation on an ongoing basis?

You can continue to participate and receive credits for a period of up to seven years. For each year you will have to submit an annual attestation form with fertilizer application data for your enrolled corn fields.

Why should we reduce N₂O emissions?

Nitrous oxide’s global warming potential is nearly 300 times that of carbon dioxide, and N₂O molecules remain in the atmosphere for 120 years. Through careful adjustments in N fertilizer application and other N management activities, farmers can reduce the harmful impact of N₂O on the environment, achieve cost savings through increased fertilizer efficiency, and maintain their crop yields while generating N credits.

What are the consequences if my N fertilizer application rates go above my historic baseline?

You will not generate any N credits, and therefore will not receive any payment. However you remain eligible for credits in your future corn rotations.

Can I withdraw from the program? Are there any penalties?

You may withdraw from the program with 30 days written notice; there are no penalties.



NITROGEN CREDIT PROGRAM

Delta's Nitrogen Credit Program (NCP) is an opportunity for farmers to generate additional revenue by adopting a "4R" nutrient stewardship strategy that reduces total nitrogen (N) fertilizer applied to their corn crops. Field trials have shown that the rate of N fertilizer is the best predictor of nitrous oxide (N₂O) emissions in row crop agriculture in the U.S. Midwest. By demonstrating increases in N use efficiency from rate adjustments, farmers can reduce their N₂O emissions and generate N credits on a voluntary basis.



North Central Region

How does the NCP work?

First, farmers provide data about their fertilizer management practices. Next, we calculate your N credits based on this data. Then, a non-governmental third-party verifies the calculations, and credits are awarded. The Program bundles and sells the credits, and returns revenue to participating farmers.

How do I know if I'm eligible?

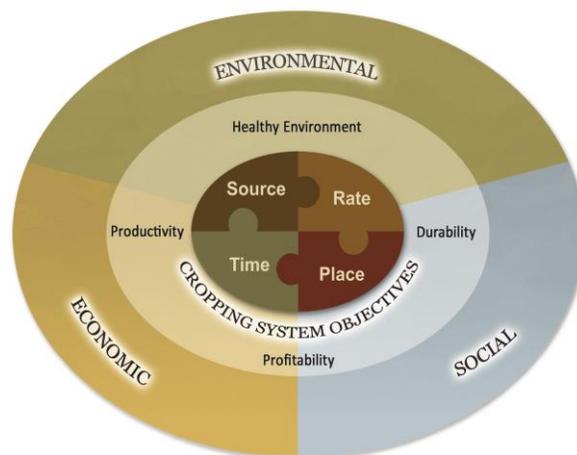
To be eligible you must be a corn farmer in the North Central Region (as shown on map) who has reduced, or is willing to reduce N fertilizer applications to the corn component of your crops.

How much does it pay and how much will it cost me?

Individual revenues will be based on the number of N credits you generate by shifting N fertilizer application rates, less costs of verification and sale. The only cost to you is the time it takes to provide the data.

What data or documentation do I need to provide?

- **Application dates, rates, and N content for each product applied**, for each field you enroll. If you have access to those same data points for the same field(s) for recent years, providing that information may help you generate more N credits. Your retailer or service provider may be able to provide recent historical data directly to the Program with your consent.
- **Field coordinates**;
- **Ownership and lease agreements** (you must document control of your land in order to establish custody of any credits generated);
- **Fertilizer application records** (receipts, load sheets, or other documentation from your retailer or service provider).
- **Adherence to voluntary state, university, or industry 4R guidelines**, depending on your state and cropping system.



Graphic Source: <http://www.ipni.net/article/IPNI-3323>

What do I do next?

The first step is to fill out an Initial Screening Form for one field to help you determine your N credit potential. After receiving the completed form, we will calculate your potential and follow up with you via your preferred method of contact. If you decide you would like to proceed beyond the screening phase, your participation will be formalized by signing an agreement with NCP. You will then need to provide the data and documentation listed above via email or the NCP website. All personal identification and farm operation information will be kept confidential.



NITROGEN CREDIT PROGRAM

INITIAL SCREENING FORM

Thank you for your interest in Delta's Nitrogen Credit Program. Please provide the information requested below, and we will follow up to provide an estimate of your N credit potential. All personal identification and farm operation information will be kept confidential.

CONTACT INFORMATION

Name: _____
Last First

Address: _____
Street Address City, State, Zip

Contact: _____ Preferred: Phone Email
Phone Email

How did you learn about NCP? _____

FIELD & CROP INFORMATION

Please enter field, crop, and fertilizer information for a field you would consider enrolling in the Program.

Total Acres Farmed: _____ Field Data: _____
County Acres (Optional) Field Name/Identifier

Please indicate your 2015 crop and rotation for previous years for a field you would consider enrolling. The Program requires at least three years of data for corn in rotation, and at least five if continuous.

_____	_____	_____	_____
<small>2015 (planned)</small>	<small>2014</small>	<small>2013</small>	<small>2012</small>
_____	_____	_____	_____
<small>2011</small>	<small>2010</small>	<small>2009</small>	<small>2008</small>

FERTILIZER INFORMATION

For the same field, please describe all synthetic and/or organic N fertilizer applications to your corn crops.

Please check: I plan to reduce my 2015 corn application rates I reduced application rates for my 2013 or 2014 corn crop

SYNTHETIC				ORGANIC			
Application	Total applied	Season or Date & Year	Product or % N content	Application	Total applied	Season or Date & Year	Manure Type or % N content
<input type="checkbox"/> lbs N/acre 1 <input type="checkbox"/> lbs/acre <input type="checkbox"/> gallons/acre				<input type="checkbox"/> lbs N/acre 1 <input type="checkbox"/> tons/acre <input type="checkbox"/> gallons/acre			
<input type="checkbox"/> lbs N/acre 2 <input type="checkbox"/> lbs/acre <input type="checkbox"/> gallons/acre				<input type="checkbox"/> lbs N/acre 2 <input type="checkbox"/> tons/acre <input type="checkbox"/> gallons/acre			
<input type="checkbox"/> lbs N/acre 3 <input type="checkbox"/> lbs/acre <input type="checkbox"/> gallons/acre				<input type="checkbox"/> lbs N/acre 3 <input type="checkbox"/> tons/acre <input type="checkbox"/> gallons/acre			

If the information above relates to a planned reduction from your last corn crop, please describe your application practices before that. If the information relates to a recent application, please describe the planned reductions you are considering, or how that recent application is a reduction from your historic baseline:



Thank you for this information. Please mail, email, or fax the completed form to Matt Harrison at the contact information below. Upon receipt, we will calculate your N credit potential, and share that information with you through your preferred method of contact.

Nitrogen Credit Program
Delta Institute

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Nitrous Oxide Reduction in Corn: GHG Plan for ACR Project 171

April 2014

Submitted By:

Delta Institute



In Partnership with Michigan State University and
the Electric Research Power
Institute

MICHIGAN STATE
UNIVERSITY



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A.
PROJECT OVERVIEW

A1. PROJECT TITLE

Nitrous Oxide Reduction in Corn

A2. PROJECT TYPE

Agricultural Land Management; N₂O Emission Reductions through Reduced Use of Fertilizer on Agricultural Crops (AFOLU Sector)

A3. PROOF OF PROJECT ELIGIBILITY

Demonstrate, with reference to the American Carbon Registry Standard and relevant ACR sector standard if applicable, that the project activity is eligible.

The project is eligible under criteria outlined in Chapter 3 (Table 2) of the ACR Standard (Version 2.1, October 2010). Specifically:

- The project activity started after the earliest allowable start date for AFOLU projects of Nov. 1, 1997;
- The project activity is implemented for one year, meeting the Minimum Project Term;
- The project activity creates quantifiable and verifiable N₂O emissions reductions;
- The Project Proponent has control over the sources from which the N₂O emissions reductions originate;
- The ownership of Offsets Title is clear;
- The ownership of Land Title is clear;
- The project activity is Additional, i.e., it passes an ACR-approved performance standard and regulatory surplus test;
- The baseline calculations are consistent with ISO and other relevant standards and follow an ACR-approved methodology;
- The project activity results in non-reversible N₂O emissions reductions;
- The project activity results in no leakage, i.e., no increase in GHG emissions or decrease in C sequestration outside the project boundary;
- The project activity is on land that has been cultivated for at least five years prior to the project start date;
- The parcel of land on which the baseline crop is grown is the same parcel of land on which the project crop is grown;
- The project activity *does not* take place on organic soils (histosols) as defined by the World Reference Base for Soil Resources (FAO 2006).
- Implementation of project activities associated with this methodology, with or without registration as an AFOLU project, shall not lead to violation of any applicable law, even if the law is not enforced.
- The project adheres to Best Management Practices (BMPs) at the cropping site as they relate to N fertilizer formulation, dates, and methods of application, as required under Section 2.2.1 of the methodology. Pursuant to the Michigan Right to Farm Act, the Michigan Department of Agriculture and Rural Development has adopted Generally Accepted Agricultural and Management Practices (GAAMPs) for farmers and farm operators. These practices are scientifically-based and updated annually to utilize current technology promoting sound environmental stewardship on Michigan farms (Michigan Department of Agriculture and Rural Development). A copy of the relevant section of 2013 GAAMPs for Nutrient Utilization is attached as Appendix A.

The GAAMPs address several specific N management practices. The table below provides a description of relevant GAAMPs, and a description of how project N application practices align with BMPs.

GAAMP	Project BMP
<p>N Fertilizer Rate (Appendix A, p. 8): "The amount of N fertilizer used for field and vegetable crops should be based on a realistic yield goal and the amount of N available from the soil, previous crop, manure, and/or other biological materials."</p>	<p>This project achieves N₂O emissions reductions through from reduced use of N fertilizer on agricultural crops.</p>
<p>Forms of N Fertilizer (Appendix A, p. 8): "Nitrate N, in calcium nitrate or ammonium nitrate, is readily available for plants but is subject to immediate leaching when added to soil. Under conditions of high leaching potential, nitrate forms of N should not be used unless the plants are actively growing and can utilize the applied nitrate N. Where there is a high potential for leaching, ammonium forms of N, such as urea, ammonium sulfate, or anhydrous ammonia, are preferred sources of N."</p>	<p>The farmer operating this project site has applied urea alone, or in combination with inhibitors/slow release fertilizers for all relevant years (2003, 2007, 2009, and 2011), even though site soils do not have a high potential for leaching (i.e. they are fine textured. (See Appendices C1-C5).</p>
<p>Timing and Placement of N Fertilizer (Appendix A, p. 9)</p> <ul style="list-style-type: none"> • "Spring applications of N on corn in Michigan are clearly superior to fall applications (Vitosh, 1991)." • "Urea and N solutions containing urea are subject to volatilization loss as gaseous ammonia if surface applied and not incorporated. Conditions which favor this loss are high temperatures, high soil pH, moist soils, and high levels of plant residue on the soil surface. Because the volatilization loss of a urea-based fertilizer is difficult to assess, and since it represents an economic loss to the farmer, urea-containing fertilizers should be incorporated whenever possible." 	<ul style="list-style-type: none"> • The farmer operating this project site applies N fertilizer in the spring (See Appendices C1-C5). • This project site is located in a Tappan loam soil with moderate pH, so therefore a single spring application is appropriate. (See Appendix B2). Additionally, the farmer operating the site uses a surface broadcast and incorporated application method.

A4. LOCATION

Describe project location, including geographic and physical information allowing for unique identification and delineation of the specific extent of the project. GPS coordinates should be provided.

The project site is located in the North Central Region (NCR) of the US. It is situated on land owned by a commercial farmer in Tuscola County in Michigan, USA (section A9). Maps and coordinates of the project area are shown in Appendix B. A KMZ file is included with project documentation to delineate the project boundary.

A5. BRIEF SUMMARY OF PROJECT

Provide a brief description of the project including:

- *Description of project activity*

The project quantifies the reduction of nitrous oxide (N₂O) emissions from a commercial farmers' field planted to corn. The emissions reductions occur as a result of the lower nitrogen (N) fertilizer rate applied to corn during the project period when compared to the baseline period.

This GHG Plan covers one reporting year, which corresponds to the 2011 cropping season. The project period started with the date of the N fertilizer application to corn at the project site on April 21, 2011 and the first reporting year continued until April 21, 2012. Under the protocol, the project reporting year is the 12-month period following the first input of N fertilizer to the corn component of the crop rotation. The project crediting period, or amount of time for which the project is valid and during which time it can generate offsets against the baseline scenario, is seven years.

Previous N fertilizer applications to corn at the project site took place on April 28, 2003, April 21, 2007, and April 16, 2009. The average of the N fertilizer rate applied in 2003, 2007, and 2009 is used as the baseline N fertilizer rate, from which the baseline N₂O emissions are calculated.

- *Background information*

General

Globally, fertilizers today provide about half of all N received by crops. Annual crop yields are determined primarily by the amount of N added. Synthetic fertilizer is the N source of choice for most farmers managing intensive cropping systems. Easily transported, it is also readily available and relatively inexpensive.

Nitrogen is mobile and hard to contain, and because of this, much of the N added to agricultural systems does not reach its intended target — protein in the human diet. Most annual grain crops in conventional production systems take up only about 50% of applied N. The remainder escapes to the air, groundwater, and surface waters via a number of pathways. Unfortunately, most of the N mobilized from agricultural systems is reactive, i.e. present in forms that are biologically active in soils and surface waters or chemically reactive in the atmosphere.

The gas nitrous oxide is a major form of environmentally harmful N from agriculture. Nitrous oxide is an important greenhouse gas in the troposphere, and in the stratosphere it is the leading cause of depletion of protective ozone. As a greenhouse gas N₂O is about 300 times more potent than carbon dioxide (CO₂) and once emitted has an atmospheric lifetime >100

years; small emissions and emissions reductions therefore matter. Globally, agriculture is responsible for about 60% of all anthropogenic N₂O emissions, and in the US this figure rises to almost 70%; most of this flux is from fertilized soils.

Given that N₂O in agricultural soil is produced predominantly through the microbial transformations of inorganic N, the potential to produce and emit N₂O increases with the increasing availability of N. Due to the strong influence of available soil N on N₂O emissions, some emissions of N₂O are an unavoidable consequence of maintaining highly productive cropland. However, any activity or process that acts to keep available soil N low will lead to smaller N₂O emissions. Anthropogenic activities that lower the input of N into cropland agriculture help to reduce emissions of N₂O.

Therefore, the reduction of N fertilizer rate to cropland is a robust and reliable management practice for reducing emissions of N₂O, and is the basis for the GHG emissions reductions calculated in this project.

Since the 1970s it has been common practice throughout the NCR for producers to apply rates of N fertilizer based on recommendations derived from yield goal estimates. The agricultural departments of land grant universities and state agricultural organizations have typically endorsed yield-goal N fertilizer rate recommendations. These organizations are a common source of external information and advice for producers, and this network serves as the foundation for producer business as usual (BAU) practice in the NCR and beyond, constituting a sector-wide approach for calculating baseline N fertilizer rates, and by extension, emissions of N₂O.

Despite concerns that yield goal-based recommendations are too liberal the practice is still widely followed, and recommended, leading to application of N fertilizer in excess of crop requirements, principally as a result of unrealistic yield goal estimates.

Therefore, reductions in N rate below those determined by yield-goal based calculations (i.e., the project BAU baseline scenario) can be implemented to reduce the amount of excess N in cropland agriculture, thereby decreasing its N₂O burden without reducing crop productivity.

Project site

The project site located on land owned by a commercial farmer in Tuscola County in Michigan, USA, has been cultivated for at least 10 years prior to the project start date.

In the absence of the ALM project activity, the continuation of these cropping practices using business-as-usual (BAU) N rate management practices is the most realistic and credible baseline scenario.

○ *Project purpose(s) and objective(s)*

The overarching objective of this project is to reduce the amount of reactive N in the environment. Although only reductions in the potent GHG nitrous oxide will be quantified and credited, other major forms of environmentally harmful N from agriculture will also be reduced, including the gases nitrogen oxides (NO and NO₂, known collectively as NO_x) and ammonia (NH₃) and the solute nitrate (NO₃⁻).

A6. PROJECT ACTION

Describe the project action(s), including:

- *Description of prior physical conditions*

The project site is situated in the Erie-Huron Lake Plain Major Land Resource Area (MLRA) in the Lake States Fruit, Truck Crop and Dairy Region (USDA NRCS 2006).

Physiography: Nearly level glacial lake plain with a few scattered ridges of sandy soils that represent past shorelines and moraines. Elevation is about 200 meters with local relief typically about 2 meters above the general level of the landscape.

Geology: Glacial deposits of till, lake sediments, and outwash from the Wisconsin and older glacial periods. Mississippian- to Silurian-age shale, limestone, and dolomite rocks are at the surface.

Climate: Characterized as humid continental. The site typically receives 820 mm of precipitation annually with a mean annual temperature of 8.3 °C. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average freeze-free period is 190 days and ranges from 155 to 220 days.

Land Use: Nearly 75% of the MLRA is in farms, with about 60% in cropland. Cash crops are important. Corn, winter wheat, soybeans, and hay are the major crops. Sugar beets and canning crops also are important.

Soils: Tappan-Londo loams with 0 to 2 percent slopes and Tappan-Avoca complex with 0 to 3 percent slopes (see Hoben et al. 2011 for more information).

Crop: The project crop is corn managed in a corn–soybean rotation with conventional tillage. Spring seedbed preparation includes chisel plow followed by disking, then cultivation using an s-tine field cultivator, with no tillage the previous fall (see Hoben et al. 2011 for more information).

- *Description of how the project will achieve GHG reductions and/or removal enhancements*
The project will achieve GHG reductions by reducing the rate of N fertilizer applied to corn at the project site during the project period to below the rate of N fertilizer previously applied to corn at the project site during the baseline period. This reduction in N rate leads to a reduction in the N₂O emissions during the project period when compared to the baseline period.
- *Description of project technologies, products, services and expected level of activity*
n/a

A7. EX ANTE OFFSET PROJECTION

List estimated GHG emission reductions and removal enhancements by year, stated in metric tons of CO₂e.

Years	Estimated net GHG emission reductions or removals (t CO ₂ e)
2011	2.32
2013	1.04

2015	2.00
2017	2.00
Total	7.36

A8. PARTIES

List full contact information, roles, and responsibilities for project proponent, other project participants, relevant regulator(s) and/or administrators of any GHG Program(s) in which the project is already enrolled, and the entities holding offset and land title (if applicable).

Name	Position	Role	Contact information
██████████ ██████████	Farmer	Offset Holder, Land Title Holder, Project Proponent	██████████ ██████████ ██████████
Neville Millar	Senior Research Associate	Project Document Developer	W.K. Kellogg Biological Station Michigan State University Hickory Corners, MI 49060 millarn@msu.edu
G. Philip Robertson	Professor of Ecosystem Science	Project Document Developer	Kellogg Biological Station Michigan State University Hickory Corners, MI 49060 robertson@kbs.msu.edu
Adam Diamant	Technical Executive	Project Document Developer and Sponsor	Electric Power Research Institute Energy and Environmental Analysis Program 3420 Hillview Avenue Palo Alto, CA 94304 adiamant@epri.com
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A9. REFERENCES

Hoben, J.P., R.J. Gehl, N. Millar, P.R. Grace, and G.P. Robertson. 2011. Non-linear nitrous oxide (N₂O) response to nitrogen fertilizer in on-farm corn crops of the US Midwest. *Global Change Biology*, 17:1140-1152.

