RESPONSE TO PEER REVIEW COMMENTS

A draft *Methodology for N_2O Emission Reductions through Changes in Fertilizer Management* was developed by Winrock International and Applied Geosolutions, LLC for potential approval by the American Carbon Registry (ACR).

All new methodologies and methodology modifications, whether developed internally or brought to ACR by external parties, undergo a process of public consultation and scientific peer review prior to approval.

This methodology was posted for public comment from July 9 through August 2, 2010. Public comments are documented in a separate *Summary and Response to Public Comments*, posted at www.americancarbonregistry.org.

The revised methodology was then submitted to four anonymous scientific peer reviewers, experts in the field of nitrogen management and agricultural GHG mitigation. The reviewers' comments are summarized below, organized by section of the methodology, along with Winrock's responses to each. Two rounds of review comments, responses, and methodology revisions took place.

GENERAL

	Comment	Response	2nd Comment	2nd Response
1	The report describes a methodology to quantify the impact of different fertilizer management strategies on both direct and indirect soil N_2O emissions. Direct emissions are from DNDC model simulations while indirect emissions are calculated by combining DNDC model outputs of N volatilization and NO_3 leaching with Tier 1 IPCC methodology. The methodology and monitoring procedures are described in sufficient detail and the writing is clear for the most part. I perceive 2 primary weaknesses: uncertainty methodology is not rigorous and soil C changes are not accounted.	Weaknesses are addressed below.	(No further comment)	(No further comment)
2	The objective of the methodology is to estimate, via modeling, nitrous oxide emissions from nitrogen fertilizer application both under baseline and project scenarios. This methodology represents an improvement over previous efforts using IPCC Tier 1 methodology. In general, the methodology is well explained and the authors should be commended for assembling an impressive amount of information.	No comments needed.	(No further comment)	(No further comment)
3	The main criticism I have is that it lacks a systems approach. All seems to be centered around fertilizer N rate and lacks options for integrated agronomic management…	The DNDC model does simulate the impact of organic sources of nitrogen based on the amount of N applied and	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
	Would changes include also organic sources of nitrogen (e.g., legumes, manure)? I am thinking more in terms of soil fertility management, rather than fertilizer management.	the C/N ratio of the organic amendments. Users may change the fertilizer type (including to organic fertilizers) and may change the crop type. To further widen the completeness of the methodology we are now including the emissions resulting from initial fertilizer manufacture.		
4	Yield-based emissions. An important opportunity may be missed here. It is possible that instead of reducing yields, alternative N fertilizer practices such as better timing or placement of applications may actually increase yields, yet there is no mention of or accounting for this possibility. This raises the question as to whether emissions in this protocol should be expressed on a yield-scaled basis, i.e., as the mass of N_2O emitted per unit yield, in contrast to typical area units, i.e., mass of N_2O emitted per unit area. A recent article by van Groenigen et al (2010) used this approach, and I believe has received much attention in the scientific and policy communities. This approach would further	We think this is a great idea. We are just unsure how it could be made to work. Farmers would never be able to change the crops grown which I think would be too great a constraint. Otherwise it would have to be per unit of crop which would make standardization across crops impossible.	It's not clear why farmers could never change crops – is it because there is no baseline yield data associated with the business as usual practices?	If emissions were expressed on a yield-scaled basis, it would be difficult to track across various crops. How would you standardize yield differences across different crop types? Given the difficulty in doing this standardization, it would make changing crops difficult.