Michigan Department of Agriculture and Rural Development. 2013. "What are GAAMPS?" Available online at: http://www.michigan.gov/mdard/0,4610,7-125-1599_1605-297733--,00.html.

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

B. METHODOLOGY

B1. APPROVED METHODOLOGY

Reference the ACR approved methodology being applied to the project.

The ACR approved methodology applied to the project is: The MSU-EPRI Methodology (Version 1, July 2012) for Quantifying Nitrous Oxide (N₂O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops. Hereafter this methodology will be referred to as MSU-EPRI v1.

B2. METHODOLOGY JUSTIFICATION

Describe why the chosen methodology is the most appropriate methodology for the project.

This is the most appropriate methodology because the project quantifies N₂O emissions reductions following N fertilizer rate reduction to an agricultural crop. The project activity meets the applicability conditions of MSU-EPRI v1 and is specific to project activities that reduce N fertilizer rate to agricultural cropping systems to reduce N₂O emissions. See section A3 for project eligibility.

The project site is located in the North Central Region (NCR) of the US, and is planted to corn in a row-crop rotation. The project is therefore eligible in **Category 1** of MSU-EPRI v1 (section 2.5).

*“Category 1: Proposed projects located in the NCR of the US that involve corn in row-crop systems such as continuous corn and rotations of corn-soybean or corn-soybean-wheat will use **Method 1** to calculate N₂O emissions reductions. Only the corn component of a rotation is eligible in this category.”*

In Method 1, a regionally derived (NCR) emission factor is used in calculations of direct emissions of N₂O for baseline and project scenarios.

Suitable site specific management records are available to enable quantification of the baseline N fertilizer rate. The project is therefore eligible to use **Approach 1** from MSU-EPRI v1.

B3. PROJECT BOUNDARIES

Identify the physical and temporal boundaries of the project.

The physical boundary of the project encompasses both direct and indirect emissions of N₂O, and includes the project site where fertilizer N is directly applied as well as any additional soils and waters where byproducts of the fertilizer N input (such as the gases NH₃ and NO_x, and their products NH₄⁺ and NO₃⁻) are re-deposited. The project document defines the project site where N fertilizer is directly applied, but does not (and is not required to) define the specific areas where by-products may be re-deposited beyond the project site.

The temporal boundary for this project is the 12-month period following the first input of N fertilizer to the corn component of the crop rotation, continuing for each eligible reporting year within the 7-year crediting period (April 21, 2011 to April 21, 2018).

B4. IDENTIFICATION OF GHG SOURCES AND SINKS

Identify the GHG sources and sinks within the project boundaries. If any sources or sinks will be considered de minimis, include a justification.

Table 1. Greenhouse gases and sources, along with explanation for inclusion or exclusion of quantification

Period	Source	Gas	Included?	Justification / Explanation
Baseline	Direct Emissions due to N fertilizer addition	CO ₂	No	Exclusion is conservative.
		CH ₄	No	Exclusion is conservative.
		N ₂ O	Yes	N ₂ O is major emissions source from fertilizer N addition
	Indirect Emissions due to N fertilizer addition	CO ₂	No	Exclusion is conservative.
		CH ₄	No	Exclusion is conservative.
		N ₂ O	Yes	N ₂ O is major emissions source from fertilizer N addition
Project	Direct Emissions due to N fertilizer addition	CO ₂	No	Exclusion is conservative.
		CH ₄	No	Exclusion is conservative.
		N ₂ O	Yes	N ₂ O is major emissions source from fertilizer N addition
	Indirect Emissions due to N fertilizer addition	CO ₂	No	Exclusion is conservative.
		CH ₄	No	Exclusion is conservative.
		N ₂ O	Yes	N ₂ O is major emissions source from fertilizer N addition

In accordance with ACR Standard (v. 2.1), any pool whose exclusion is conservative can be omitted from accounting. With this methodology reductions in N fertilizer rate resulting from project implementation will not result in soil C stock change. Therefore, soil C pools do not require monitoring. See MSU-EPRI v1 (Annex B) for further information.

Table 2. Carbon pools considered in the project

Carbon Pool	Included?	Justification/Explanation
Above ground woody biomass	No	Not relevant or subject to significant change
Above ground non woody biomass	No	Not relevant or subject to significant change
Below ground biomass	No	Not relevant or subject to significant change
Litter	No	Not relevant or subject to significant change
Dead wood	No	Not relevant or subject to significant change
Soil	No	Not relevant or subject to significant change
Wood products	No	Not relevant or subject to significant change

B5. BASELINE

Describe the baseline scenario, how the baseline was identified and chosen, and why it is the most appropriate baseline for the project. Address all baseline-related topics required by the chosen methodology, ACR Standard, and relevant ACR sector standard if applicable.

The baseline scenario is the situation where in the absence of the project activity, N fertilizer would be applied at a business-as-usual (BAU) rate to corn at the project site. This will result in higher emissions of N₂O when compared to the project scenario where a lower N fertilizer rate is applied to corn on the same parcel of land.

In the absence of the project activity, the continuation of a management practice that uses the BAU N fertilizer rate is the most realistic and credible scenario, leading to higher N₂O emissions than if the project activity was implemented.

The project uses Method 1 (Approach 1) in MSU-EPRI v1 to determine the baseline N fertilizer rate. Corn was grown at the project site in 2003, 2007, and 2009. Site specific documents are used to determine

the N fertilizer rate applied to the corn in these years. The average of the N fertilizer rate applied to the corn in these years is used as the baseline N fertilizer rate from which baseline N₂O emissions are calculated.

B6. PROJECT SCENARIO

Describe the project scenario, including the project actions that will take place and any additional information required by the ACR Standard, the chosen methodology, and the relevant ACR sector standard if applicable.

The project scenario is the situation where N fertilizer was applied at a lower than business as usual (BAU) rate to corn at the project site during the project period. This resulted in lower emissions of N₂O when compared to the baseline scenario where a higher N fertilizer rate was applied to corn at the project site in 2003, 2007, and 2009.

B7. REDUCTIONS AND ENHANCED REMOVALS

Describe how the project reduces GHG emissions or enhances the removal of GHGs from the atmosphere beyond what would have taken place in the baseline scenario.

Activities at the project site reduce emissions of nitrous oxide. These emissions reductions occur as a result of the lower N fertilizer rate applied to the corn crop during the project period when compared to the baseline period.

B8. PERMANENCE

Demonstrate whether the project offsets face any risk of reversal by identifying any risks that may substantially affect the project's GHG emission reductions or removal enhancements. If the offsets do face a risk of reversal, describe what method of permanence assurance will be used.

Nitrous oxide emission reductions associated with reducing N fertilizer rate are permanent and irreversible. Reduced applications of N fertilizer lead to lower concentrations of N in the soil and result in lower emissions of N₂O. These avoided emissions of 'new' N₂O occur immediately, are permanent and irreversible. The project offsets therefore face no risk of reversal, and no buffer or other risk mitigation mechanism is required.

C.
ADDITIONALITY

ACR requires that every project either pass an approved performance standard and a regulatory additionality test, or pass a three-pronged test to demonstrate that the project activity is beyond regulatory requirements, beyond common practice, and faces at least one of three implementation barriers.

This project is based in the US, and must pass the approved performance standard set out in MSU-EPRI v1 (section 5). Therefore, steps C2 and C3 below can be omitted.

C1. REGULATORY SURPLUS TEST

Demonstrate how the project passes the regulatory surplus additionality test described in the ACR Standard v2.0. Include a summary and references to any relevant local laws and regulations related to the project and provide of demonstration of compliance with them.

Consistent with ACR Standard (v. 2.1), project developers pass the Regulatory Surplus Test if there are no 'existing laws, regulations, statutes, legal rulings, or other regulatory frameworks that directly or indirectly affect GHG emissions associated with a project action or its baseline, and which require technical, performance, or management actions.'

No such existing laws, regulations, statutes, legal rulings, or other regulatory frameworks currently exist that require N fertilizer rate to be lowered from a baseline BAU rate at the project site. Nitrous oxide emissions associated with the project action (reducing N fertilizer application rate to corn compared to a baseline scenario) or the baseline scenario (average N fertilizer application rate to corn in three previous corn years) are not affected by any regulation.

C2. COMMON PRACTICE TEST

Demonstrate how the project passes the common practice additionality test described in the ACR Standard v2.0. (If the project is using the regulatory surplus + performance standard approach to additionality, skip this step.)

This step is not required - the project is using the regulatory surplus + performance standard approach to additionality.

C3. IMPLEMENTATION BARRIERS TEST

Demonstrate how the project passes at least one of the following implementation barriers tests described in the ACR Standard v2.0 and allowed by the chosen methodology. (If the project is using the regulatory surplus plus performance standard approach to additionality, skip this step.)

- *Financial*
- *Technological*
- *Institutional*

This step is not required - the project is using the regulatory surplus plus performance standard approach to additionality.

C4. PERFORMANCE STANDARD TEST

Demonstrate how the project activity exceeds an approved performance standard by showing that the GHG emissions generated per unit output by the project are below the level (or GHG removals are above

the level) defined as business-as-usual for the product, service, sector or industry in which the project takes place. (If the project is using the three-prong approach to additionality, skip this step.)

The relevant performance standard test for this project is defined in MSU-EPRI v1 (sections 5.2).

The project activity exceeds the performance standard test by reducing the N fertilizer rate at the project site during the project period below the BAU N fertilizer rate at the project site during the baseline period, which is equal to the baseline N fertilizer rate at the project site.

The reduction in N fertilizer rate and therefore N₂O emissions at the project site during the project period to below the BAU N₂O emissions at the project site during the baseline period results in project additionality.

D.
MONITORING PLAN

D1. MONITORED DATA AND PARAMETERS

List all relevant data and parameters that will be monitored using the table below.

<i>Data or Parameter Monitored</i>	$M_{P_{SF,t}}$
<i>Unit of Measurement</i>	Mg N yr ⁻¹
<i>Description</i>	Mass of project synthetic N containing fertilizer applied
<i>Data Source</i>	Project proponent records
<i>Measurement Methodology</i>	Generally accepted field application methods using calibrated applicators of known capacity for fertilizer mass or volume determination
<i>Data Uncertainty</i>	Zero
<i>Monitoring Frequency</i>	Annual
<i>Reporting Procedure</i>	
<i>QA/QC Procedure</i>	Project proponents adhere to QA/QC procedures as outlined in ISO 14064-2:2006 Section A3.6 "Managing Data Quality." These include: establishing and maintaining a complete GHG information system; regular accuracy checks for technical errors; periodic internal audits and technical review; appropriate training for team members; and uncertainty assessments. Project data is securely stored on a file server requiring user authentication; the server is copied to cloud based storage for disaster recovery purposes. QA/QC procedures were also informed by the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (2003).
<i>Notes</i>	

<i>Data or Parameter Monitored</i>	$NC_{P_{SF}}$
<i>Unit of Measurement</i>	g N (100g fertilizer) ⁻¹
<i>Description</i>	Nitrogen content of project synthetic fertilizer applied
<i>Data Source</i>	Project proponent records
<i>Measurement Methodology</i>	Generally accepted procedures for sampling, handling and analysis of bulk fertilizer
<i>Data Uncertainty</i>	Zero
<i>Monitoring Frequency</i>	Annual
<i>Reporting Procedure</i>	
<i>QA/QC Procedure</i>	Project proponents adhere to QA/QC procedures as outlined in ISO 14064-2:2006 Section A3.6 "Managing Data Quality." These include: establishing and maintaining a complete GHG information system; regular accuracy checks for technical errors; periodic internal audits and technical review; appropriate training for team members; and uncertainty assessments. Project data is securely stored on a file server requiring user authentication; the server is copied to cloud based storage for disaster

	recovery purposes. QA/QC procedures were also informed by the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (2003).
<i>Notes</i>	

<i>Data or Parameter Monitored</i>	Project Crop area
<i>Unit of Measurement</i>	Hectare (ha)
<i>Description</i>	Area of crop(s) planted, from which project fertilizer N rate determined
<i>Data Source</i>	Project proponent records and KMZ file
<i>Measurement Methodology</i>	
<i>Data Uncertainty</i>	Zero
<i>Monitoring Frequency</i>	
<i>Reporting Procedure</i>	
<i>QA/QC Procedure</i>	Verify KMZ file agrees with project site coordinates
<i>Notes</i>	

E.
QUANTIFICATION

E1. BASELINE

Detail the GHG quantification methodology for the baseline scenario including all relevant emissions or removals. Provide sample calculations wherever possible.

The N₂O quantification methodology for the baseline scenario are given in MSU-EPRI v1 (section 6.1).

Relevant equations are presented below with sample calculations.

Baseline emissions can be calculated by the following equation:

$$N_2O_{B \text{ total}, t} = N_2O_{B \text{ direct}, t} + N_2O_{B \text{ indirect}, t} \quad (1)$$

Where:

- $N_2O_{B \text{ total}, t}$ Total baseline N₂O emissions, Mg CO₂e ha⁻¹ in year t;
- $N_2O_{B \text{ direct}, t}$ Direct baseline N₂O emissions from the project site, Mg CO₂e ha⁻¹ in year t;
- $N_2O_{B \text{ indirect}, t}$ Indirect baseline N₂O emissions beyond the project site, Mg CO₂e ha⁻¹ in year t.

Direct emissions

The project is eligible to use Method 1 from MSU-EPRI v1 to calculate N₂O emissions for the baseline scenario. Method 1 uses a regional specific emissions factor to calculate direct N₂O emissions.

The direct baseline nitrous oxide emissions from nitrogen fertilization for Method 1 can be calculated using the following equations:

$$N_2O_{B \text{ direct}, t} = (F_{B \text{ SN}, t} + F_{B \text{ ON}, t}) * EF_{BDM1} * N_2O_{MW} * N_2O_{GWP} \quad (2)$$

$$F_{B \text{ SN}, t} = M_{B \text{ SF}, t} * NC_{B \text{ SF}} \quad (3)$$

$$F_{B \text{ ON}, t} = M_{B \text{ OF}, t} * NC_{B \text{ OF}} \quad (4)$$

$$EF_{BDM1} = 6.7 * 10^{-4} * (\exp [6.7 * (F_{B \text{ SN}, t} + F_{B \text{ ON}, t})] - 1) / (F_{B \text{ SN}, t} + F_{B \text{ ON}, t}) \quad (5)$$

Where:

- $F_{B \text{ SN}, t}$ Baseline synthetic N fertilizer applied, Mg N ha⁻¹ in year t;
- $F_{B \text{ ON}, t}$ Baseline organic N fertilizer applied, Mg N ha⁻¹ in year t;
- $M_{B \text{ SF}, t}$ Mass of baseline N containing synthetic fertilizer applied, Mg ha⁻¹ in year t;
- $M_{B \text{ OF}, t}$ Mass of baseline N containing organic fertilizer applied, Mg ha⁻¹ in year t;
- $NC_{B \text{ SF}}$ N content of baseline synthetic fertilizer applied, g N (100g fertilizer)⁻¹;
- $NC_{B \text{ OF}}$ N content of baseline organic fertilizer applied g N (100g fertilizer)⁻¹;
- EF_{BDM1} Emission factor for baseline direct N₂O emissions from N inputs Mg N₂O-N (Mg N input)⁻¹;

N_2O_{MW} Ratio of molecular weights of N_2O to N, $Mg N_2O (Mg N)^{-1}$;

N_2O_{GWP} Global Warming Potential for N_2O , $Mg CO_2e (Mg N_2O)^{-1}$.

Calculation of $F_{B SN, t}$

To determine the baseline N rate and therefore the baseline N_2O emissions at the project site, the N fertilizer applied to corn from three previous years at the project site is calculated.

Synthetic N containing fertilizer applications to corn at the project site took place on:

April 28, 2003;
April 21, 2007; and,
April 16, 2009.

No organic N containing fertilizer was applied during the baseline period.

In order to establish baseline emissions of N_2O , management records documenting the fertilizer application to corn at the project site in 2003, 2007, and 2009 are required. Copies of these documents are found in Appendix C and calculations of N rate derived from these documents are presented in Appendix D.

Average N fertilizer rate applied over baseline period

$$F_{B SN, t} = [(F_{B SN, 2003} + F_{B SN, 2007} + F_{B SN, 2009}) / 3], Mg N ha^{-1} yr^{-1} \quad (6)$$

Where:

$$\begin{aligned} F_{B SN, 2003} &= \text{Synthetic N fertilizer applied in 2003, } Mg N ha^{-1}; \\ &= 0.175 Mg N ha^{-1} \end{aligned}$$

$$\begin{aligned} F_{B SN, 2007} &= \text{Synthetic N fertilizer applied in 2007, } Mg N ha^{-1}; \\ &= 0.169 Mg N ha^{-1} \end{aligned}$$

$$\begin{aligned} F_{B SN, 2009} &= \text{Synthetic N fertilizer applied in 2009, } Mg N ha^{-1}. \\ &= 0.170 Mg N ha^{-1} \end{aligned}$$

From equation (6), the baseline N rate:

$$\begin{aligned} F_{B SN, t} &= [(0.175 + 0.169 + 0.170) / 3] \\ &= 0.172 Mg N ha^{-1} yr^{-1} \end{aligned}$$

From equation (2), direct baseline N_2O emissions:

$$\begin{aligned} N_2O_{B direct, t} &= (0.172) * 6.7 * 10^{-4} * (\exp [6.7 * (0.172)] - 1) / (0.172) * 44/28 * 310 \\ &= 0.707 Mg CO_2e ha^{-1} yr^{-1} \end{aligned}$$

Indirect emissions

The indirect baseline nitrous oxide emissions from nitrogen fertilization can be calculated using the following equations:

$$N_2O_{B \text{ indirect}, t} = N_2O_{B \text{ volat}, t} + N_2O_{B \text{ leach}, t} \quad (7)$$

$$N_2O_{B \text{ volat}, t} = [(F_{B \text{ SN}, t} * \text{Fra}_{\text{CGASF}}) + (F_{B \text{ ON}, t} * \text{Fra}_{\text{CGASM}})] * EF_{\text{BIV}} * N_2O_{\text{MW}} * N_2O_{\text{GWP}} \quad (8)$$

$$N_2O_{B \text{ leach}, t} = (F_{B \text{ SN}, t} + F_{B \text{ ON}, t}) * \text{Fra}_{\text{CLEACH}} * EF_{\text{BIL}} * N_2O_{\text{MW}} * N_2O_{\text{GWP}} \quad (9)$$

Where:

$N_2O_{B \text{ indirect}, t}$	Indirect baseline N_2O emissions beyond the project site, $\text{Mg CO}_2\text{e ha}^{-1}$ in year t ;
$N_2O_{B \text{ volat}, t}$	Indirect baseline N_2O emissions produced from atmospheric deposition of N volatilized as a result of N application at the project site, $\text{Mg CO}_2\text{e ha}^{-1}$ in year t ;
$N_2O_{B \text{ leach}, t}$	Indirect baseline N_2O emissions produced from leaching and runoff of N in regions where leaching and runoff occurs, as a result of N application at the project site, $\text{Mg CO}_2\text{e ha}^{-1}$ in year t ;
$F_{B \text{ SN}, t}$	Mass of baseline synthetic N fertilizer applied adjusted for volatilization as NH_3 and NO_x , and leaching and runoff where applicable, Mg N ha^{-1} in year t ;
$F_{B \text{ ON}, t}$	Mass of baseline organic N fertilizer applied adjusted for volatilization as NH_3 and NO_x , and leaching and runoff where applicable, Mg N ha^{-1} in year t ;
$\text{Fra}_{\text{CGASF}}$	Fraction of all synthetic N added to baseline soils that volatilizes as NH_3 and NO_x , dimensionless;
$\text{Fra}_{\text{CGASM}}$	Fraction of all organic N added to baseline soils that volatilizes as NH_3 and NO_x , dimensionless;
$\text{Fra}_{\text{CLEACH}}$	Fraction of N added (synthetic or organic) to baseline soils that is lost through leaching and runoff, in regions where leaching and runoff occurs, dimensionless;
EF_{BIV}	Emission factor for baseline N_2O emissions from atmospheric deposition of N on soils and water surfaces, $[\text{Mg } N_2O\text{-N} (\text{Mg } \text{NH}_3\text{-N} + \text{NO}_x\text{-N volatilized})^{-1}]$;
EF_{BIL}	Emission factor for baseline N_2O emissions from N leaching and runoff, $\text{Mg } N_2O\text{-N} (\text{Mg N leached and runoff})^{-1}$;
N_2O_{MW}	Ratio of molecular weights of N_2O to N, $\text{Mg } N_2O (\text{Mg N})^{-1}$;
N_2O_{GWP}	Global Warming Potential for N_2O , $\text{Mg CO}_2\text{e} (\text{Mg } N_2O)^{-1}$.

Emission factors for baseline indirect emissions are taken from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 11, revised August, 2011). These emissions factors are also shown in MSU-EPRI v1 (Annex F, Table F1).

N₂O Emissions	Protocol factor	Default value
Indirect	EF _{BIV}	0.010
Indirect	EF _{BIL}	0.0075
Indirect	FraC _{GASF}	0.10
Indirect	FraC _{GASM}	0.20

Determination of $Frac_{LEACH}$

The determination of whether leaching occurs at the project site uses default (Tier 1) values for leaching and run-off from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Revised August 2011), and the ratio of growing season values of precipitation to potential evapotranspiration (see MSU-EPRI v1, Annex A). Data and calculations to determine $Frac_{LEACH}$ are given in Appendix E.

A project site has a $Frac_{LEACH}$ value of 0.30 kg N (kg N additions)⁻¹) when:

$$Precip_{GS} / PET_{GS} \geq 1.00 \quad (A1)$$

A project site has a $Frac_{LEACH}$ value of 0.00 kg N (kg N additions)⁻¹) when:

$$Precip_{GS} / PET_{GS} < 1.00 \quad (A2)$$

Where:

Precip_{GS} = Precipitation during the growing season, mm;

PET_{GS} = Potential evapotranspiration during the growing season, mm.

For the baseline period

$$\begin{aligned} Precip_{GS} / PET_{GS} &= 0.52 \\ &< 1.00 \end{aligned}$$

Therefore, the project site has a $Frac_{LEACH}$ value of 0.00 kg N (kg N additions)⁻¹.

From equation (9)

$$\begin{aligned} N_2O_{B \text{ leach, t}} &= 0.172 * 0.00 * 0.0075 * 44/28 * 310 \\ &= 0.000 \text{ Mg CO}_2\text{e ha}^{-1} \text{ yr}^{-1} \end{aligned}$$

From equation (8)

$$\begin{aligned} N_2O_{B \text{ volat, t}} &= [(0.172 * 0.10) + (0 * 0.20)] * 0.01 * 44/28 * 310 \text{ Mg CO}_2\text{e ha}^{-1} \\ &= 0.084 \text{ Mg CO}_2\text{e ha}^{-1} \text{ yr}^{-1} \end{aligned}$$

From equation (7), indirect baseline N₂O emissions:

$$\begin{aligned} \text{N}_2\text{O}_{\text{B indirect, t}} &= 0.084 + 0.000 \\ &= 0.084 \text{ Mg CO}_2\text{e ha}^{-1} \text{ yr}^{-1} \end{aligned}$$

From equation (1), baseline total N₂O emissions:

$$\begin{aligned} \text{N}_2\text{O}_{\text{B total, t}} &= 0.707 + 0.084 \\ &= 0.791 \text{ Mg CO}_2\text{e ha}^{-1} \text{ yr}^{-1} \end{aligned}$$

E2. PROJECT SCENARIO

Detail the GHG quantification methodology for the project scenario including all relevant emissions or removals. Provide sample calculations wherever possible.

The N₂O quantification methodology for the project scenario are given in MSU-EPRI v1 (section 6.2).

Relevant equations are presented below with sample calculations.

Project emissions can be calculated by the following equation:

$$\text{N}_2\text{O}_{\text{P total, t}} = \text{N}_2\text{O}_{\text{P direct, t}} + \text{N}_2\text{O}_{\text{P indirect, t}} \quad (10)$$

Where:

- $\text{N}_2\text{O}_{\text{P total, t}}$ Total project N₂O emissions, Mg CO₂e ha⁻¹ in year t;
- $\text{N}_2\text{O}_{\text{P direct, t}}$ Direct project N₂O emissions from the project site, Mg CO₂e ha⁻¹ in year t;
- $\text{N}_2\text{O}_{\text{P indirect, t}}$ Indirect project N₂O emissions beyond the project site, Mg CO₂e ha⁻¹ in year t.

Direct emissions

The project is eligible to use Method 1 from MSU-EPRI v1 to calculate N₂O emissions for the project scenario. Method 1 uses a regional specific emissions factor to calculate direct N₂O emissions.

The direct project nitrous oxide emissions from nitrogen fertilization for Method 1 can be calculated using the following equations:

$$\text{N}_2\text{O}_{\text{P direct, t}} = (\text{F}_{\text{P SN, t}} + \text{F}_{\text{P ON, t}}) * \text{EF}_{\text{PDM1}} * \text{N}_2\text{O}_{\text{MW}} * \text{N}_2\text{O}_{\text{GWP}} \quad (11)$$

$$\text{F}_{\text{P SN, t}} = \text{M}_{\text{P SF, t}} * \text{NC}_{\text{P SF}} \quad (12)$$

$$\text{F}_{\text{P ON, t}} = \text{M}_{\text{P OF, t}} * \text{NC}_{\text{P OF}} \quad (13)$$

Where:

- $\text{F}_{\text{P SN, t}}$ Project synthetic N fertilizer applied, Mg N ha⁻¹ in year t;
- $\text{F}_{\text{P ON, t}}$ Project organic N fertilizer applied, Mg N ha⁻¹ in year t;
- $\text{M}_{\text{P SF, t}}$ Mass of project N containing synthetic fertilizer applied, Mg ha⁻¹ in year t;
- $\text{M}_{\text{P OF, t}}$ Mass of project N containing organic fertilizer applied, Mg ha⁻¹ in year t;

$NC_{P_{SF}}$	N content of project synthetic fertilizer applied g N (100g fertilizer) ⁻¹ ;
$NC_{P_{OF}}$	N content of project organic fertilizer applied g N (100g fertilizer) ⁻¹ ;
EF_{PDM1}	Emission factor for project N ₂ O emissions from N inputs, Mg N ₂ O–N (Mg N input) ⁻¹ ;
N_2O_{MW}	Ratio of molecular weights of N ₂ O to N, Mg N ₂ O (Mg N) ⁻¹ ;
N_2O_{GWP}	Global Warming Potential for N ₂ O, Mg CO ₂ e (Mg N ₂ O) ⁻¹ .

Calculation of $F_{P_{SN}, t}$

N fertilizer application to corn at the project site took place on April 21, 2011.

No organic N containing fertilizer was applied during the project period.

In order to determine project emissions of N₂O, management records documenting the fertilizer application to corn at the project site in 2011 are required. Copies of these documents are found in Appendix C and calculations of N rate derived from these documents are presented in Appendix D.

N fertilizer rate applied over project period

$$F_{P_{SN}, t} = F_{P_{SN}, 2011}, \text{ Mg N ha}^{-1} \text{ yr}^{-1} \quad (12)$$

Where:

$$F_{P_{SN}, 2011} = \text{Synthetic N fertilizer applied in 2011, Mg N ha}^{-1}.$$

From equation (16), the project N rate:

$$F_{P_{SN}, t} = 0.147 \text{ Mg N ha}^{-1}$$

From equation (13), direct project N₂O emissions:

$$\begin{aligned} N_2O_{P_{direct}, t} &= (0.147) * 6.7 * 10^{-4} * (\exp [6.7 * (0.147)] - 1) / (0.147) * 44/28 * 310 \\ &= 0.547 \text{ Mg CO}_2\text{e ha}^{-1} \text{ yr}^{-1} \end{aligned}$$

Indirect emissions

The indirect project nitrous oxide emissions from nitrogen fertilization for Method 1 can be calculated using the following equations:

$$N_2O_{P_{indirect}, t} = N_2O_{P_{volat}, t} + N_2O_{P_{leach}, t} \quad (16)$$

$$\begin{aligned} N_2O_{P_{volat}, t} &= [(F_{P_{SN}, t} * \text{Frac}_{GASF}) + (F_{P_{ON}, t} * \text{Frac}_{GASM})] \\ &\quad * EF_{PIV} * N_2O_{MW} * N_2O_{GWP} \end{aligned} \quad (17)$$

$$N_2O_{P_{leach}, t} = (F_{P_{SN}, t} + F_{P_{ON}, t}) * \text{Frac}_{LEACH} * EF_{PIL} * N_2O_{MW} * N_2O_{GWP} \quad (18)$$

Where:

$N_2O_{P \text{ indirect}, t}$	Indirect project N_2O emissions beyond the project site, $Mg \text{ CO}_2e \text{ ha}^{-1}$ in year t ;
$N_2O_{P \text{ volatil}, t}$	Indirect project N_2O emissions produced from atmospheric deposition of N volatilized as a result of N application at the project site, $Mg \text{ CO}_2e \text{ ha}^{-1}$ in year t ;
$N_2O_{P \text{ leach}, t}$	Indirect project N_2O emissions produced from leaching and runoff of N in regions where leaching and runoff occurs, as a result of N application at the project site, $Mg \text{ CO}_2e \text{ ha}^{-1}$ in year t ;
$F_{P \text{ SN}, t}$	Project synthetic N fertilizer applied adjusted for volatilization as NH_3 and NO_x , and leaching and runoff where applicable, $Mg \text{ N ha}^{-1}$ in year t ;
$F_{P \text{ ON}, t}$	Project organic N fertilizer applied adjusted for volatilization as NH_3 and NO_x , and leaching and runoff where applicable, $Mg \text{ N ha}^{-1}$ in year t ;
$Fra_{C_{GASF}}$	Fraction of all synthetic N added to project soils that volatilizes as NH_3 and NO_x , dimensionless;
$Fra_{C_{GASM}}$	Fraction of all organic N added to project soils that volatilizes as NH_3 and NO_x , dimensionless;
$Fra_{C_{LEACH}}$	Fraction of N added (synthetic or organic) to project soils that is lost through leaching and runoff, in regions where leaching and runoff occurs, dimensionless;
EF_{PIV}	Emission factor for project N_2O emissions from atmospheric deposition of N on soils and water surfaces, $[Mg \text{ N}_2O-N (Mg \text{ NH}_3-N + NO_x-N \text{ volatilized})^{-1}]$;
EF_{PIL}	Emission factor for project N_2O emissions from N leaching and runoff, $Mg \text{ N}_2O-N (Mg \text{ N leached and runoff})^{-1}$;
N_2O_{MW}	Ratio of molecular weights of N_2O to N , $Mg \text{ N}_2O (Mg \text{ N})^{-1}$;
N_2O_{GWP}	Global Warming Potential for N_2O , $Mg \text{ CO}_2e (Mg \text{ N}_2O)^{-1}$

Emission factors for project indirect emissions are taken from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 11, revised August, 2011). These emissions factors are also shown in MSU-EPRI v1 (Annex F, Table F1).

N_2O Emissions	Protocol factor	Default value
Indirect	EF_{PIV}	0.010
Indirect	EF_{PIL}	0.0075
Indirect	$Fra_{C_{GASF}}$	0.10
Indirect	$Fra_{C_{GASM}}$	0.20

The $Fra_{C_{LEACH}}$ value calculated for the baseline period is considered valid throughout the project period.

For the baseline period

$$\begin{aligned} \text{Precip}_{GS} / \text{PET}_{GS} &= 0.52 \\ &= < 1.00 \end{aligned}$$

Therefore, the project site has a F_{CLEACH} value of $0.00 \text{ kg N (kg N additions)}^{-1}$.

$$F_{\text{P SN, t}} = 0.147 \text{ Mg N ha}^{-1}$$

From equation (19)

$$\begin{aligned} N_{2\text{O P leach, t}} &= 0.147 * 0.00 * 0.0075 * 44/28 * 310 \\ &= 0.000 \text{ Mg CO}_2\text{e ha}^{-1} \text{ yr}^{-1} \end{aligned}$$

From equation (18)

$$\begin{aligned} N_{2\text{O P volatil, t}} &= [(0.147 * 0.10) + (0 * 0.20)] * 0.01 * 44/28 * 310 \text{ Mg CO}_2\text{e ha}^{-1} \\ &= 0.072 \text{ Mg CO}_2\text{e ha}^{-1} \text{ yr}^{-1} \end{aligned}$$

From equation (17), indirect project N_2O emissions:

$$\begin{aligned} N_{2\text{O P indirect, t}} &= 0.072 + 0.000 \\ &= 0.072 \text{ Mg CO}_2\text{e ha}^{-1} \text{ yr}^{-1} \end{aligned}$$

From equation (12), total project N_2O emissions:

$$\begin{aligned} N_{2\text{O P total, t}} &= 0.547 + 0.072 \\ &= 0.618 \text{ Mg CO}_2\text{e ha}^{-1} \text{ yr}^{-1} \end{aligned}$$

E3. LEAKAGE

Describe how leakage is accounted for and quantified. Provide sample calculations wherever possible.

As defined by ACR Standard (v. 2.1) “leakage is an increase in GHG emissions or decrease in sequestration outside the project boundaries that occurs because of the project action.”

As the project site was actively maintained for corn production during the project-crediting period, the leakage risk is negligible. Corn producers are highly risk averse and will not intentionally suffer reduced yields in exchange for marginally increased revenue associated with ERTs from reducing N fertilization rates in a manner that affects expected crop yields.

Consequently, with no expected reduction in productivity at the project site, there was no associated incentive or requirement for a shift of activity or increased production outside of the project site, which might then result in increased N fertilizer use and N_2O emissions. The leakage potential is therefore negligible and is not quantified.

E4. UNCERTAINTY

Describe how ex post uncertainty is accounted for and quantified. Provide sample calculations wherever possible.

The uncertainty associated with a reduction in N_2O emissions brought about by a reduction in N rate between the baseline period and the project period is calculated as:

F.
COMMUNITY & ENVIRONMENTAL
IMPACTS

F1. NET POSITIVE IMPACTS

Provide an assessment of net positive community and environmental impacts, and a mitigation plan for any foreseen negative community or environmental impacts.

Nitrogen is mobile and difficult to contain. Because of this, much of the N added to agricultural systems does not end up as protein in the human diet. Nearly 50% of N applied to crops escapes to soil, air, and water where it can alter the balance of nitrogen naturally cycling through these environments, and the human and economic systems that they support. This project will deliver net community and environmental benefits by reducing these impacts.

N is a critical nutrient that supports plant growth and aquatic ecosystems. However, excessive N loading to streams, rivers, and lakes can pollute surface waters and create hypoxic conditions that deplete oxygen and can cause adverse impacts to fish. In some areas, including the Gulf of Mexico, hypoxia has been attributed to the death of entire fish populations (U.S. EPA).

Excess nitrogen that is volatilized to the atmosphere can also have significant impacts beyond its global warming potential. Excess atmospheric N can limit visibility and cause or exacerbate human health issues. Additionally, excess atmospheric N is returned to terrestrial ecosystems through precipitation and runoff.

These patterns also impact economic activity. Streams, rivers, and lakes support fisheries, tourism, and other industries that rely on healthy aquatic ecosystems. Similarly, adverse human health impacts may deplete human capital and strain limited social resources. This project reduces N loading at its source, and limits disruptions to the N cycle and its impacts to the environment, economy, and human health.

F2. STAKEHOLDER COMMENTS

Describe relevant outcomes from stakeholder consultations and mechanisms for ongoing communication, as applicable.

Not applicable.

F3. REFERENCES

U.S. EPA Office of Wetlands, Oceans, and Watersheds. "Mississippi River Gulf of Mexico Watershed Nutrient Task Force." Available online at:
<http://water.epa.gov/type/watersheds/named/msbasin/learn.cfm>.

G.
OWNERSHIP AND TITLE

G1. PROOF OF TITLE

Describe how title to the reductions or enhanced removals created by the project is established and attach Proof of Title documents containing one or more of the following:

- *A legislative right*
- *A right under common law*
- *Ownership of the plant, land, equipment and/or process generating the reductions/removals*
- *A contractual arrangement with the owner of the plant, land, equipment or process that grants all reductions/removals to the Project Proponent*

The land on which the project site is located is owned by Mr. [REDACTED] (section A9). A copy of the State of Michigan Farmland Development Rights Agreement is presented in Appendix F.

G2. CHAIN OF CUSTODY

If the offsets have been bought or sold previously, or if the project has a forward option contract, the Project Proponent must include documentation establishing chain of custody. Documentation may include:

- *Delivery of Confirmation Notice*
- *Emission Reduction Purchase Agreement*
- *Signed Attestation of Ownership*
- *Forward Option Purchase Agreement*

Please see Appendix G for signed attestation of ownership

G3. PRIOR APPLICATION

Describe whether or not the project proponent has applied for GHG emission reduction or removal credits for this project through any other GHG emissions trading system or program and the success of any of these applications. If the project has previously been rejected by another GHG emissions trading system or program, provide the reasons why.

No previous application has been submitted.

H.

PROJECT TIMELINE

H1. START DATE

Provide the project start date, and describe how it was determined and why it is appropriate and consistent with the requirements of the ACR Standard v2.1, any relevant ACR sector standard, and the chosen methodology.

From MSU-EPRI v1 (Section 2.2):

“Nitrogen fertilizer addition to a project site during growth of a single crop (or double or multiple crops) during a growing season is eligible for determination of ‘yearly’ N fertilizer rate irrespective of when N fertilizer is applied during the calendar year or whether N fertilizer applied is split between calendar years to the same crop.