	Comment	Response	2nd Comment	2nd Response
	incentivize increased nitrogen use efficiency and conservative N mgmt practices, and I believe would make sense from a macro perspective in terms of reducing leakage. Perhaps there are additional policy issues that I am not considering, but it makes sense to me.			
5	Current model adequacy. The protocol depends heavily on the DNDC model, but at this point in time, I am not very confident that existing models including DNDC are able to fully account for or accurately predict the effects of management practices on N_2O emissions. It is not clear how the effects of fertilizer chemical form or vertical placement are accounted for. For example, there is much evidence that anhydrous ammonia, which is one of the most commonly used N sources in the U.S., results in elevated emissions compared with urea (Bremner et al., 1981; Thornton et al., 1996; Venterea et al., 2010). While not all studies have shown this effect (e.g., Burton et al., 2008), the study by Burton et al. (2008) was done in a wheat system where total N application rates were approximately half of that used in the corn studies. Thus, there could be an interaction	We agree that the models are not perfect, but feel strongly that they are the best available option and we also fully expect that the models will improve over time. The methodology requires that the latest version of DNDC be used. DNDC does account for chemical form or vertical placement of fertilizer. DNDC does account for depth of fertilizer application. In addition, there are 7 chemical forms of fertilizer in DNDC, including anhydrous ammonia and urea. Based on our modeling work the form of fertilizer also effects N cycling and N_2O emissions. The model does also account for multiple interactions	We agree that a modeling based approach is the only way to go practically. On the other hand, DNDC (or other models) may claim to account for various factors like depth, form, etc., the accuracy it achieves in doing this is highly uncertain. The most serious issue is the critical lack of field data to verify the outcomes of the model with the range of management practices, cropping systems and environmental conditions covered by the protocol. The use of the model in this protocol may overextend its validated reach. There are very few	The scientific and theoretical basis of DNDC is that it is a process model that captures the state of the science. We do recognize that there will be improvements in the model over time as more rigorous testing and independent validation is completed. We acknowledge there are uncertainties, and in some case we do not have a full estimate of what the uncertainties are for certain applications. The methodology requires the most recent version of DNDC, which

	Comment	Response	2^{nd} Comment	2^{nd} Response
	between N form and rate. There is also evidence that N cycling models that consider nitrification as a simplified single step process when in fact it is a two-step process cannot fully account for N_2O emissions (Venterea, 2007). Another potentially important limitation relates to interactions between management factors. For example, several studies have addressed the question as to whether reduced tillage results in increased or decreased N_2O emissions. The question itself may be an oversimplification, as Venterea et al. (2005) and Venterea and Stanenas (2008) showed that the answer may depend on the vertical placement of N fertilizer. Thus, at best, I consider these models to be the best available, but not as good as they need to be.	between management factors. The impact of reduced tillage on N_2O will largely depend on soil and climate drivers. The model is designed to capture these interactions by capturing how management influences the soil and crop environment. The model then relies on biogeochemical mechanism to simulate the impact on microbial, chemical and physical processes. Regarding 1-step versus 2-step models: we recognize that nitrification can be a 2 step process (oxidation of ammonium to nitrite followed by nitrite to nitrate). However, in most agricultural soils the conversion of ammonium to nitrite is the limiting factor. Thus DNDC simulates nitrification as a single step process, but with the added function of simulating the dynamic of nitrifier bacteria.	substantiated data sets for N_2O emissions, even for the most common and important (environmentally and economically) cropping systems, e.g., corn in the US Midwest. Saying that it is the best may be true, but how about the question of good enough? For example, are tillage-fertilizer placement interactions accounted for? Is nitrite accumulation and subsequent emissions accounted for? Each have been demonstrated in published studies yet not accounted for in DNDC or any model. Thus, you are stuck between rock and hard place, and we think the best approach would be to acknowledge the uncertainties and need for future improvements as they become available very	requires proponents to accept future improvements when they become available. What we believe we have is a conservative methodology that uses the most advanced science to give the very best possible estimates of emissions resulting from fertilizer usage short of placing chambers out in fields which we all acknowledge would not be reasonable. We face the same contradiction that clearly the reviewers face. In this document we are criticized both for DNDC potentially not being good enough and for creating a methodology that is too complex. We sought to balance a methodology that has the highest

	Comment	Response	2nd Comment	2nd Response
			explicitly.	atmospheric integrity with current modeling science while making a methodology that is sufficiently practical and cost-effective to be implemented. If you compare with other methodologies being proposed that are based on default factors clearly this methodology stands on its high integrity. This integrity will only improve through time as DNDC itself improves.
6	Future flexibility. Given the existing limitations in knowledge regarding controls over N_2O emissions in fertilized agricultural soils, some of which are highlighted above, what is the accommodation within the protocol for revising and improving the quantitative estimates for alternative practices in the future as new information and data become available?	This is really a comment for the Registry rather than the methodology developers. The ACR has a process in place for revising/updating methodologies. This is really not an issue for the approval of the methodology as it stands today. To make sure that the best results are always produced the methodology requires the	Why commit to sticking to DNDC if other models prove to be better in the future?	This is a DNDC-based methodology; however, nothing prevents other models or approaches from being proposed in future methodologies.

	Comment	Response	2nd Comment	2nd Response
		most recent version of DNDC at all times.		
7	This is a welcome attempt to quantify N_2O emissions reductions for use in agriculture offset projects. Using a Tier III model such as DNDC provides the important advantages of: a) generality (crops, soils, and climate); b) numerous management variables to adjust for savings. However there are also major problems with its proposed implementation. The major barrier I see with this protocol is the considerable burden of responsibility placed upon the Project Proponent, and the possibility that this would discourage potential project developers. I believe the major interlinked components to this barrier are: • Required familiarity with a complex biogeochemical modeling package (DNDC); • Requirement for large number of model input parameters (>40); • Requirement for estimations of fossil fuel use during baseline and project periods; • Expense, both in terms of time and money required to collect large numbers of field and/or literature/database measurements prior	Given the complexity and non-linearity of nitrous oxide emissions we feel that quantification tools must capture the complexity of the processes that control production, consumption and emissions of N_2O. We recognize that using the DNDC model is more complicated than using simple emission factor approaches. While the initial learning curve for Project Proponents will be steep, we feel the benefits and flexibility of using a process model will lead to more projects over the long-term. It is a requirement on registries, standards and methodology developers to produce methodologies that have the highest integrity. There are many who wish to detract from land use offset projects and never have such projects occur. We avoid this by demonstrating that the quality of offsets from such projects is at least as good as	One reviewer states: "I agree that the process is complex but it can produce more realistic results based on process and not empirical relationships." One reviewer is still very much concerned that the complexity of the DNDC model will discourage participation and even possibly encourage misuse. One concern is that the sensitivity of the model to manipulation of the large number of input parameters has not been fully explored. In the absence of this evaluation it is not possible to judge the potential for 'gaming' model outcomes. The adjustment of a host of site and regional variables that are hard to verify may result in more favorable and unwarranted outcomes for	It would be possible to game the system easily if it were possible to adjust some of the internal parameters of the model. However, users do not have that ability with the executable version of the model. One can only adjust the external parameters (namely input parameters). Verifiers will verify that the inputs the users provide accurately reflect their system and have been correctly entered. These factors ensure the integrity. The validator/verifier plays an important role. This is defined by the ACR rather than the methodology. However, experience with verifiers gives us complete

	Comment	Response	2nd Comment	2nd Response
	to and during project period to run the model. I suspect many potential Project Proponents are unlikely to have experience with the DNDC model. Although it is one of the most common complex biogeochemistry models in agricultural research with a number of peer-reviewed articles detailing it, I would assume that interested participants in this type of project (e.g., producers, aggregators, environmental consultants) would have limited (if any) experience using it. From a practical viewpoint, I think the requirements to submit a Project Proposal using the DNDC model are quite daunting, and may be off-putting – however I may be wrong!	the quality of offsets in any other system, and of equal or better integrity than inventories of sectoral or national emissions.	project developers. Can the protocol address measures to combat this?	confidence in their ability to prevent gaming and maintain integrity. In verifying a project based on this methodology a verifier would require justification for all the input factors and would rerun the model or a subset of the model.
8	I suggest that a simplified approach to the modeling may be more appropriate, i.e., less input parameters and a prioritization or a hierarchical approach to the factors required. For example, this could take the form of a small set of 'required' parameters that most readily influence N_2O emissions (e.g. the 4-R N stewardship – N rate, type, placement, timing) and then a further set or sets of factors in a tiered hierarchy of importance. If the PP was able to provide further input parameters beyond the	We recognize that a simplified approach would be easier for Project Proponents to develop project, especially as they first begin using a given methodology. However, the simplified approaches do not: 1. Capture the factors that control net nitrous oxide emissions. 2. Allow for a range of fertilizer management strategies that are	See above comment.	See above response.