In this project a single application of N fertilizer was made to corn at the project site during the crediting period. This application took place on April 21, 2011 and signaled the start of the project period. The first project reporting year includes the planting, growth, and harvest of the 2011 corn crop through April 21, 2012, 12 months following the first fertilizer application date (as specified in Section 6 of MSU-EPRI v1). The planting of the next crop, soybeans, took place on May 25, 2012.

This one-year project time period meets the minimum term for changes in fertilizer management project activities set out in the *ACR Methodology for N₂O Emission Reductions through Changes in Fertilizer Management* (November 2010) and MSU-EPRI v1.

H2. PROJECT TIMELINE

Provide a timeline for project activities including:

- *Initiation of project activities*

Project activities were initiated on April 21, 2011 when application of N fertilizer was made to corn at the project site.

- *Project reporting year*

The first project reporting year is between April 21, 2011 and April 21, 2012.

- *Crediting period*

The crediting period is between April 21, 2011 and April 21, 2018.

- *Frequency of monitoring, reporting and verification*

The relevant parameters outlined in MSU-EPRI v1 (Section 11.1) will be monitored, reported on and verified for at least the 2011 project reporting year. Subsequent project reporting years will be subject to a desk audit and a follow-up full verification (as needed) by an approved verifier, per the ACR Standard v2.1.

Nitrous Oxide Reduction in Corn: GHG Plan Annexes for ACR 171

April 2014

Submitted By:

Delta Institute



**In Partnership with Michigan State University and
the Electric Power Research Institute**

**MICHIGAN STATE
UNIVERSITY**



APPENDIX A

MICHIGAN DEPARTMENT OF AGRICULTURE AND RURAL DEVELOPMENT GENERALLY ACCEPTED AGRICULTURAL AND MANAGEMENT PRACTICES FOR NUTRIENT UTILIZATION, JANUARY 2013

Appendix A shows the excerpted relevant section of Michigan Department of Agriculture and Rural Development Generally Accepted Agricultural and Rural Development Generally Accepted Agricultural and Management Practices (GAAMPs).



Michigan Department of
AGRICULTURE
& Rural Development

**Generally Accepted Agricultural
and Management Practices
for Nutrient Utilization**

January 2013

Michigan Commission of Agriculture
& Rural Development

PO Box 30017
Lansing, MI 48909

PH: (517) 241-4366
www.michigan.gov/mda

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stand when it is killed by tillage or applying an herbicide. See MSU Extension Bulletin E-2904 (Warncke *et al.*, 2004a) for suggested legume N credits.

Livestock manure is also a good source of plant nutrients. Manure should be analyzed periodically to determine the appropriate credit for the nutrients supplied. See the current "Generally Accepted Agricultural and Management Practices for Manure Management and Utilization" for recommended management practices when utilizing manure.

Other organic (biological) materials, such as human sewage, food processing by-products, industrial organic by-products, wood, and municipal refuse can potentially be used as a source of plant nutrients. Most of these materials are regulated by DEQ. More information on the use of these organic materials and by-product liming materials can be found in Section VII and Section VIII of these GAAMPs.

NITROGEN MANAGEMENT PRACTICES

10a. To enhance N uptake, match N fertilizer applications to the demand of the crop and the conditions of the soil.

Efficient use of N fertilizer is important economically, agronomically, and environmentally. Greater efficiencies can be achieved by using university recommended rates of N fertilizer, by using sources of N fertilizer compatible with the crop and the environment, and by following good N management practices.

Nitrogen Fertilizer Rate

The amount of N fertilizer applied is crucial for efficient use by plants. Excessive applications can lead to contamination of both surface water and groundwater. The amount of N fertilizer used for field and vegetable crops should be based on a realistic yield goal and the amount of N available from the soil, previous crop, manure, and/or other biological materials. See MSU Extension Bulletins E-2904 and E-2934 (Warncke *et al.*, 2004a, 2004b) for more information on selecting the appropriate rate of N fertilizer. Recommended N rates for fruit crops are given in MSU Extension Bulletins E-852 (Hanson, 1996) and E-2011 (Hanson and Hancock, 1996).

Forms of Nitrogen Fertilizer

Nearly all N fertilizers are soluble in water and are subject to movement in soils as soon as they are applied. However, certain forms of N fertilizers have greater potential for movement out of the root zone. Nitrate N, in calcium nitrate or ammonium nitrate, is readily available for plants but is subject to immediate leaching when added to soil. Under conditions of high leaching potential, nitrate forms of N should not be used unless the plants are actively growing and can utilize the applied nitrate N. Where there is a high potential for leaching, ammonium forms of N, such as urea, ammonium sulfate, or anhydrous ammonia, are preferred sources of N. Ammonium in soil is held on clay and

organic matter and must first be converted to nitrate N before it can be leached or denitrified. This process, known as nitrification, occurs rapidly under warm, moist conditions.

Urea and N solutions containing urea are subject to volatilization loss as gaseous ammonia if surface applied and not incorporated. Conditions which favor this loss are high temperatures, high soil pH, moist soils, and high levels of plant residue on the soil surface. Because the volatilization loss of a urea-based fertilizer is difficult to assess, and since it represents an economic loss to the farmer, urea-containing fertilizers should be incorporated whenever possible. See MSU Extension Bulletin E-896 (Vitosh, 1990) for more information on fertilizer types, uses and characteristics. In fruit plantings and sod production fields where incorporation is not possible, apply urea when conditions are cool and not conducive to volatilization.

Time and Placement of Nitrogen Fertilizer

A small amount of N in a starter fertilizer applied to annual row crops at planting time is often desirable and normally has a beneficial effect on P uptake, particularly under cool, wet conditions. Crops on sandy soils low in organic matter and available N are also likely to respond to starter N fertilizer.

Spring applications of N on corn in Michigan are clearly superior to fall applications (Vitosh, 1991). Fall applications of N for spring or summer-seeded crops are not recommended. Climatic conditions from fall to spring can significantly affect the amount of N movement from the plant root zone. Estimates of N loss from fall applications vary from ten to 20 percent on fine to medium textured soils (clay, clay loams, and loams) and 30 to greater than 50 percent on coarse textured soils (sandy loams, loamy sands, and sands).

For establishment of winter small grains, such as winter wheat or rye, small applications of N fertilizer (20-30 lbs./acre) can be made in the fall at planting time. The remainder of the N requirement for these crops should be applied just prior to green-up in the spring. Avoid applications of N to snow-covered ground and to frozen land with slopes greater than six percent. Nitrogen applications on highly sloping land should be made after the spring thaw.

Split applications of N fertilizer during the growing season on corn and most vegetable crops are frequently beneficial on coarse textured soils (Vitosh, 1986). The benefits of split applications of N on corn grown on fine textured soils are less likely to occur, therefore, total N applications at planting or after emergence are acceptable. Fruit plantings on coarse textured soils may also benefit from split applications of N. Apply part of the N in early spring and part in late spring. Rates in the second application can be adjusted for anticipated yield.

For sod production, a small application of N fertilizer (20-40 lbs./acre) can be made in the fall at seeding time. During the growing season, multiple small applications of N can

be made at four to six week intervals as long as roots are actively growing. This practice will help to maintain turf density and reduce the need for herbicides.

Additional N fertilizer may be used in emergency situations, such as when heavy rains occur early in the growing season causing excessive leaching and/or denitrification. The use of additional N fertilizer in these situations may be necessary to prevent severe yield losses. Adding N fertilizer after heavy rains or flooding late in the season is usually not agronomically or economically effective and should be done only after careful consideration of the benefits and the effect on the environment.

10b. Use special N management practices on sandy soils and in groundwater-sensitive or well-head protection areas.

Many site-specific management practices and tools can be adopted which may improve N recovery and reduce the potential for nitrate contamination of groundwater. Crop rotations, forage crops, cover crops, plant analysis, soil sampling for nitrate, split applications of N, and use of nitrification inhibitors are some of the special N management practices that can be used on sandy soils and other groundwater-sensitive areas to minimize nitrate losses to groundwater. See MSU Extension Bulletin WQ-25 (Vitosh and Jacobs, 1996) for more information on these management practices. The NRCS Field Office Technical Guide (USDA-NRCS) located in each conservation district office contains information for identification of groundwater-sensitive areas.

PHOSPHORUS MANAGEMENT PRACTICES

11a. Apply phosphorus fertilizer based on soil tests or plant tissue analyses using Michigan State University recommended rates and methods of application that will enhance P recovery and uptake.

Michigan State University fertilizer recommendations are found in Extension Bulletins E-2904 (Warncke *et al.*, 2004a) E-2934, (Warncke *et al.*, 2004b), E-852 (Hanson, 1996), and E-2011 (Hanson and Hancock, 1996). When soils have a Bray P1 test of 80-100 lbs./acre (40 to 50 ppm), fertilizer recommendations for P₂O₅ will likely be zero for most crops and yields grown in Michigan. So, increasing soil P test levels beyond this range will usually not be beneficial agronomically or economically.

Band application of starter fertilizer to the side and below the seed at planting time is considered to be the most efficient placement of P for field and vegetable crops when grown in rows. Broadcast applications of P are less efficient and normally will result in lower yields than band applications when soil test P levels are low. When broadcast applications are necessary, the P fertilizer should be applied and incorporated prior to establishment of the crop, to improve nutrient utilization by plants and prevent excessive nutrient runoff. For no-till crops, such as soybeans and wheat planted with a narrow row drill, the necessary broadcast application should be made just prior to planting. For established crops, such as grass sod, pastures, legumes, and other forages, where it is

APPENDIX B

PROJECT SITE MAPS and COORDINATES

Appendix B shows geographic maps and coordinates of the location of the project site, and a soil map of the farm on which the project site is located.

B1. Project site description and coordinates

The project site is located in the North Central region (NCR) of the US. It is situated on land owned by a commercial farmer in Tuscola County in Michigan, USA. Figure A1 shows maps of varying scale to identify the project site. A KMZ file is also included with project documentation to delineate the project boundary.

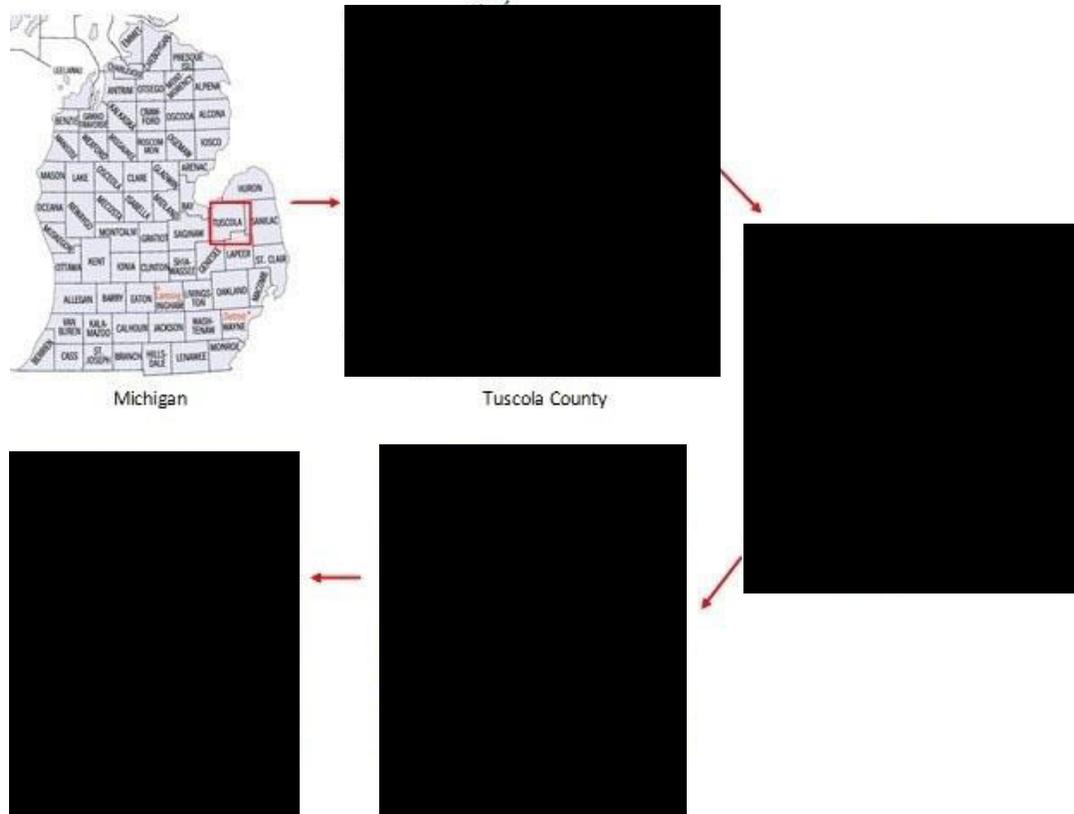
Project site details:

Area 39.62 acres (16.05 hectares)

Local name [REDACTED]

Coordinates [REDACTED]
[REDACTED]
[REDACTED]

Figure B1. Maps showing project site in Tuscola County in Michigan.



B2. Project site soil map and description

Figure B2 below is generated from USDA-NRCS certified data, Web Soil Survey 2.0, National Cooperative Soil Survey (<http://websoilsurvey.nrcs.usda.gov>).

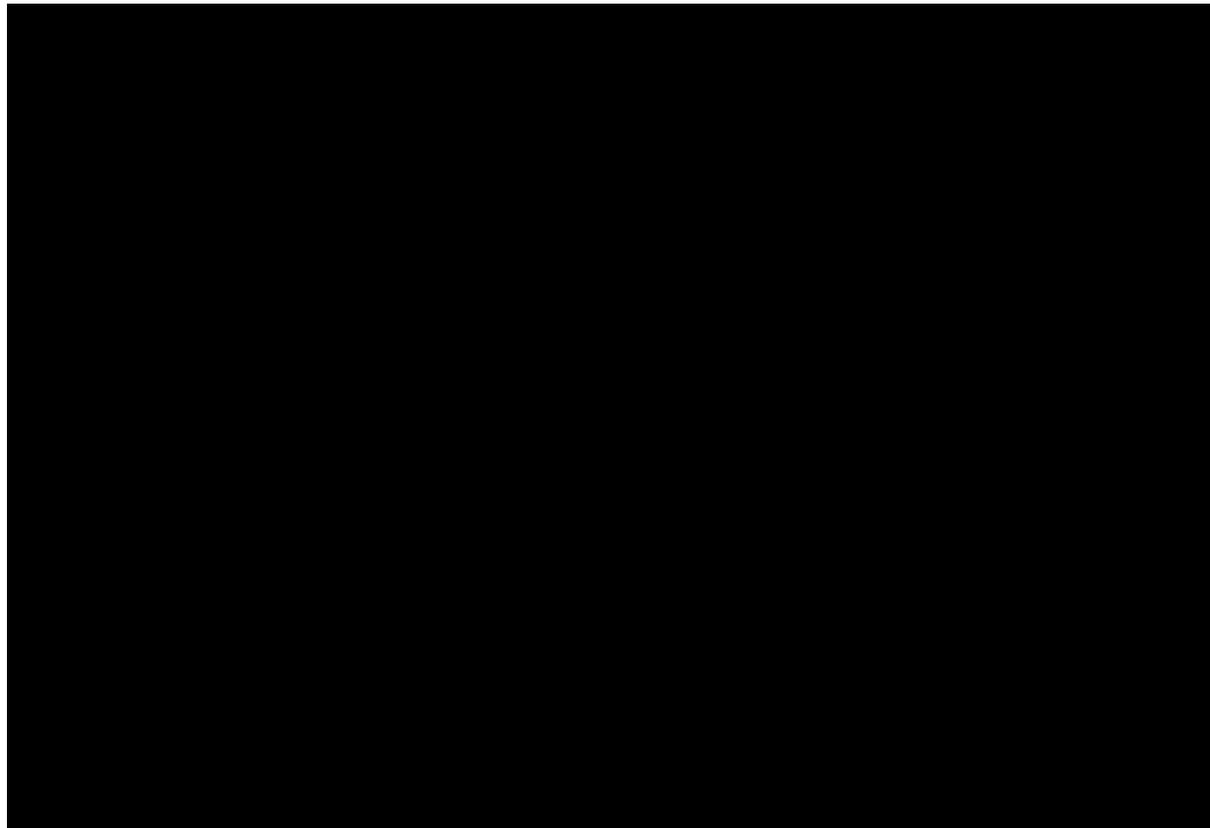
Map details are:

Soil Survey Area: Tuscola County, Michigan [REDACTED]

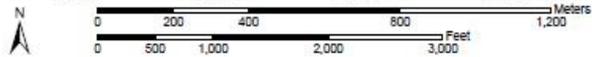
Survey Area Data: Version 6. December, 2006

Coordinate System: UTM Zone 17N

Aerial images: 25 April 2000



Unit Symbol	Unit Name
6A	Tappan-Avoca complex, 0 to 3 percent slopes
8A	Tappan-Londo loams, 0 to 2 percent slopes
14A	Avoca loamy fine sand, 0 to 3 percent slopes
18	Essexville loamy fine sand
25A	Londo loam, 0 to 3 percent slopes
64	Tappan-Lenawee variant complex
67B	Pipestone fine sand, loamy substratum, 0 to 4 percent slopes



Project Site
 Soil Map Unit
 — Streams and Canals

Figure B2. Soil map of [redacted] encompassing project site (approximate boundary) in Tuscola County in Michigan.

APPENDIX C

PROJECT SITE MANAGEMENT RECORDS

Delta-MSU-EPRI / Nitrous Oxide Reduction in Corn (NORC)

Appendix C presents fertilizer load sheets and nitrogen application maps for the project site during the baseline years (2003, 2007, and 2009), and the project year (2011).

Each Figure is a scanned copy annotated to show relevant information to aid in N rate calculations and project validation and verification, including: 1. Crop type; 2. Location; 3. Fertilizer application rate; 4. Fertilizer type and amount; and, 5. Application date.

Figure C1. Fertilizer load sheet for corn in 2003

Figure C2. Fertilizer load sheet for corn in 2007

Figure C3. Fertilizer nitrogen map for corn in 2009

Figure C4. Fertilizer load sheet for corn in 2011

Figure C5. Fertilizer nitrogen map for corn in 2011

Delta-MSU-EPRI / Nitrous Oxide Reduction in Corn (NORC)

[REDACTED]

BATCH 1 OF 1 SHEET#: 6969
27458

NAME: [REDACTED]
 1. CROP: CORN AIR TRUCK FERTILIZER

ANALYSIS: 33-4 -12 Mg Mn S P Z Cu

DENSITY: 52.937

COMMENTS: AT [REDACTED] BACK LN. AND [REDACTED] 2.

AIR TRUCK ACRES - 59. () LBS/ACRE- 460. 3.

NUMBER OF TONS: 13.6 MINUTES PER TON: 1.25 TIME RUN: 16.96MINUTES

#/TON	BIN#	PRODUCT	RPM
148	1A	11-52-00 MAP	112.
700	2A	46-00-00 UREA	266.
407	3A	00-00-62 WHITE	305.
745	6A	POLY-COATED UREA	993.
2000			

4.

MISCELLANEOUS INGREDIENTS	UNITS	EPA#	IMPREGNATOR	UNIT	RPM	---	@
	0.	[]		RATE	RPM		
	0.	[]		/ACRE	0		
	0.	[]		/ACRE	0		
	0.	[]		/ACRE	0		
	0.	[]		/ACRE	0		

WIND DIRECTION: _____ CALM: _____ SLIGHT: _____ LIMIT: _____

WEATHER: APPROX. TEMPERATURE _____ SUNNY _____ CLOUDY _____ OVERCAST _____

SOIL: WET _____ MEDIUM _____ DRY _____

APPLIED BY: _____ DATE: _____

TIME STARTED: _____ FINISHED: _____

FERTILIZER BLEND SHEET #: 6969 BATCH 1 OF 1 DATE: 04/28/03 5.

5/5
304569

Figure C1. Fertilizer load sheet for corn in 2003.

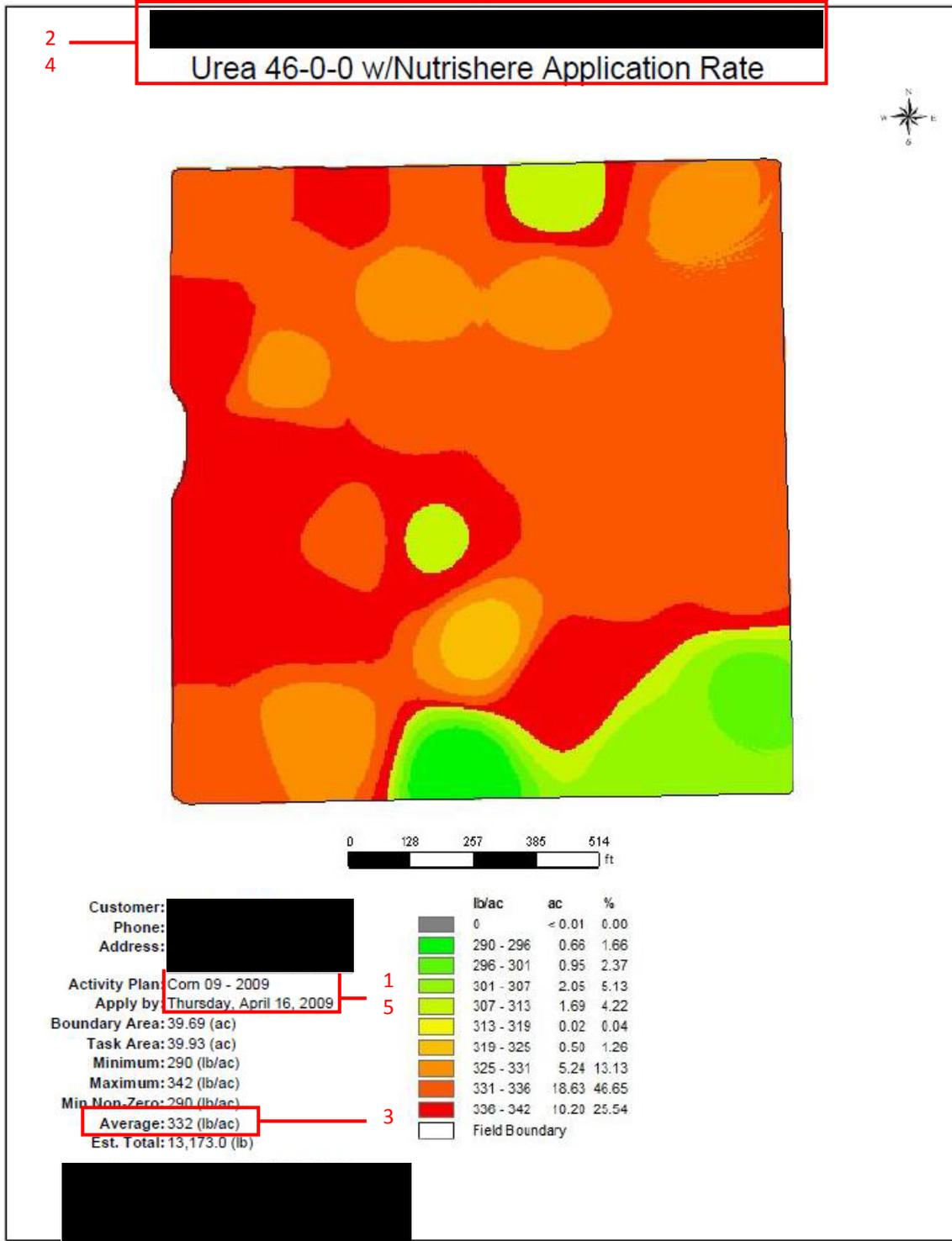


Figure C3. Fertilizer nitrogen map for corn in 2009.

Delta-MSU-EPRI / Nitrous Oxide Reduction in Corn (NORC)

Load Sheet

5. Apply by: Thursday, April 21, 2011 Latitude: Longitude: 2.

Boundary Area: 39.37 (ac) Customer: Phone: Address:

Task Area: 39.62 (ac)

Application Plan Name: Corn 2011 - 2011

1. Crop(s): Corn Notes:

Dry Products

Name	Abbreviation	Rate	Total
45-0-0 ESN-urea blend	45-0-0 ESN-urea	304 (lb/ac)	12,028.3 (lb)
Potash 0-0-62	Potash 62% white	99 (lb/ac)	3,910.9 (lb)
KMAG	KMAG	0 (lb/ac)	0.0 (lb)
Dry Total:			15,939.3 (lb)

4. 3.

5.

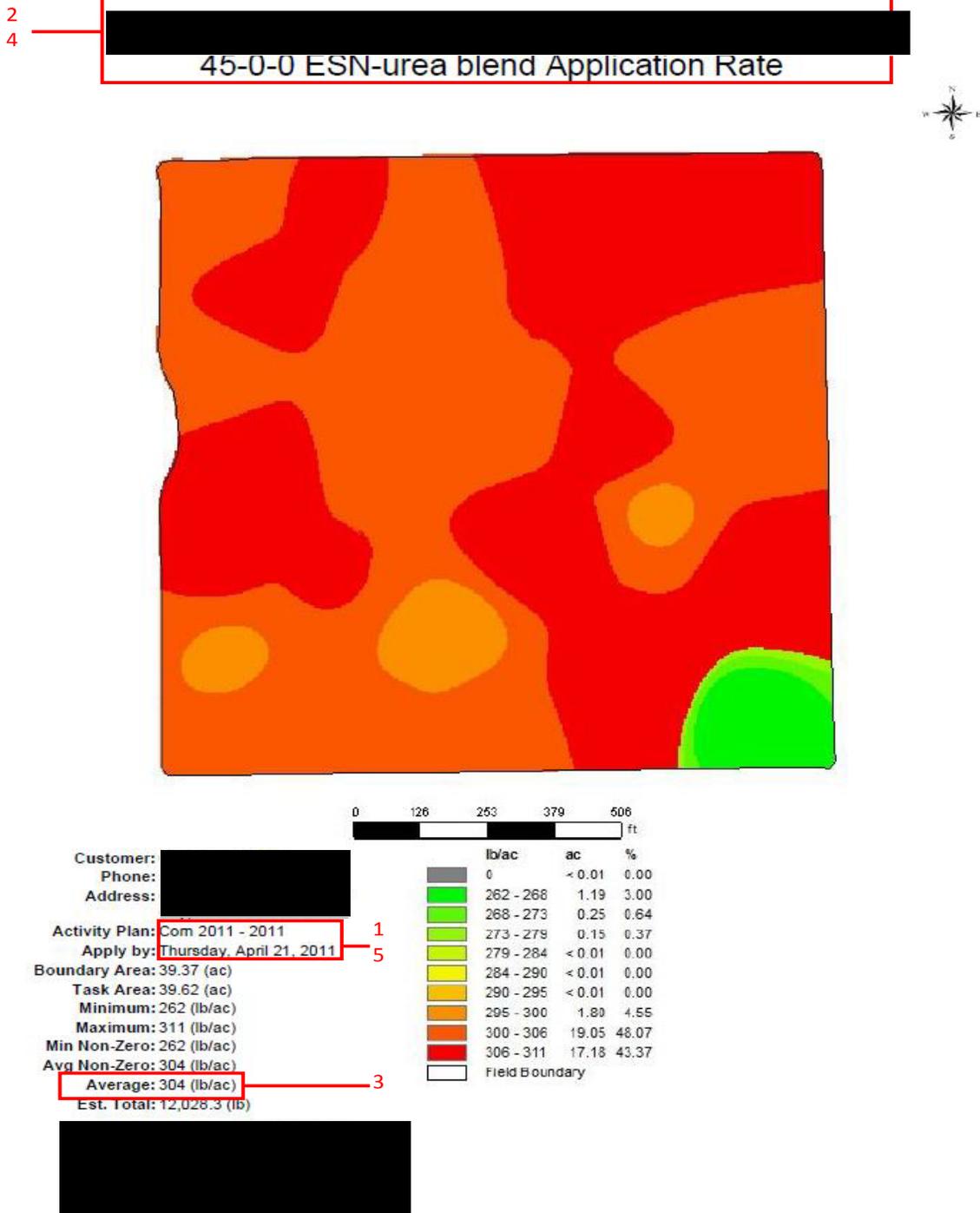
COMMODITY/ANALYSIS		DENSITY # FT ³	GROSS
45-0-0 w/ESN	<input type="checkbox"/> SPREADER TANK #		42180 lb TARE
	<input type="checkbox"/> DELIVERED		30640 lb NET
<input checked="" type="checkbox"/> CUSTOM APPLIED ACRES	VRT		11540 lb
<input type="checkbox"/> RECEIVED DIRECT PU			Weight In: 30640 lb
PRICE/TON			ID#: 734
NET PRICE			11:52 am 05/06/11
			30640 lb
			ID#: 734
			12:20 PM 05/06/11
			NET WGT. TOTAL \$

WEIGHER DRIVER TRUCK # 278 ON OFF

THIS IS NOT A STORAGE RECEIPT

Figure C4. Fertilizer load sheet for corn in 2011.

Delta-MSU-EPRI / Nitrous Oxide Reduction in Corn (NORC)



1. Crop 2. Location 3. Fertilizer application rate 4. Fertilizer type 5. Application date
 Figure C5. Fertilizer nitrogen map for corn in 2011

APPENDIX D

BASELINE and PROJECT NITROGEN RATE CALCULATIONS

Delta-MSU-EPRI / Nitrous Oxide Reduction in Corn (NORC)

Appendix D presents calculations of the baseline (2003, 2007, and 2009) and project (2011) period N fertilizer rate derived from the management records presented in Appendix C.

The information and data presented below are taken directly from these documents.

No organic N containing fertilizer was applied during the baseline or project period.

Application practices during the baseline period align closely with practices during the project period for both timing and placement: for all relevant corn years during the baseline and project periods, the farmer applied N fertilizer once annually in the spring. Application rates for the baseline were determined using yield-goal estimates and consideration of the farmer's economic circumstances. Reduced project N rates were determined following discussions with service providers, and in consideration of new economic guidelines.

D1. Baseline Period

Average N fertilizer rate applied over baseline period

$$F_{B\ SN, t} = [(F_{B\ SN, 2003} + F_{B\ SN, 2007} + F_{B\ SN, 2009}) / 3], \text{ Mg N ha}^{-1} \text{ yr}^{-1} \quad (D1)$$

Where:

$$\begin{aligned} F_{B\ SN, t} &= \text{Baseline synthetic N fertilizer applied, Mg N ha}^{-1} \text{ in year } t; \\ F_{B\ SN, 2003} &= \text{Synthetic N fertilizer applied in 2003, Mg N ha}^{-1}; \\ F_{B\ SN, 2007} &= \text{Synthetic N fertilizer applied in 2007, Mg N ha}^{-1}; \\ F_{B\ SN, 2009} &= \text{Synthetic N fertilizer applied in 2009, Mg N ha}^{-1}. \end{aligned}$$

Calculation of $F_{B\ SN, 2003}$

In 2003, in each short ton (2000 lb) of fertilizer applied, 148 lb of Monoammonium Phosphate (MAP), 700 lb of Urea (U), and 745 lb of Poly-Coated Urea (PCU) was applied to the project site (see Figure C1).

Converting lb to Mg

$$\begin{aligned} 2000 \text{ lb} &= 2000 * 0.454 / 1000 \\ &= 0.907 \text{ Mg} \\ F_{B\ SN, 2003} &= (M_{B\ SF\ 2003\ MAP} * NC_{B\ SF\ 2003\ MAP}) + \\ &\quad (M_{B\ SF\ 2003\ U} * NC_{B\ SF\ 2003\ U}) + \\ &\quad (M_{B\ SF\ 2003\ PCU} * NC_{B\ SF\ 2003\ PCU}) \quad (D2) \end{aligned}$$

Where:

$$\begin{aligned} M_{B\ SF\ 2003\ MAP} &= \text{Mass of Monoammonium Phosphate (MAP)} \\ &= 148 * 0.45 / 1000 \\ &= 0.067 \text{ Mg} \\ M_{B\ SF\ 2003\ U} &= \text{Mass of Urea (U)} \\ &= 700 * 0.45 / 1000 \\ &= 0.315 \text{ Mg} \\ M_{B\ SF\ 2003\ PCU} &= \text{Mass of Poly-Coated Urea (PCU)} \\ &= 745 * 0.45 / 1000 \\ &= 0.335 \text{ Mg} \\ NC_{B\ SF\ 2003\ MAP} &= \text{N content of MAP} \end{aligned}$$

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$$\begin{aligned}
 &= 11 \text{ g N (100g fertilizer)}^{-1} \\
 \text{NC}_{\text{B SF 2003 U}} &= \text{N content of U} \\
 &= 46 \text{ g N (100g fertilizer)}^{-1} \\
 \text{NC}_{\text{B SF 2003 PCU}} &= \text{N content of PCU} \\
 &= 46 \text{ g N (100g fertilizer)}^{-1} \\
 \text{Total N applied} &= (0.067 * 0.11) + (0.315 * 0.46) + (0.335 * 0.46) \\
 &= 0.306 \text{ Mg N} \\
 \text{Therefore:} & \\
 \text{NC}_{\text{B SF 2003}} &= 0.306 / 0.907 \\
 &= 0.340 \\
 &= 34.0 \text{ g N (100g fertilizer)}^{-1}
 \end{aligned}$$

Fertilizer was applied at a rate of 460 lb acre⁻¹

Converting lb acre⁻¹ to Mg ha⁻¹

$$\begin{aligned}
 \text{M}_{\text{B SF, 2003}} &= 460 * 1.121 / 1000 \\
 &= 0.516 \text{ Mg ha}^{-1} \\
 \text{From equation (D2)} & \\
 \text{F}_{\text{B SN, 2003}} &= 0.516 * 0.340 \text{ Mg N ha}^{-1} \\
 &= 0.175 \text{ Mg N ha}^{-1}
 \end{aligned}$$

Calculation of F_{B SN, 2007}

In 2007, in each short ton (2000 lb) of fertilizer applied, 644 lb of 44-0-0 (44), and 897 lb of Urea (U) was applied (see Figure C2) to the project site.

Converting lb to Mg

$$\begin{aligned}
 2000 \text{ lb} &= 2000 * 0.454 / 1000 \\
 &= 0.907 \text{ Mg} \\
 \text{F}_{\text{B SN, 2007}} &= (\text{M}_{\text{B SF 2007 44}} * \text{NC}_{\text{B SF 2007 44}}) + \\
 & \quad (\text{M}_{\text{B SF 2007 U}} * \text{NC}_{\text{B SF 2007 U}}) \tag{D3}
 \end{aligned}$$

Where:

$$\begin{aligned}
 \text{M}_{\text{B SF 2007 44}} &= \text{Mass of 44 - 0 - 0 (44)} \\
 &= 644 * 0.45 / 1000 \\
 &= 0.290 \text{ Mg} \\
 \text{M}_{\text{B SF 2007 U}} &= \text{Mass of Urea (U)} \\
 &= 897 * 0.45 / 1000 \\
 &= 0.404 \text{ Mg} \\
 \text{NC}_{\text{B SF 2007 44}} &= \text{N content of 44} \\
 &= 44 \text{ g N (100g fertilizer)}^{-1} \\
 \text{NC}_{\text{B SF 2007 U}} &= \text{N content of U} \\
 &= 46 \text{ g N (100g fertilizer)}^{-1} \\
 \text{Total N applied} &= (0.290 * 0.44) + (0.404 * 0.46) \\
 &= 0.313 \text{ Mg N}
 \end{aligned}$$

$$\begin{aligned}
 \text{Therefore:} & \\
 \text{NC}_{\text{B SF 2007}} &= 0.313 / 0.907 \\
 &= 0.346 \\
 &= 34.6 \text{ g N (100g fertilizer)}^{-1}
 \end{aligned}$$

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Fertilizer was applied at a rate of 435 lb acre⁻¹

Converting lb acre⁻¹ to Mg ha⁻¹

$$\begin{aligned} M_{B\ SF, 2007} &= 435 * 1.121 / 1000 \\ &= 0.488 \text{ Mg ha}^{-1} \end{aligned}$$

From equation (C3)

$$\begin{aligned} F_{B\ SN, 2007} &= 0.488 * 0.346 \\ &= 0.169 \text{ Mg N ha}^{-1} \end{aligned}$$

Calculation of $F_{B\ SN, 2009}$

In 2009, in each short ton (2000 lb) of fertilizer applied, 2000 lb of Urea (U) was applied (see Figure C3) to the project site.

$$F_{B\ SN, 2009} = (M_{B\ SF\ 2009\ U} * NC_{B\ SF\ 2009\ U}) \quad (D4)$$

Where:

$$\begin{aligned} M_{B\ SF\ 2009\ U} &= \text{Mass of Urea (U)} \\ &= 2000 * 0.454 / 1000 \\ &= 0.907 \text{ Mg} \\ NC_{B\ SF\ 2009\ U} &= \text{N content of U} \\ &= 46 \text{ g N (100g fertilizer)}^{-1} \\ \text{Total N applied} &= 0.907 * 0.46 \\ &= 0.414 \text{ Mg N} \end{aligned}$$

Therefore:

$$\begin{aligned} NC_{B\ SF\ 2009} &= 0.414 / 0.907 \\ &= 0.460 \\ &= 46.0 \text{ g N (100g fertilizer)}^{-1} \end{aligned}$$

Fertilizer was applied at a rate of 332 lb acre⁻¹

Converting lb acre⁻¹ to Mg ha⁻¹

$$\begin{aligned} M_{B\ SF, 2009} &= 332 * 1.121 / 1000 \\ &= 0.372 \text{ Mg ha}^{-1} \end{aligned}$$

From equation (D4)

$$\begin{aligned} F_{B\ SN, 2009} &= 0.372 * 0.460 \\ &= 0.170 \text{ Mg N ha}^{-1} \end{aligned}$$

From equation (D1), the baseline N rate:

$$\begin{aligned} F_{B\ SN, t} &= [(0.175 + 0.169 + 0.170) / 3] \\ &= 0.172 \text{ Mg N ha}^{-1} \text{ yr}^{-1} \end{aligned}$$

D2. Project Period

Calculation of $F_{P\ SN, t}$

N fertilizer rate applied over project period

$$F_{P\ SN, t} = F_{P\ SN, 2011}$$

Where:

$$\begin{aligned} F_{P\ SN, t} &= \text{Project synthetic N fertilizer applied, Mg N ha}^{-1} \text{ in year t.} \\ F_{P\ SN, 2011} &= \text{Synthetic N fertilizer applied in 2011, Mg N ha}^{-1}. \end{aligned}$$

Calculation of $F_{P\ SN, 2011}$

$$F_{P\ SN, 2011} = M_{P\ SF\ 2011\ U/ESN} * NC_{P\ SF\ 2011\ U/ESN}, \text{ Mg N ha}^{-1} \text{ yr}^{-1} \quad (D5)$$

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Where:

$$\begin{aligned} M_{P\ SF\ 2011\ U/ESN} &= \text{Mass of 45-0-0 ESN-urea blend} \\ N_{C_{P\ SF\ 2011\ U/ESN}} &= \text{N content of 45-0-0 ESN-urea blend} \end{aligned}$$

In 2011, 11,540 lb of 45-0-0 ESN-urea blend was applied to the project site (see Figures C4 and C5).

$$\begin{aligned} M_{P\ SF\ 2011\ U/ESN} &= 11,540 * 0.454 / 1000 \\ &= 5.239 \text{ Mg} \\ N_{C_{P\ SF\ 2011\ U/ESN}} &= 45 \text{ g N (100g fertilizer)}^{-1} \\ \text{Total N applied to project site} &= 5.239 * 0.45 \\ &= 2.358 \text{ Mg N} \\ \text{Total N applied per hectare to project site – project N rate:} & \\ F_{P\ SN, 2011} &= 2.358 / 16.05 \\ &= 0.147 \text{ Mg N ha}^{-1} \end{aligned}$$

APPENDIX E

DATA and CALCULATIONS to DETERMINE LEACHING

Appendix E presents data and calculations used to determine the value of $Frac_{LEACH}$ used in calculations of indirect baseline and project N_2O emissions at the project site.