	Comment	Response	2nd Comment	2nd Response
	'required' set, depending on his/her financial/time abilities, then maybe this extra information and effort expended could be rewarded with 'extra' credits, i.e., modifiers built into the payment of ERTs, justified by a more 'precise' modeled value for baseline and project emissions of N_2O. This approach is similar to the N_2O reduction protocol in Alberta (Table 1 at end of this document). Here, the reduction modifier reflects experts' confidence that increasingly sophisticated 4-R N stewardship plans will decrease N_2O emissions, but acknowledges experts' uncertainty of the precise magnitude of the decrease. The reduction modifier concept is a science-based standard to incentivize growers to intensify efforts to manage N fertilizer for reduction of N_2O emissions, and not an empirical prediction of N_2O dynamics, spatially or temporally. Also there are simplified approaches to using DNDC equations as outlined in: *Harnessing Farms and Forest in the Low–Carbon Economy, 2007, Nicholas Institute for Environmental Policy Solutions (Willey and Chameides, Eds).* Chapter 9 (pp 86–87) provides a table with 'simple' equations that estimate N_2O emissions, based on a few factors, that are deemed relatively easy to measure. A number of these are the same as required in the ACR current	known to impact net N_2O emissions (placement, nitrification inhibitors, split applications, etc) 3. Provide feedbacks on expected crop yield impacts of changes in management practices.		

	Comment	Response	2nd Comment	2nd Response
	methodology. This method would remove the requirements to be familiar with the complexities of the online DNDC model, but in effect provide output from the model as derived from results of DNDC simulations from soils in the US. See Figure 1 at end of this document. In this example, there are 9 input parameters required as opposed to the 40+ mandatory parameters listed in the ACR methodology: • N fertilizer rate (farmers records) • C rate in manure application. • Organic C in topsoil • Crop demand for N • Water input from precipitation and irrigation • Average annual air temperature • Clay content of soil • Acidity (pH) of soil • Land use type Perhaps the input data could be entered in an online spreadsheet format, so that the PP could enter his input parameters for the Baseline and Project scenarios to get immediate feedback on his N_2O reductions and potential ERTs. This I believe would be simpler for a PP to deal with, but still retain the integrity of the DNDC modeling			

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	approach. *Justification for this modified approach* In Pearson and Brown (2010b), section 10.0 Summary '*Both the IPCC Tier 1 method and the (modified Bouwman approach) have the advantage of being inexpensive to implement with a low requirement for expert technical support.*' I believe the simplified DNDC modeling approach would reduce the requirements for *expert technical support*, and have the advantage of being *inexpensive to implement*. In the Executive Summary of Pearson and Brown 2010b, it is stated *'Yet a methodology must not be excessively expensive to implement as it would preclude the possibility of any project being implemented…'* Also, as stated in Pearson and Brown 2010b in Section 2.0 *'…investigate the potential for a methodology that can be implemented without a high level of expertise in modeling and without incurring the high costs of hiring experts or complex scientific equipment.'* I believe that the requirements of the current protocol may exceed the threshold at which the time and costs incurred for submitting the project are equal to the 'payback' received from adopting the			

	Comment	Response	2nd Comment	2nd Response
	changed management practice(s).			
9	As I understand from Pearson and Brown (2010b), the Winrock team did not collect empirical data on N_2O emissions from the investigated cotton, corn and lettuce systems? If this is the case, I believe it would therefore be difficult to conclude that the Bouwman exponential model approach and the highly parameterized DNDC model are better at representing *'the reality of emissions from fertilizer use'* in these and other systems if no 'real' emissions were measured in the field and used to verify the veracity of these models. In Pearson and Brown (2010b), section 10.0 Summary 'Both the IPCC Tier 1 method and the (modified Bouwman approach) have the advantage of being inexpensive to implement with a low requirement for expert technical support.' As mentioned previously I believe a modified DNDC approach also has these advantages. In the Pearson and Brown (2010b) Summary they conclude 'However, unfortunately neither method (IPCC and Bouwman) can estimate nitrous oxide emissions with sufficient accuracy to qualify for carbon offset markets'. • What is the reasoning for this	The Pearson and Brown 2010 paper is not why we feel using a full process model is better. The main reason is the large body of research that has shown that at the field level process models are more often than not better at predicting emissions. That said, there have not been any studies that have extensively looked at comparing a process model like DNDC to an empirical model like Bouwman et al to quantify how much better the process models are. The "catch-22" is that one should not use any of the field data used to develop the Bouwman model for this comparison because it would not be an independent evaluation. The Bouwman model may indeed match the field measurements used to create it, but that is not an independent validation. What we can say from the wide body of literature is that: 1. The specific climatic	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
	statement? • What accuracy 'qualifies' for carbon market inclusion and what does not? It would appear that there was a pre-conception that a more highly parameterized model gives a more accurate and 'real' value for N_2O emissions. This assumption would seem to form the basis of the current ACR approach. This may or may not be the case, but without actual field data from the sites, I believe this conclusion cannot be reached, and therefore invalidates the original rationale used for proposing the highly parameterized DNDC model. Ultimately, the use of the IPCC Tier III methodologies – using more complex models – is desirable for GHG inventories for individual projects. However, until further parameterization of these models with empirical GHG field data from various representative agricultural ecosystems has been undertaken, then they do not necessarily represent a better method for estimating emissions reductions brought about by management change and environmental variability. I believe the widespread adoption of altered N management practices to reduce reactive N in the environment, can be best achieved by projects that utilize protocols	conditions in the year of assessment has a significant impact on the timing and magnitude of emissions. Simplified approaches do not incorporate recorded meteorological data. 2. Emissions are affected by timing and placement of fertilizers. Simplified methodologies cannot account for these variables.		

	Comment	Response	2nd Comment	2nd Response
	that are amenable to the widest audience possible, and that are 'easy' to use and provide transparency to all stakeholders, whilst still maintaining the highest degree of scientific integrity possible. To that end I believe the current ACR / Winrock Methodology may be unsuitable for a wide market. I believe that the complexity of the modeling approach, even if it were warranted, is prohibitive in terms of its requirement for data (either empirically measured, of from other resources), and its assumed level of understanding of models, biogeochemistry etc, and the likely high financial and time costs associated with obtaining and attaining these obligations. I would recommend (as suggested above) either: a tiered or hierarchical approach for model input requirements, based upon the ability of the PP to provide them, such that there are incentives for higher ERT (or other) payback as a result of greater initial investment in developing the project, or; a modified approach to the DNDC model similar to that outlined above where there are many fewer input requirements (less than 10), but the integrity of the modeling approach and scientific robustness is retained.			