Determination of $Frac_{LEACH}$

The determination of whether leaching occurs at the project site uses default (Tier 1) values for leaching and run-off from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Revised August 2011), and the ratio of growing season values of precipitation to potential evapotranspiration (see MSU-EPRI v1, Annex A).

A project site has a $Frac_{LEACH}$ value of 0.30 kg N (kg N additions)⁻¹) when:

$$Precip_{GS} / PET_{GS} \geq 1.00 \quad (E1)$$

A project site has a $Frac_{LEACH}$ value of 0.00 kg N (kg N additions)⁻¹) when:

$$Precip_{GS} / PET_{GS} < 1.00 \quad (E2)$$

Where:

- Precip_{GS} = Precipitation during the growing season, mm;
- PET_{GS} = Potential evapotranspiration during the growing season, mm.

Average values for precipitation and potential evapotranspiration for baseline determination are calculated from the same years (during the growing season) used to determine baseline fertilizer N rate.

At the project site the growing season is defined as between May and September inclusive during the baseline years (2003, 2007, and 2009).

Crop irrigation was not employed during the growing seasons at the project site.

The $Frac_{LEACH}$ value calculated for the baseline period is considered valid throughout the project period.

Meteorological data from Enviro-weather, formerly the Michigan Automated Weather Network (MAWN) web site was used to determine the growing season precipitation and potential (reference) evapotranspiration. Data for 2003 was collected from the station at Pigeon and data for 2007 and 2009 from the station at Fairgrove. Both stations experience very similar precipitation and evapotranspiration patterns and are located in the same Major Land Resource Area (MLRA) approximately 40 and 15 km from the project site, respectively (Table E1).

Pigeon: <http://www.agweather.geo.msu.edu/mawn/station.asp?id=pig>

Fairgrove: <http://www.agweather.geo.msu.edu/mawn/station.asp?id=fgv>

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Table E1. Precipitation (Precip) and Potential Evapotranspiration (PET) during the growing season (GS) between 2003 and 2009 at two meteorological sites (Pigeon and Fairgrove) close to the project site.

	Fairgrove			Pigeon		
	Precip _{GS} (mm)	PET _{GS} (mm)	Precip _{GS} /PET _{GS}	Precip _{GS} (mm)	PET _{GS} (mm)	Precip _{GS} /PET _{GS}
2003	na	na	na	315	545	0.58
2004	303	556	0.55	382	527	0.73
2005	389	578	0.67	322	574	0.56
2006	352	560	0.63	322	574	0.56
2007	258	635	0.41	280	656	0.43
2008	491	545	0.90	389	569	0.68
2009	319	554	0.58	344	566	0.61

From Table E1, the values for Precip_{GS}/PET_{GS} used to determine whether leaching and run-off occurs at the project site are taken from the Pigeon station in 2003 (0.58) and from the Fairgrove station in 2007 (0.41) and 2009 (0.58).

$$\begin{aligned}
 \text{Precip}_{\text{GS}}/\text{PET}_{\text{GS}} &= (0.58 + 0.41 + 0.58) / 3 \\
 &= 0.52 \\
 &= < 1.00
 \end{aligned}$$

Therefore, the project site has a Fra_{CLEACH} value of 0.00 kg N (kg N additions)⁻¹.

This value is used in calculations of indirect baseline and project N₂O emissions at the project site (Sections E1 and E2).

APPENDIX F

TITLE and OWNERSHIP DOCUMENTS

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Appendix F presents a fully executed Michigan Farmland Development Rights Agreement as evidence of land title and land ownership for the project site.

LIBER [redacted] PAGE [redacted]

RECEIVED FOR RECORD
LIBER NO. 804 PAGE NO. 224-225
FILE NO. [redacted]

60 JUN 21 PM 2:06

[Signature]
TUSCOLA COUNTY
REGISTER OF DEEDS



STATE OF MICHIGAN - FARMLAND DEVELOPMENT RIGHTS AGREEMENT

THIS FARMLAND DEVELOPMENT RIGHTS AGREEMENT, MADE AND EXECUTED THIS 3rd day of May AD. 2000, by and between [redacted] husband & wife hereinafter referred to as the "Owner" and the Department of Natural Resources for and on behalf of the State of Michigan; WITNESSETH WHEREAS, the Owner owns real property in the County of Tuscola, State of Michigan, hereinafter referred to as the "Subject Property", which is [redacted]

[redacted]

[Large redacted block]

[redacted]

(X) _____ (X) _____ 79-1497-123117 77TRANSFER
[redacted] Hs [redacted] 20

Delta-MSU-EPRI / Nitrous Oxide Reduction in Corn (NORC)

LIBER 804 PAGE 225

STATE OF MICHIGAN)
) ss.
COUNTY OF (Ypsilanti)

Prepared by:
Arminda Koch, Chief
LAND AND MINERAL SERVICES DIVISION
MICHIGAN DEPARTMENT OF NATURAL RESOURCES
PO BOX 30449
LANSING MI 48909-7949

On this 23rd day of May AD 2000, before me, a Notary Public, personally appeared [redacted] to me known to be the same person who executed the foregoing instrument, and who acknowledges the same to be his own free act and deed.

(X) Joanne B. Buchinger
JOANNE B. BUCHINGER Notary Public

My Commission Expires: _____
Signed in the presence of: _____ County, Michigan
My Commission Expires: 24, 2002

(X) John W. Buchinger (please print names of witnesses beneath signatures) (X) Joanne B. Buchinger
JOHN W. BUCHINGER JOANNE B. BUCHINGER

STATE OF MICHIGAN)
) ss.
COUNTY OF _____)

On this _____ day of _____ AD _____, before me, a Notary Public, personally appeared _____ to me known to be the same person who executed the foregoing instrument, and who acknowledges the same to be _____ own free act and deed.

(X) _____
Notary Public

My Commission Expires: _____
Signed in the presence of: _____ County, Michigan

(X) _____
(please print names of witnesses beneath signatures)

SPACE BELOW FOR DEPARTMENT USE ONLY

Department of Natural Resources
State of Michigan
By: Richard A. Harlow
Richard A. Harlow, Unit Chief
Farmland & Open Space Preservation Unit
Acquisition Section/Land and Mineral Services Division

STATE OF MICHIGAN)
) ss.
COUNTY OF INGHAM)

On this 31st day of May AD 2000, before me, a Notary Public in and for said County personally appeared Richard A. Harlow, to me known to be the same person who executed the foregoing agreement, and who acknowledged the same to be his free act and deed and the free act of the Department of Natural Resources for the State of Michigan in whose behalf he acts.

Katharine McGarry
Katharine McGarry, Notary Public
Eaton County acting in Ingham County, Michigan
My Commission Expires: January 28, 2003

Signed in the presence of:
John Mayes
John Mayes
Katharine McGarry
Katharine McGarry

Figure F. State of Michigan Farmland Development Rights Agreement

APPENDIX G

CHAIN OF CUSTODY DOCUMENTS

Appendix G presents chain of custody documents relevant to the project site.

**APPLICATION AND PROGRAM AGREEMENT
FOR NITROUS OXIDE EMISSIONS REDUCTION CREDIT PROGRAM**

1. Parties and Program

A. [REDACTED] ("Applicant") hereby applies to participate in the Nitrous Oxide Emission Reduction in Corn Program ("Program") managed by the Delta Institute ("Delta"). The purpose of the Program is to create greenhouse gas (GHG) credits by reducing nitrous oxide emissions and to obtain payment(s) in conjunction with the sale of those credits. The Applicant is the owner and operator for the Farm and the activities covered by the Program and the Project. With respect to entitlement or title to GHG credits or any other similar environmental attribute, the Parties agree that this Application and Agreement shall supersede any other Agreement or rule of law.

B. Delta manages the Program pursuant to a Project Development Document filed with the American Carbon Registry ("ACR"). ACR has adopted a protocol for calculating Emission Reduction Tons ("ERTs"), a unit of measurement for quantifying emissions reductions, associated with the Program.

C. Michigan State University ("MSU") and the Electric Power Research Institute ("EPRI") created the protocol that will be used for the Program. In addition, EPRI has agreed to fund the verification activities required for the Program. However, neither MSU nor EPRI is a Party to this Agreement and both have agreed not to be compensated pursuant to this Agreement.

2. Applicant's Representations and Warranties

A. Applicant hereby certifies it owns and/or controls the rights to agricultural production and generation of GHG credits on the property described in the Project Development Document and the State of Michigan Farmland Development Rights Agreement dated May 23, 2000 (the "Project") and that it is legally authorized to enter this Agreement and to participate in the Program.

B. Applicant further certifies that the Project meets or exceeds the eligibility requirements set forth in section 2 of ACR's July 2012 "Methodology for Quantifying Nitrous Oxide (N₂O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops" (the "ACR Methodology"), a copy of which is attached hereto as Exhibit A.

C. Applicant agrees that, so long as this contract is in effect, it will not take any action that would destroy, compromise, or otherwise interfere with the Project's ability to meet or exceed the eligibility requirements set forth in section 2 of the ACR Methodology.

3. Agreement Regarding GHG Offset Credits

A. The Parties recognize and agree that the purpose of the Program is to create GHG credits by reducing nitrous oxide emissions and to obtain payment(s) in conjunction with the sale of those credits.

B. Delta shall have the exclusive legal right to register, obtain issuance of, and sell the GHG credits derived from or otherwise attributable to the Project. All decisions regarding the registry, marketing, and/or sale of the credits shall be made by Delta. Applicant and Delta recognize and agree that credits may, but need not be:

1. Issued on the basis of Emission Reduction Tons ("ERTs");
2. Created entirely through the services of ACR;

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3. Created and/or sold by and through some or all of the following: a private purchase agreement; or another carbon reserve, registry, fund, exchange or other, similar entity.

C. With respect to verification, the Parties understand and agree that:

1. EPRI has separately agreed to take responsibility for funding verification activities (including, without limitation, data collection, measurement, verification, and monitoring activities required for the registry, issuance, creation or sale of GHG credits) related to the Program, per section D. EPRI has further agreed not to be compensated by the Parties or from this Agreement.

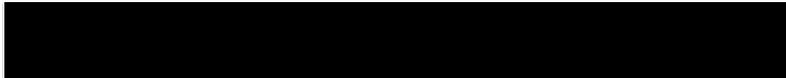
2. An accredited verifier will be selected by Delta;

3. Applicant will cooperate with all verification activities and timely to provide or submit any documents, forms, or other information requested by the verifier(s);

4. Applicant will provide reasonable access to any real property within its control upon request by Delta or the verifier(s); and

5. Verification activities required for the specific purpose of complying with California Air Resources Board ("California ARB") requirements will be subject to the additional provisions set forth in part 4 of this Agreement and any further agreements entered pursuant thereto as required to qualify for ARB Compliance Offsets.

D. Delta shall distribute the proceeds from any sale of GHG credits according to the following criteria:



2. The crediting period for which the project is valued and during which time it can generate offsets against a baseline scenario is 7 years. For years 2 through 7 the transfer price of the credits covered by this contract shall be the net of sales price as determined by net sales proceeds less verification, registration, and listing fees, less the Aggregator Service Fee.

3. If the project complies with ACR requirements in place at the time of a crediting period renewal than in accordance with ACR Standard (v 2.1) there is no limit to the allowed number of project crediting period renewals. The terms established in Section 3.D.1-2 of this agreement will apply to crediting period renewals.

E. The Parties shall cooperate and use their best efforts to secure any necessary permits or other governmental approvals. No Party shall interfere with any other Party's efforts to secure any approvals necessary for registry or issuance of GHG credits derived from or otherwise attributable to the Project.

F. Delta makes no representation or warranty regarding the issuance or registry of GHG credits derived from or otherwise attributable to the Project or the market price of such credits.

Applicant shall retain all rights to GHG credits derived from or attributable to activities other than the Project.

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4. Provisions Related To California Air Resources Board Offset Credits
- A. The Parties understand and agree that Delta may, in its sole discretion, seek to list the Project with the California ARB and to obtain offset credits derived from the Project as part of the California ARB's Greenhouse Gas Emissions Market-Based Compliance Mechanism.
- B. In the event that Delta seeks to obtain offset credits derived from the Project which are issued by the California ARB as Compliance Offsets:
1. Delta shall serve as "Authorized Project Designee" (as that term is defined in the regulations implementing ARB Offset Credits and Registry Offset Credits) for all matters related to listing, monitoring, record retention, issuance, and sale of such credits;
 2. Applicant will assume the role of "Operator" (as that term is defined in the regulations implementing ARB Offset Credits and Registry Offset Credits);
 3. Applicant will cooperate in all efforts to list the Project with the California ARB and to obtain offset credits derived from the Project as part of the California ARB's Greenhouse Gas Emissions Market-Based Compliance Mechanism, including, without limitation, timely provision of any attestations, documents, data, or other information requested by the California ARB or by Delta;
- C. The Parties understand that the requirements Greenhouse Gas Emissions Market-Based Compliance Mechanism California ARB are amended from time to time, and they agree to use their best efforts to revise this Agreement if and as necessary to facilitate compliance with any such amendments.
5. Other Contract Provisions
- A. The term of this Agreement shall commence on the date it is signed by all parties, and shall continue from that time until the earlier of (1) the end of the project crediting period including crediting period renewals or (2) the Agreement is terminated.
- B. Each party shall have the right to terminate the Agreement upon thirty days prior written notice to the other party. Following the termination of this Agreement, neither Party shall have any obligation to the other Party except that the obligation set forth in Section 5.C shall survive the termination of this agreement.
- C. The illegality, invalidity, or unenforceability of any particular word, phrase, sentence, paragraph, or provision of this Agreement shall not affect the other words, phrases, sentences, paragraphs, or provisions hereof. This Agreement shall be construed in all respects as if such invalid or unenforceable provisions were omitted and the remainder construed so as to give them meaningful and valid effect. It is the intention of the parties that if any particular provision of this Agreement is capable of two constructions, one which would render the provision void and the other of which would render the provision valid, the provision shall have the meaning which renders it valid.
- D. In the case of suspension of the ACR registry or governing protocols, this Agreement will remain in effect pending the outcome of that suspension. If the suspension is restored within a commercially reasonable time period, the Parties agree to use best efforts to amend or terminate this Agreement with an objective of removing any further obligation on either party for actions in the future.
- E. Invalidation of Project – In the case of invalidation of the Project, the Applicant will either return payment in an amount equal to the replacement value of offsets generated by the invalidated project or provide replacement offset credits, at Delta's sole discretion.

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F. Dispute Resolution – All claims and disputes arising under or relating to this Agreement are to be settled through negotiation, conciliation, mediation, or binding arbitration in a location mutually agreeable to the Parties.

G. This contract shall be governed by and construed in accordance with the laws of the State of Illinois, with respect to any dispute arising out of this agreement.

H. This agreement may be executed in one or more counterparts, each of which will be considered an original.

I. (a) Information provided by [redacted] may be used to model N₂O reductions from nutrient management practices. Delta agrees to maintain in confidence and not to disclose to any person or entity unrelated to the Project, proprietary information about [redacted] or its practices except information which is (i) already known and not received from the other party in the course of negotiating or fulfilling this agreement, (ii) information which becomes generally available to the public through no fault of the party who wishes to utilize that information, (iii) information received from a non-party who has the right to disclose such information without breaching any obligations to the other party, or (iv) information which a party is legally obligated to disclose.

(b) Applicant agrees to maintain confidence with respect to information provided by Delta and which Delta identifies as confidential, except information which is (i) already known and not received from the other party in the course of negotiating or fulfilling this agreement, (ii) information which becomes generally available to the public through no fault of the party who wishes to utilize that information, (iii) information received from a non-party who has the right to disclose such information without breaching any obligations to the other party, or (iv) information which a party is legally obligated to disclose.

(c) Furthermore, nothing herein contained shall prohibit Delta from disclosing general project information pertaining to this Agreement for marketing, training, or fundraising purposes.

J. This Agreement and the material attached hereto constitutes the entire agreement and understanding of the Parties with respect to its subject matter and supersedes any other, prior representations.

THE DELTA INSTITUTE, an Illinois not-for-profit corporation

By: [Signature]
Signature of Authorized Person

WILLIAM SCHLEIZER
(printed name)

Its: MANAGING DIRECTOR
(title)

[Redacted Signature]
(printed name)

Its: president
(title)

[Redacted Signature]
(printed name)

Its: Secretary
(title)

Figure G. Fully executed application and program agreement N₂O emissions reduction credit program.



ENVIRONMENTAL SERVICES, INC.

American Carbon Registry

Nitrous Oxide Reduction in Corn Project Validation and Verification Report

01 May 2014

Project Developed by:

Delta Institute

Michigan State University

WK Kellogg Biological Station

3700 E Gull Lake Drive

Hickory Corners, MI 49060

Validation and Verification Conducted by:

Environmental Services, Inc.