TITLE

	Comment	Response	2nd Comment	2nd Response
1	Title: suggest inserting 'Nitrous Oxide' before 'Emissions' because that is the primary gas addressed.	Change made.	(No further comment)	(No further comment)
2	Title: The last part of the title should be changed to: "…through changes in commercial fertilizer management" to reflect the extent of the methodology. This, however, is too narrow a view.	The methodology could be used in instances where fertilizer management is not commercial. There is nothing causing such a restriction. We don't believe it would be used in this circumstance but see no need or motivation to make this change.	(No further comment)	(No further comment)
3	Title: "Emissions" needs a qualifier – is this limited to N_2O emissions, or more broadly GHG emissions?	Change made.	(No further comment)	(No further comment)

ACRONYMS

	Comment	Response	2nd Comment	2nd Response
1	Acronyms: curious why NO_3^- (nitrate) is not listed.	Change made.	(No further comment)	(No further comment)

INTRODUCTION

	Comment	Response	2nd Comment	2nd Response

	Comment	Response	2nd Comment	2nd Response
1	Page 5. Pearson, Grimland and Brown (2010b) reference is included in the reference list on p. 50 but without Grimland as an author.	No longer relevant. The introduction has been substantially shortened to only the parts that contribute to the methodology.	(No further comment)	(No further comment)
2	Page 5. Discussion regarding potential for yield reductions raises question as to whether emissions in this protocol should be/will be expressed on a yield-scaled basis, i.e., mass N_2O emitted per unit yield, in contrast to typical area units, i.e., mass N_2O emitted per unit area ? The recent article by van Groenigen et al (2010) used this approach, and has received a lot of attention.	See discussion above.	(No further comment)	(No further comment)
3	Page 6. 1st paragraph under purpose: should it be clarified that only synthetic fertilizer management is being addressed here, not manures, or is it?	Yes, manures are included.	(No further comment)	(No further comment)
4	Page 5, paragraph 4. *'In conversations with the agricultural community, Winrock has often heard resistance to methodologies that require reductions in fertilizer rate, because of perceptions that this will decrease yields.'* While I understand that rigorous farmer surveys may have been impractical for the purposes of this protocol, is there more information or data that can given as to the veracity of this statement?	The introduction is not the key point of the methodology so this discussion has been cut.	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
5	*'Nitrogen fertilizers represent the dominant cause of GHG emissions from agricultural production.'* Re–phrase and clarify this sentence.	"Nitrous oxide emissions from the application of nitrogen fertilizer are the largest source of GHG emissions from agricultural production." But no longer relevant in the shortened introduction.	(No further comment)	(No further comment)

I. Sources, Definitions and Applicability

	Comment	Response	2nd Comment	2nd Response
1	Page 7, first bullet. The letter "N" should be added after fertilizer. Also, what does it mean "for enhancing the growth and survival of agricultural lands"?	Text clarified: "…enhancing crop growth and survival on agricultural lands."	(No further comment)	(No further comment)
2	Page 7, fifth bullet. Up to now, the only change in management proposed is change in rate of fertilizer application. Besides, how do you control the rate of fertilizer application to other lands that are not part of the project?	The goal here is to avoid increases in N application on other fields controlled by the farmer as part of a risk reduction strategy. Verifiers are qualified to ensure this criterion is met. They fulfill similar requirements in other sectors.	(No further comment)	(No further comment)
3	Page 7. Is it necessary to more precisely define	This is defined in Section	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
	what is meant by “significant decrease in yields.” Does this mean significant in the statistical sense or something other?	7.		
4	*‘Projects must not lead to a significant decrease in yields as a result of project implementation’* • Just to clarify – what is definition of term *significant* (statistical use)? • I assume this applicability criterion refers to the project scenario(s) as modeled by DNDC and not actual measured field data. Rephrase to make this clearer if this is the case. Of course actual project yields may be decreased due to unforeseen circumstances (weather patterns, pest infestation, environmental variability etc).	The purpose of this applicability condition is to prevent leakage. If yields are decreased then the market will be impacted and leakage will result. In addition, it is at the heart of our philosophy with regard to agricultural offset projects that greenhouse gas emission reductions should not be achieved by a decrease in food supply. Applicability conditions often are further qualified in the heart of the methodology. That is the case here (see Section 7). As indicated in Section 7, the yield comparison is between the measured project case and baseline projection under the identical weather conditions.	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
5	*'Projects must incorporate a minimum of 10 separate fields.'* I'm unclear as to the rationale for this – why a minimum of 10? • Would a minimum land–use area for the project fields be more appropriate? • Does separate mean 'individual'? That is the fields can be adjacent to each other but should be considered as individual fields, with a defined boundary? • Does this refer to the minimum number of 'aggregated' fields, irrespective of landowner that must be included by a PP (as described in Section II, 1.1, 2nd bullet point)?	DNDC developer experience has shown that aggregation to 10 sites (in this case these were observations) lead to a significant improvement in model accuracy. The text has been clarified but this refers to individual fields that can be justified as such to verifiers. The idea here is that if we model multiple fields the modeled average emissions will be closer to the average measured. This is part of the model structural uncertainty discussions. "Project must incorporate a minimum of 10 individual fields" Footnote: "Fields may be adjacent but must be justifiable as individual fields at the time of verification."	(No further comment)	(No further comment)
6	*'Fertilizer use must not be increased in owned or managed lands that are not part of the project.'*	This covers all crops owned/managed. And yes likely would involve	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
	• Does this refer to only the same crops as represented within the project, or all crops owned / managed by the PP? • Does this cover manures and other organic amendments or only synthetic fertilizers? • Would this then entail obtaining management records for all fields / crops grown by the PP, irrespective if they were to be included in the project, for verification procedures? This could be more difficult to justify?	management records being subject to verification. Text has been clarified "Fertilizer use must not be increased on all crops on owned or managed lands that are not part of the project;"		
7	*'This methodology therefore requires no buffer or other risk mitigation mechanism.'* Might it be appropriate to set up a 'Nitrous Oxide Reserve Pool' similar to the pool for conservation tillage in the CCX methodology? This could act as a precaution against increases in nitrous oxide emissions, due to 'illegal' application rates of N fertilizer in excess of the baseline N fertilizer rate or other alterations of practice (intentional or otherwise) leading to increased N_2O emissions occurring during the project contract period. For instance each ACR nitrous oxide reduction project could be required to place 20% of the Offsets it earns into a Nitrous Oxide Reserve Pool. These Offsets would be released to PP upon satisfaction of the long term Project commitment. In the event that a PP does not conform to the requirements of the protocol, ACR could then cancel the Offsets held in the	We disagree with this approach. Emission reductions achieved are permanent at any point in time. So a buffer is not necessary and would be penalizing to projects that already have costs associated with implementing this methodology. This is akin to any other permanent offset sector. Yes suddenly a HFC destruction plant could emit a bunch of gases but these projects do not need a buffer. We have to avoid setting a higher	Agree with response.	(No further comment)

	Comment	Response	2nd Comment	2nd Response
	Pool in an amount equal to the quantity of Offsets previously issued to the Project.	bar repeatedly for land use projects.		

II.1 Project Boundary and Eligibility of Land

	Comment	Response	2nd Comment	2nd Response
1	Soil C: page 8 states that "Carbon pools are not monitored as part of the methodology, as changes in stocks as a result of fertilizer management are considered to be *de minimis*." However, there exists plenty of evidence which shows that soil C and N cycling are highly related and reducing N fertilizer can decrease soil C levels (e.g., Schlesinger 2000, Alvarez 2005).	Soil carbon balance is driven by carbon inputs and rates of decomposition. Changing fertilizer use can lead to changes in crop residue inputs to the soil due to changes in yield. This is a valid point in terms of the science, but not significant in this case since there is a guideline that projects cannot results in significant reductions in yields. Decreases in soil carbon due to reductions in residue inputs to the soil are not likely going to happen due to our guideline regarding yield reductions. Thus, by not adding impacts on soil carbon we anticipate that we are being	And carbon outputs as well, including eroded carbon.	We agree. This is captured in the methodology.