Forestry, Carbon, and GHG Services Division

Corporate Offices at:

7220 Financial Way, Suite 100, Jacksonville, Florida 32256

Phone: 904-470-2200; Fax: 904-470-2112

Project No. VO12082.00



ANSI ACCREDITED PROGRAM
GREENHOUSE GAS
VALIDATION AND VERIFICATION
0800



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1 Executive Summary

Environmental Services, Inc. (ESI) prepared this validation /verification report in accordance with the outlined requirements of the American Carbon Registry's (ACR), Forest Carbon Project Standard, Version 2.1 (November 2010). ESI presents validation and verification findings of the Nitrous Oxide Reduction in Corn: ACR Project 171 – prepared by the Delta Institute and MSU. The project validation and verification was conducted as part of ACR's program requirements for GHG offset projects.

By ACR definition, the Nitrous Oxide Reduction in Corn project is considered a single Agricultural Land Management project (ALM). Project lands are located within the Count of Tuscola, Michigan.

The GHG Project Plan validation and implementation verification included emissions reduced through nitrogen fertilizer rate reductions on one field (39.62 acres), for the year 2011. The project asserts emissions reductions of 2.32 Mg CO₂e for 2011.

The Nitrous Oxide Reduction in Corn project validation/verification objective included an assessment of the likelihood that implementation of the planned GHG project would result in the GHG emission removal/ enhancements as stated by the project developer (ISO 14064-3:2006). The objective was to ensure that the project was in compliance with the ACR Standard, Version 2.1 (October 2010), the ACR Validation and Verification Guideline for GHG Projects, Version 1.1 (July 2012), the applicable requirements of ACR's Forest Carbon Project Standard (Version 2.1), and ACR's Methodology for Quantifying Nitrous Oxide (N₂O) Emissions Reductions From Reduced Use Of Nitrogen Fertilizer on Agricultural Crops, Version 1.0 (July 2012) criteria. ESI assessed the GHG emission removals of the ALM project.

ESI confirms all validation/verification activities including objectives, scope and criteria, level of assurance and the GHG Project Plan's adherence and implementation (of validated GHG Project Plan) to the applicable requirements of the Forest Carbon Project Standard (Version 2.1) and the Methodology for Quantifying Nitrous Oxide (N₂O) Emissions Reductions From Reduced Use Of Nitrogen Fertilizer on Agricultural Crops, (Version 1.0), as documented in this report, are complete and concludes without any qualifications or limiting conditions that the Nitrous Oxide Reduction in Corn: GHG Plan for ACR Project 171 (April 2014) meets the requirements of ACR's Standard and the Forest Carbon Project Standard Version 2.1 (November 2010)

Project adherence to the Forest Carbon Project Standard Version 2.1 (November 2010) was also evaluated, as far as it was applicable.

The GHG assertion provided by the Delta Institute/Michigan State University and verified by ESI has resulted in the GHG emission removal of 2.32 Mg CO₂ equivalents by the project during the verification period/reporting period (21 January 2011 – 21 April 2012).



2 Introduction

This validation /verification report is prepared in accordance with the outlined requirements of the ACR’s Forest Carbon Project Standard, Version 2.1 (November 2010). Environmental Services, Inc. (ESI) presents validation and verification findings of the Nitrous Oxide Reduction in Corn: GHG Plan for ACR Project 171 project – prepared by the Delta Institute/Michigan State University. The project validation and verification was conducted as part of ACR’s program requirements for GHG offset projects (ALM). ESI is accredited by the American National Standards Institute under ISO14065:2007 for greenhouse gas validation and verification bodies including ISO 14064-3:2006, ISO 14065:2007, and validation/verification of assertions at the project level for Land Use and Forestry (Group 3) and is approved to validate/verify for ACR.

The GHG Project Plan validation and implementation verification included emissions reductions through the reduced use of nitrogen fertilizer on corn, on 39.62 acres, including the 2011 crop year. The project asserts emission reductions of 2.32 Mg CO₂e for 2011.

2.1 Contact Information – Roles and Responsibilities

Project Owner :	[REDACTED]
Project Proponent:	Ryan Anderson Delta Institute (312) 559-0900 ext. 14 randerson@delta-institute.org
Accredited V/V Body: Environmental Services, Inc.	<ul style="list-style-type: none"> • Shawn McMahan – Lead Validator/Verifier (smcmahan@esinc.cc / 330-833-9941) • Stewart McMorrow – Validation/Verification Team Member (smcmorrow@esinc.cc / 530-525-2232) • Richard Scharf – Validation/Verification Team Member (rscharf@esinc.cc / 252-402-7354) • Caitlin Sellers – Validation/Verification Team Member (csellers@esinc.cc / 772-834-8571) • Jonathon Pomp – Validation/Verification Team Member (jpomp@esinc.cc / 304-642-1277) • Guy Pinjuv – Validation/Verification Team Member (gpinjuv@esinc.cc / 503-459-1318) • Matthew Perkowski – Validation/Verification Team Member (mperkowski@esinc.cc / 301-332-0771) • Eric Jaeschke – Validation/Verification Trainee (ejaeschke@esinc.cc / 703-314-9064) • Janice McMahan – QA/QC (jmcmahan@esinc.cc / 330-833-9941)



2.2 Project Description

By ACR definition, the Nitrous Oxide Reduction in Corn: GHG Plan for ACR Project 171 project is considered an Agricultural Land Management (ALM) project. The project land is located within [REDACTED] Tuscola County, Michigan. The project uses reduced nitrogen application rates on the corn crop on lands that have been in continuous agricultural use for many years prior to the project baseline period. The emissions reductions occurred as a result of the lower nitrogen fertilizer rate applied to the corn during the project period when compared to the baseline period. Baseline nitrogen application rates were based on yield goals. Reduced project nitrogen rates were determined following discussions with service providers and in consideration of economic guidelines.

2.3 Objective

The GHG Project Plan validation/verification objective included an assessment of the likelihood that implementation of the planned GHG project would result in the GHG emission reductions as stated by the project developer (ISO 14064-3:2006). The objective was to ensure that the project was in compliance with the ACR Standard, Version 2.1 (October 2010), ACR's Verification Guideline for GHG Projects, Version 1.0 (July 2010), the applicable requirements of the Forest Carbon Project Standard Version 2.1 (November 2010), and the ACR Methodology for Quantifying Nitrous Oxide (N₂O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops, Version 1.0 (July 2012). ESI assessed the GHG emission reductions of the ALM project.

2.4 Criteria

The criteria followed by ESI included ISO 14064-3, ISO 14065, and the validation/verification guidance documents provided by ACR located at <http://www.americancarbonregistry.org/carbon-accounting/standards>. These documents included:

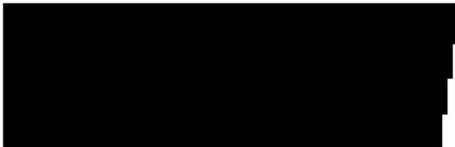
- ACR Standard, October 2010
- The applicable requirements of the Forest Carbon Project Standard (Version 2.1),
- ACR Methodology for Quantifying Nitrous Oxide (N₂O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops, Version 1 – July 2012
- ACR Validation and Verification Guidelines for GHG Projects, June 2012-v1.1

2.5 Scope

The scope of the validation/verification generally included the GHG Project Plan and eligibility requirements; GHG project and baseline scenarios; physical infrastructure, activities, technologies and processes of the GHG project; GHG sources, sinks and/or reservoirs; types of GHG's; and time periods covered. The geographic scope was defined by the project boundary, which included a single, contiguous parcel of land, the carbon reservoir types, management



activities, and contract periods. The scope of the Nitrous Oxide Reduction in Corn: GHG Plan for ACR Project 171 project in Tuscola County, Michigan, is defined below.

Baseline Scenario	Business as Usual N rate was 0.172 Mg N ha ⁻¹ yr ⁻¹ , or 0.792 Mg CO ₂ e ha ⁻¹ yr ⁻¹
Activities/Technologies/Processes	Reduced N fertilizer applications to corn.
Sources/sinks/Reservoirs	N ₂ O emissions from fertilizer applications.
GHG Type	Nitrous oxide
Project location	Tuscola County, Michigan
Project Boundary and Time Period	Coordinates of field:  21 April 2011 – 20 April 2012

2.6 Level of Assurance

The level of assurance was used to determine the depth of detail that the validator/verifier (ESI) placed in the validation and verification plan to determine if there are any errors, omissions, or misrepresentations (ISO 14064-3:2006). ESI reviewed all data and information to be verified to provide reasonable assurance and to meet the requirements of the ALM project (ACR Verification Guideline for GHG Projects v1.1, June 2012). ACR considers verification to be a risk-based process where the verifier examines a sufficient amount of data and uses the verifier’s professional judgment to provide a reasonable assurance.

2.7 Materiality

Materiality is a concept that the individual or aggregation of errors, omissions, and misstatements could affect the GHG assertion and the decisions of the intended users. Materiality was also used as part of the verification sampling plan design, to determine the type of verification processes used by ESI to minimize the risk of not detecting a material misstatement. ACR’s materiality threshold is +/-5% of the GHG project’s emission reductions or removal enhancements. In other words, ACR requires that any differences between emission reductions/removals claimed by the project proponent and estimated by the verifier be immaterial (less than +/- 5%). Individual or aggregation of errors or omissions greater than the ACR materiality threshold of +/-5% require re-stating before verification statements can be accepted by ACR.

3 Validation Process and Findings

3.1 Validation Process

The validation process closely followed the guidance provided by ACR's Methodology for Quantifying Nitrous Oxide Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops (Version 1), ACR's Verification Guideline for GHG Projects (Version 1.1), ISO14064-3, ISO 14065, and the ESI Management System and Management System Manual, Section V.5.

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". Specifically the project validation included the review of the requirements outlined in the Methodology for Quantifying Nitrous Oxide Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops, Version 1 (July 2012). The assessment included the following items: eligibility criteria, baseline approach, additionality, project boundary, emissions, leakage, data and parameters, monitoring plan design, and environmental impacts.

3.2 GHG Project Plan

The Nitrous Oxide Reduction in Corn – ACR Project 171 Project's GHG Plan was found to be in compliance with ACR's Methodology for Quantifying Nitrous Oxide Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops, Version 1.

3.2.1 ACR Standard Requirements/Eligibility

Prior to the initiation of the project validation, ACR first conducts its own assessment of meeting all applicable requirements and issues a certification letter. ACR issued the certification on 11 December 2013 for the Nitrous Oxide Reductions in Corn project. Copy of Certification is located in Appendix A.

The Nitrous Oxide Reductions in Corn project was found to be in compliance with ACR's project eligibility requirements set forth in ACR's Methodology for Quantifying Nitrous Oxide Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops, Version 1 [Chapter 1 (D) and Chapter 7 (F)]. Specifically, the GHG Project Plan outlined and described the following aspects of the project:

- The project started in April, 2011 which is after the earliest allowable start date of 1 November 1997.
- The project activity is implemented for one year, meeting the minimum project term requirement.
- The project activity creates quantifiable and verifiable N₂O emissions reductions.
- Ownership of offsets is clear.
- Ownership titling of land is clear.
- Project land is eligible because it was cultivated for at least 5 years before the project start date.



- The project activity is additional, i.e., it passes an ACR-approved performance standard and regulatory surplus test.
- The baseline calculations are consistent with ISO and other relevant standards and follow an ACR-approved methodology;
- The project activity results in non-reversible N₂O emissions reductions;
- The project activity results in no leakage, i.e., no increase in GHG emissions or decrease in C sequestration outside the project boundary;
- The project activity is on land that has been cultivated for at least five years prior to the project start date;
- The parcel of land on which the baseline crop is grown is the same parcel of land on which the project crop is grown;
- The project activity does not take place on organic soils (histosols) as defined by the World Reference Base for Soil Resources (FAO 2006).
- Implementation of project activities associated with this methodology, with or without registration as an AFOLU project, shall not lead to violation of any applicable law, even if the law is not enforced.
- The project adheres to Best Management Practices (BMPs) at the cropping site as they relate to N fertilizer formulation, dates, and methods of application, as required under Section 2.2.1 of the methodology. Pursuant to the Michigan Right to Farm Act, the Michigan Department of Agriculture and Rural Development has adopted Generally Accepted Agricultural and Management Practices (GAAMPs) for farmers and farm operators. These practices are scientifically-based and updated annually to utilize current technology promoting sound environmental stewardship on Michigan farms (Michigan Department of Agriculture and Rural Development).
- Project lands were not forest at the project start date.

3.2.2 Approved Methodology

The Nitrous Oxide Reduction in Corn project utilized the following methodology and tools:

- *ACR Methodology for Quantifying Nitrous Oxide (N₂O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops*, Version 1.0, July 2012

ESI confirms that the project meets the applicability requirements of the methodology under which the project was validated and verified:

- The project site is located in the North Central Region (NCR) of the US and is planted to corn in a row-crop rotation. The project is therefore eligible in Category 1 of the methodology.
- A regionally derived (NCR) emissions factor is used in calculations of direct emissions of N₂O for baseline and project scenarios.
- Suitable site-specific management records are available to enable quantification of the baseline N fertilizer rate. The project is therefore eligible to use approach 1 from the methodology.

3.3 Validation Findings and Conclusions

The ESI validation team identified 6 non-conformity reports (NCRs) and clarifications (CL). All were addressed satisfactorily by Delta Institute/MSU during the project validation process. These NCR's and CL's provided needed clarity to ensure that the GHG Project Plan was in compliance



with ACR's Standard (Versions 2.1, October 2010), the applicable requirements of ACR's Forest Carbon Project Standard (Version 2.1), and ACR's Methodology for Quantifying Nitrous Oxide Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops (Version 1, July 2012).

The complete list of validation finding and resolutions has been compiled and located in Appendix C.

ESI confirms all validation activities including objectives, scope and criteria, level of assurance and the GHG Project Plan's adherence to the Forest Carbon Project Standard (Version 2.1), as documented in this report, are complete and concludes without any qualifications or limiting conditions that the Nitrous Oxide Reduction in Corn: GHG Plan for ACR Project 171 (April 2014) meets the requirements of ACR's Standard and ACR's Methodology for Quantifying Nitrous Oxide Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops (Version 1, July 2012).

4 Verification Process, Findings, and Conclusions

The verification process closely followed the guidance provided by The American Carbon Registry, the applicable requirements of the Forest Carbon Project Standard (Version 2.1), the Verification Guideline for GHG Projects (Version 1.0), ISO14064-3 and ISO 14065, and the ESI Management System and Management System Manual, Section V.5.

As defined by ISO 14064-3:2006 (E), "verification is the systematic, independent and documented process for the evaluation of a greenhouse gas assertion in a GHG project plan against agreed verification criteria". Specifically the project verification included the review of the requirements outlined in the Forest Carbon Project Standard, Version 2.1 (November 2010). The assessment included the following items: eligibility criteria, baseline approach, additionality, project boundary, emissions, leakage, quantification of GHG reductions/removals, monitoring, data and parameters, and adherence to the project-level principals (relevance, completeness, consistency, accuracy, transparency, conservativeness).

ESI's verification for this project included the following three parts: desktop assessment, quantitative review, and meetings/interviews.

4.1 Desktop Assessment

ESI reviewed the Nitrous Oxide Reduction in Corn Project Plan to assess conformance with the requirements of the Methodology for Quantifying Nitrous Oxide Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops (Version 1, July 2012). Key factors that impacted the reported emissions reductions were identified and a Verification and Sampling Plan was created to focus on the critical elements presenting potential risk for errors in reported data. These elements included:



- Implementation of appropriate and adequate eligibility criteria, by reviewing documentation and field conditions indicative of the pre-project conditions of the project area, and compliance with all eligibility requirements of the methodology.
- Implementation of appropriate and adequate baseline approach, by reviewing documentation of field conditions indicative of the most-likely without-project scenario.
- Implementation of appropriate and adequate approach/tools for additionality, by reviewing documentation and field conditions which reflect the most-likely without-project scenario, as it deviates from the with-project scenario.
- Implementation of appropriate and adequate approach to project boundary definitions, by reviewing documentation of project boundaries and ownership status, and field conditions relative to clearly delineated ownership extents and control over management activities within the project area.
- Implementation of appropriate and adequate approach to baseline emissions calculations, by reviewing documentation which reflect the most-likely without-project scenario and the emissions resulting from that scenario.
- Implementation of appropriate and adequate approach to inventory calculations and modeling, by reviewing documentation, reviewing conversion factors, and re-running selected calculations and modeling
- Implementation of appropriate and adequate monitoring, by confirming the application of approved/acceptable monitoring practices in the field, and the appropriate handling and analysis of field data once collated.
- Implementation of appropriate and adequate approach to data and parameters, by reviewing data handling practices, and reviewing documentation at each step of the data analysis procedure.
- Implementation and adherence to project-level principles, by reviewing documentation and discussing the application of project-level principles with core staff.

A complete list of documents received and reviewed is located in Appendix D.

4.2 Site Visit

Since the time period under which this project is being verified passed and no additional evidence of the project activity could be gleaned from a site visit, it was mutually agreed between ACR's Chief Technical Officer and ESI that the site visit could be waived. A copy of the 21 August 2012 email exchange can be found in Appendix B.

4.3 Quantitative Review

ESI focused on the quantitative analyses undertaken by the Project Proponent to assess the GHG pool accounted for by the project (direct emissions due to N fertilizer applications, indirect emissions due to N fertilizer applications). ESI's review included an assessment of the site management records, specifically fertilizer load data supporting the GHG assertion and the calculation of ERTs.



4.4 Meetings/Interviews

During the course of the project verification, ESI and Delta Institute/MSU held multiple meetings. In addition, an hour long interview was conducted with the farmer, landowner and offset holder, [REDACTED]. All other correspondence occurred via email. The details of the meetings are briefly described in the table below.

Date	Attendees	Topics Discussed
16 January 2014	Adam Dumont Neville Millar Ryan Anderson Matthew Harrison (Delta) Shawn McMahon (ESI) Richard Scharf (ESI)	Opening Meeting, preliminary review of validation/verification and sampling plan, review of interview logistics, discussion of ACR's allowing the project to proceed without a site visit, project timeframes and deadlines. Discussion of the main goals and nature of the project.
23 January 2014	Ryan Anderson Matthew Harrison (Delta) Neville Millar Richard Scharf (ESI)	Meeting to review calculations.
21 February 2014	[REDACTED] Richard Scharf (ESI) Shawn McMahon (ESI)	Interview with farmer to confirm statements of fact and assumptions made based on the project documents. Discussed management, including rotations, method of application, how suitable N reductions were determined, etc.
30 April 2014	Matthew Harrison (Delta) Ryan Anderson Neville Millar Shawn McMahon (ESI) Richard Scharf Phil Robertson	Closing Meeting - Review of draft validation/verification report - Next steps - Request feedback on process

4.5 Verification Milestones

Project/Verification Activity	Date
ACR issues Certification	11 December 2013
ESI Internal Conflict of Interest (COI) process completed and approved (no issues).	17 December 2013
ACR approval of ACR-Specific COI Form	19 December 2013
Submission of Verification and Sampling Plan to Delta/MSU for approval	21 January 2014

Opening meeting with Delta/MSU	16 January 2014
Farmer interview	21 February 2014
NCRs/CLs submitted	23 February 2014 and 31 March 2014
ESI completes Review	07 April 2014
Draft verification report submitted to Delta/MSU for review	10 April 2014
Closing Meeting with Delta/MSU	30 April 2014
ESI finalizes report and submits to ACR and Delta/MSU	1 May 2014

4.6 ACR Methodology for Quantifying N₂O Emissions Reductions on Agricultural Crops Requirements

4.6.1 Eligibility Requirements

The Nitrous Oxide Reduction in Corn Project is an ALM project that is intended to reduce nitrous oxide emissions in the project area through the reduction of nitrogen fertilizer applications on the corn crop, grown in rotation with soybeans. The project area has been in agricultural use for many years. The Nitrous Oxide in Corn ALM Project is in compliance with ACR's project eligibility requirements set forth in ACR's Methodology for Quantifying N₂O Emissions Reductions on Agricultural Crops, Version 1 [Chapter 2]. Specific details are located in the Validation portion of this report

4.6.2 Additionality

ESI confirms that the Nitrous Oxide Reduction in Corn Project conducted the proper additionality analysis and conforms to the ACR Standard requirements for a methodology specific performance standard with a regulatory additionality test. The project proponent sufficiently demonstrated in the GHG Project Plan and through the verification process that through the crediting period, the project activity exceeded laws and regulations, as required by the methodology. The project proponents passed the Performance Standard Test described in the methodology, because the business as usual practice in the region, used by the project proponent during the baseline period, was to apply N fertilizers at rates dictated by yield goals.

4.6.3 Permanence and Risk Mitigation

As explained in the methodology (section 7, p. 18), "Nitrous oxide emission reductions associated with reducing N fertilizer rate are permanent and cannot be reversed". Therefore, use of this methodology does not require any buffer or other risk mitigation mechanism to be used.



4.6.4 Baseline and Leakage

ESI confirms the project baseline as the continuation of the business-as-usual N fertilizer application rate for corn based on traditional yield goals.

As explained in the methodology (section 7, p. 18) leakage is negligible for ALM projects involving cropland management activities when the site is maintained for commodity production. Leakage potential is negligible for projects using this methodology.

4.6.5 Monitoring and Contractual Requirements

ESI confirmed the appropriateness and implementation of the Nitrous Oxide Reduction in Corn project monitoring plan, which details monitored data and parameters, measurements, timing, and date storages.

ESI confirmed land ownership documentation as described in the GHG Project Plan.

4.6.6 Community and Environmental Impacts

ESI confirms the project's net positive community and environmental impacts. Aside from reduced impact of a potent GHG on the atmosphere, reduced nitrogen fertilizer use may reduce water and air pollution. No change in production is anticipated. No negative impacts can reasonably be expected.

4.6.7 Stakeholders Comments

Not applicable. The only stakeholder is the farmer/landowner/project proponent, [REDACTED]

[REDACTED] confirmed ownership of the land, and that this area of the state was largely cleared for agriculture many years ago. He described the management practices on the land, especially with regard to fertilizer application practices during the entire rotation. A brand of polycoated, controlled release urea is custom applied using precision farming techniques. Baseline application rates were determined through a yield goal method.

[REDACTED] said he intends to continue the current corn-soybean rotation using a reduced rate of nitrogen, and may adjust the rate downward in the future.

4.6.8 GHG Emissions Reduction and Removal Enhancements (ERTs)

GHG Reductions or Removals	Units
Baseline Emissions / Reductions	12.7 tCO ₂ e
Project Emissions	9.92 tCO ₂ e
Leakage	0
Uncertainty Deduction Rate	0.164
2011 GHG emission removals total (tCO ₂ e)	2.32 tCO ₂ e



Total Emission Reduction Tonne(s) (ERTs)	2.32 ERT
--	----------

4.7 Verification Findings

The ESI verification team identified 6 non-conformity reports (NCRs) and clarifications (CL). All were addressed satisfactorily by Delta/MSU during the project validation process. These NCR's and CL's provided needed clarity to ensure that the project was implemented in accordance to the GHG Project Plan and was in compliance with ACR's Standard (Versions 2.1, October 2010) and Methodology for Quantifying Nitrous Oxide Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops (Version 1, July 2012).

The complete list of verification finding and resolutions has been compiled and located in Appendix C.

4.8 Verification Results/Conclusions

ESI confirms all verification activities including objectives, scope and criteria, level of assurance and the project's adherence to the Forest Carbon Project Standard (Version 2.1) and the validated GHG Project Plan, as documented in this report, are complete and concludes without any qualifications or limiting conditions that the Nitrous Oxide Reduction in Corn Project meets the requirements of ACR's Standard and the Methodology for Quantifying Nitrous Oxide Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops (Version 1, July 2012).

The GHG assertion provided by the Delta/MSU and verified by ESI has resulted in the GHG emission removal of 2.32 tCO₂ equivalents by the project during the verification period/reporting period (21 April 2011 – 21 April 2012).

Report Submitted to:	Delta/MSU American Carbon Registry
Report Submitted by:	Environmental Services Inc. Corporate Office 7220 Financial Way, Suite 100 Jacksonville, Florida 32257
ESI Lead Validator/Verifier Name and Signature:	 Shawn McMahan Lead Verifier
ESI Regional Technical Manager Name and Signature	 Janice McMahan Vice President and Forestry, Carbon and GHG Division Regional Technical Manager
Date:	1 May 2014

SMM/JPM/rb/VO12082 EPRI-MSU report-final doc
K pf 5/1/14f



Appendix A – ACR Certification



December 11, 2013

Ryan Anderson
Ecological Economist
Delta Institute
35 E. Wacker Drive, Suite 1200
Chicago, IL 60601

Dear Mr. Anderson,

The American Carbon Registry (ACR) has reviewed the Greenhouse Gas Project Plan for ACR171, Nitrous Oxide Reduction in Corn, against the *ACR Standard v2.1* and the approved *Methodology for Quantifying Nitrous Oxide (N₂O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops* (version 1, July 2012).

We find that the revised December 9, 2013 version of the GHG Project Plan complies with all applicable requirements of the standard and methodology. This letter constitutes ACR's certification, as defined in the *ACR Standard*, of the Greenhouse Gas Project Plan.

Please note that our certification does not take the place of, nor reduce the scope of, the required independent third-party validation and verification.

Congratulations on this first-of-a-kind project!

Sincerely,

Lauren Nichols
Technical Manager, American Carbon Registry

2121 Crystal Drive, Suite 500
Arlington, Virginia 22202

www.americancarbonregistry.org



Appendix B – ACR’s Waiver of Need for Site Visit

From: Martin, Nick [<mailto:NMartin@WINROCK.ORG>]
Sent: Tuesday, August 21, 2012 1:59 PM
To: Janice McMahon; Grady, Mary
Cc: Richard Scharf; Shawn McMahon
Subject: RE: V/V question for MSU-EPRI methodology

Janice, I agree in this case since the time period being validated and verified is in the past, there might not be much point in visiting the 16-acre field. I imagine you might still want to interview the farmer, in addition to MSU, as one of your requirements to provide a reasonable assurance opinion.

Nicholas Martin Chief Technical Officer
American Carbon Registry, an enterprise of Winrock International
www.americancarbonregistry.org
office 703.842.9500 | cell 651.233.3385 | e-mail nmartin@winrock.org

From: Janice McMahon [<mailto:jcmahon@ESINC.CC>]
Sent: Tuesday, August 21, 2012 12:51 PM
To: Martin, Nick; Grady, Mary
Cc: Richard Scharf; Shawn McMahon
Subject: V/V question for MSU-EPRI methodology

Hi Mary and Nick,

I hope you’re both doing well.

We have been asked to provide MSU-EPRI a proposal to provide ACR validation/verification services on their 16-acre pilot project in Michigan based on the newly approved ACR methodology. In the process, we have been asked if a site visit is necessary to validate/verify the project since

“The project period has passed (2011 corn growing season) at the project site, and so no on-site 'evidence' is visually available, other than the project site is indeed a cropped field. Confirmation of this will be provided with site history, appropriate maps and KMZ/L files.

The project document will also provide full document evidence of baseline and project period management practice, as well as proof of title and proof of offset custody and site details proving that the site has been in commodity production for many years and continues to be so”.

My first response is yes a site visit is required in order to meet the reasonable assurance requirement, but at the same time if on-site evidence is not available, do we really need to visit the site. I definitely think in the future with larger projects and parcels that site visits would have to happen during the appropriate season to confirm on-site evidence.



I was looking to see if I could find any ACR guidance on this issue for ALM, especially Improved Cropland Management and did not find anything. Is ACR working on a ALM Project Standard?

Can you provide any guidance on the issue relating to the MSU-EPRI polite project regarding the site visit?

Thank you,
Janice



ENVIRONMENTAL
SERVICES, INC.

Janice McMahon | Forestry, Carbon, and GHG Services Division Director

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330-833-9941 Phone | 330-833-9875 Fax | 904-626-5931 Cell

001-330-833-9941 or +1-330-833-9941 International Calls

Skype™ Username "janice.mcmahon1"

Appendix C – ESI’s Validation/Verification Findings

1. Non-Conformity Report (ACR Standard Version 2.1 Checklist) Managing Data Quality

<p>ACR Criteria: The Project Proponent shall establish and apply quality assurance and quality control (QA/QC) procedures to manage data and information, including the assessment of uncertainty, relevant to the project and baseline scenarios. QA/QC procedures shall be outlined in the GHG Project Plan.</p>	
<p>Evidence Used to Assess Conformance: ACR171 GHG Plan.</p>	
<p>Findings: The PD does not appear to include and apply a quality assurance and quality control (QA/QC) procedures to manage data and information. Section D.1 of the PD does state for one of the 3 variables, the QA/QC Procedure is to "Verify KMZ file agrees with project site coordinates". Other variables are assumed to be 100% accurate and no checks are in place to ensure that data is reported accurately.</p>	
<p>Non-conformity report (NCR): Please establish and apply quality assurance and quality control (QA/QC) procedures to manage data and information, including the assessment of uncertainty, relevant to the project and baseline scenarios. QA/QC procedures shall be outlined in the GHG Project Plan.</p>	
<p>Date issued:</p>	<p>23 February 2014</p>
<p>Project proponent response/actions and date: Reviewed ISO documentation and WRI LULUCF Guidance for GHG Project Accounting. Complete, section D.1 updated to show QA/QC and uncertainty for monitored parameters. 5 March 2014.</p>	
<p>Round 2 Non-conformity report (NCR): Updates to section D.1 are not sufficient to show QA/QC procedures. Please include a description of the measures/procedures in place to ensure monitored parameters are reviewed, recorded and saved securely before they are provided to validating-verifying bodies.</p>	
<p>Date issued:</p>	<p>31 March 2014</p>
<p>Project proponent response/actions and date: Project proponents adhere to QA/QC procedures as outlined in ISO 14064-2:2006 Section A3.6 "Managing Data Quality." These include: establishing and maintaining a complete GHG information system; regular accuracy checks for technical errors; periodic internal audits and technical review; appropriate training for team members; and uncertainty assessments. Project data is securely stored on a file server requiring user authentication; the server is copied to cloud based storage for disaster recovery purposes. QA/QC procedures were also informed by the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (2003)</p>	



Evidence used to close NCR: Addition of accuracy checks and periodic internal audits sufficiently addresses the auditor's concerns.	
Date closed:	7 April 2014

2. Non-Conformity Report (ACR Standard Version 2.1 Checklist) Land Title

ACR Criteria: For U.S. projects, Project Proponent shall provide land ownership documentation and attestation of clear, unique, and uncontested land title.	
Evidence Used to Assess Conformance: ACR171 GHG Plan section G1 and Appendix F.	
Findings: Section G.1 of the PD states, "The land on which the project site is located is owned by [REDACTED] (section A8). A copy of the State of Michigan Farmland Development Rights Agreement is presented in Appendix F". However, Appendix F does include a State of Michigan Farmland Agreement, but it is not for the parcel described as the one with the project activity.	
Non-conformity report (NCR): NCR: Please provide evidence of land ownership title or copy of the State of Michigan Farmland Development Rights Agreement for the parcel of land described in appendix B.	
Date issued:	23 February 2014
Project proponent response/actions and date: Confirmed through earthpoint.us that parcel described in 'State of Michigan Farmland Development Rights Agreement (PA116)' is located in Section 9, as described in PA116. Corrected GHG Plan and Annex references to Section 8. To be provided to ESI: screenshots of Township and Range description that created .kmz file, and Google Earth view of .kmz file showing site. 5 March 2014.	
Round 2 Non-conformity report (NCR): Though minor, please change figure B1 in the annexes to depict section 9, and not section 8 in the small map of [REDACTED].	
Date issued:	31 March 2014
Project proponent response/actions and date: Done.	
Evidence used to close NCR: All figures and references now refer to the same tract in section 9	
Date closed:	7 April 2014



3. Non-Conformity Report (ACR Methodology for Quantifying N2O Emissions Reductions from Reduced Use of N Fertilizer on Ag Crops (Version 1) 1.3 Applicability and Scope

ACR Criteria: To the best of our knowledge, implementation of project activities associated with this methodology, with or without registration as an AFOLU project, shall not lead to violation of any applicable law, even if the law is not enforced.	
Evidence Used to Assess Conformance: Not found.	
Findings: This appears to be a statement ACR requires in the project document and does not appear to be addressed.	
Non-conformity report (NCR): NCR: Please provide a statement in the project document attesting to this.	
Date issued:	23 February 2014
Project proponent response/actions and date: Added statement in Sec. A3, 'Proof of Project Eligibility' that "Implementation of project activities associated with this methodology, with or without registration as an AFOLU project, shall not lead to violation of any applicable law, even if the law is not enforced." 5 March 2014.	
Evidence used to close NCR: Inclusion of the statement adequately addresses this NCR.	
Date closed:	31 March 2014

4. Non-Conformity Report (ACR Standard Version 2.1 Checklist) Monitoring Procedure

ACR Criteria: The Project Proponent must provide sufficient geographic and physical information in the Project Document to allow for the unique identification and delineation of the extent of the project site(s). This can be achieved by field survey (e.g., using GPS), or by using geo-referenced spatial data (e.g., maps, GIS datasets, orthorectified aerial photography, or geo-referenced remote sensing images).	
Evidence Used to Assess Conformance: Appendices B and F.	
Findings: Appendix B describes a parcel of land in section 8 of [REDACTED], [REDACTED] Township, Tuscola County, Michigan. The Farmland Development Rights Agreement describes a parcel of land in Section 9. The title insurance document shows no information describing the property or properties for which title is insured.	
Non-conformity report (NCR): NCR: Please provide the correct documents for the parcel depicted in maps, on which the project activity took place.	
Date issued:	23 February 2014



Project proponent response/actions and date: This is an accurate observation. Based on reviewing ACR Standard 2.1, title insurance documentation was removed. Appendix B was revised to accurately reflect that the parcel is located in Section 9 of [REDACTED], [REDACTED] Township, Tuscola County, MI. Appendix E language was revised to reflect that the Michigan Farmland Development Rights Agreement provides land title and ownership evidence for the project site. 5 March 2014.	
Round 2 Non-conformity report (NCR): Though minor, please change figure B1 in the annexes to depict section 9, and not section 8 in the small map of [REDACTED].	
Date issued:	31 March 2014
Project proponent response/actions and date: Done.	
Evidence used to close NCR: All figures and references now refer to the same tract in section 9	
Date closed:	7 April 2014

Appendix C – ESI’s Verification Findings

1. Non-Conformity Report (ACR Methodology for Quantifying N2O Emissions Reductions from Reduced Use of N Fertilizer on Ag Crops (Version 1) 2.2.1 BMP

ACR Criteria: During the project crediting period, adherence to BMPs as they relate to the application of synthetic and organic N fertilizer at cropping site is required. These BMPs are related to N fertilizer formulation (or N content of organic additions) and dates and methods of application. Project proponents shall describe and justify in the GHG Project Plan how relevant BMPs have been adhered to.	
Evidence Used to Assess Conformance: Section A3 and Appendix A.	
Findings: This appears to be a statement ACR requires in the project document and does not appear to be addressed.	
Non-conformity report (NCR): NCR: Please provide a statement in the project document attesting to this.	
Date issued:	23 February 2014
Project proponent response/actions and date: Added statement in Sec. A3, 'Proof of Project Eligibility' that "Implementation of project activities associated with this methodology, with or without registration as an AFOLU project, shall not lead to violation of	



any applicable law, even if the law is not enforced." 5 March 2014.	
Evidence used to close NCR: Inclusion of the statement adequately addresses this NCR.	
Date closed:	31 March 2014

Project Verification - Non-Conformity Reports (NCR) / Clarification (CL) Requests

2. Non-Conformity Report (ACR Methodology for Quantifying N₂O Emissions Reductions from Reduced Use of N Fertilizer on Ag Crops (Version 1) Uncertainty Assessment

ACR Criteria: Management practices: Project proponents will be required to provide specific information for on-farm practices relating to N fertilizer management, which will adhere to BMPs (section 2.2.1). These will be verified prior to and during the project crediting period, therefore uncertainty will be negligible.	
Evidence Used to Assess Conformance: Appendices A and C.	
Findings: Fertilizer load sheets and nitrogen maps are provided, leading the reader to assume that the practice during the baseline and project periods was a single springtime application of N fertilizers. However, no short narrative or explanation is provided to confirm.	
Non-conformity report: Please provide a description of baseline and project practices regarding fertilizer applications. How were the application rates determined, including reasoning or calculations behind the N rate reduction in the project period?	
Date issued:	23 February 2014
Project proponent response/actions and date: Appendix D was revised to clarify baseline and project practices for N fertilizer applications.	
Evidence used to close NCR: The description and explanation provided in Appendix D sufficiently addresses this NCR.	
Date closed:	31 March 2014



Appendix D – List of Documents Received and Reviewed by ESI

Project Documents downloaded from ACR website

- ACR 171 GHG Plan (Revised).pdf
- ACR 171 GHG Plan Annexes (Revised).pdf
- ACR certification of ACR 171 GHG Project Plan.pdf
- ACR review of ACR171 GHG Project Plan.pdf

Documents received 02 August 2012

- Project Details to ESI.doc

Documents received 01 January 2014

- Tuscola N Rate Calculations 2003-2011.xlsx

Documents received 05 March 2014

- VO12082 00_Round 1 NCRsCLs_DeltaReview.xlsx
- ACR 171 GHG Plan (Round 1 NCRs).pdf
- ACR 171 GHG Plan Annexes (Round 1 NCRs).pdf
- [REDACTED] EarthPointFlyTo.kml

Documents received 04 April 2014

- VO12082 00_Round 2 NCRsCLs_DeltaReview.xlsx
- ACR 171 GHG Plan (Round 2 NCRs)_Final.pdf
- ACR 171 GHG Plan Annexes (Round 2 NCRs)_Final.pdf

Documents received 16 April 2014

- EPRI-MSU Report_draft_10April2014_Delta Review.docx
- EPRI-MSU Report_draft_10April2014_Delta Review.docx