	Comment	Response	2nd Comment	2nd Response
		conservative, without adding to the complexity of the methodology.		
2	The 2nd half of Table 1 that appears on the top of page 9 is confusing. What are CH_4 and N_2O emissions from fossil fuel combustion? Does this part of the table relate to CO_2 emissions associated with production and transport of N fertilizers? Should CO_2 emissions from operation of farm equipment be included here too?	Both N_2O and CH_4 result from fossil fuel combustion alongside CO_2. This is just emissions within the project boundaries in the process of agricultural land management.	(No further comment)	(No further comment)
3	Page 8, section 1.2. Sentence starting with "Carbon pools are not…" is not correct. The authors should revise this statement or provide support for it.	The impact of soil carbon pools on N_2O emissions is accounted for in the modeling. However, the protocol assumes the changes in carbon stocks are *de minimis* with respect to fertilizer management (see response to comment 1 in this section).	(No further comment)	(No further comment)
4	What is the proposed duration of a project? It may be appropriate to include a section 'temporal boundary within this section to go alongside the Physical and GHG boundary assessments. I may have missed it, but I did not see any defined time limits for each project period or number of project renewals possible.	The duration must be at least for 1 year. However, minimum project durations are defined by the standard and not by the methodology. The methodology does not seek to alter the standard in any way here.	(No further comment)	(No further comment)

	Comment	Response	2^{nd} Comment	2^{nd} Response
5	*1.2 GHG assessment boundary* • It would be useful to have further justification of why carbon pools are not monitored, and why changes in stocks are considered to be *de minimis*. Perhaps a section in the Annexes? • In this protocol is there a threshold percentage change in total CO_2e benefits derived from the change in management practice that reduces N_2O emissions, that is considered *de minimis* for the associated alterations in soil carbon stock? For example in VCS ALM projects this figure is 5%.	See response to question 1 in this section. The *de minimis* threshold is defined in the ACR Standard.	(No further comment)	(No further comment)
6	*Inclusion of fossil fuel in Methodology* If fuel use is included on farm for the various management practices relating to GHG emissions reduction, should avoided GHG emissions during fertilizer manufacture based upon N fertilizer reductions on–farm also be included? As an example see CDM Type III Other project types (*III.A. Version 2. Offsetting of synthetic nitrogen fertilizers by inoculant application in legumes-grass rotations on acidic soils on existing cropland*). Where: *Baseline emissions consist of CO_2 emissions from synthetic nitrogen fertilizer production. The baseline is based on the quantity of synthetic nitrogen fertilizer that each farmer would have applied in the absence of the project activity to grow legumes and grass.*	This has now been included for completeness (new sections 5.3 and 6.3).	(No further comment)	(No further comment)

II.2. IDENTIFICATION OF THE BASELINE SCENARIO AND ADDITIONALITY

	Comment	Response	2nd Comment	2nd Response
1	Page 10, 4th bullet. What would be the economic implications of growing a crop with lower fertilizer use? Economics (from a farmer's perspective) is very important! What about the use of other nitrogen sources such as legumes and manure. Both are really important N sources but they don't seem to have a place in the methodology.	The economics of a shift in management practice will be accounted for through the yield impact. However given the constraint on negative yield impacts, the project should not result in significant economic implications from yield impacts. Assessing the cost associated with implementation of changes in management will be the budget of the Project Proponent. Other sources of N are accounted for in the methodology since DNDC model accounts for the use of legumes and manure on nitrous oxide emissions.	The key term to emphasize is profitability.	Yes. This is a motivation behind the design of the methodology. We believe we give users a broad range of choices to allow balancing of practices and greenhouse gases in a way that maximizes profitability.
2	Page 11. "….does not lead the preclusion…" should "to" be inserted after "lead"?	Yes. Changed.	(No further comment)	(No further comment)
3	Footnote page 9. Is EB acronym for Executive Board?	Yes. Clarified.	(No further comment)	(No further comment)
4	STEP 1: Determination of Baseline Scenario	This is an effort to remove activities that	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
	• I'm unclear – are all the possible land-use scenarios evaluated using the DNDC model to determine potential alternatives to the actual proposed project? • If I understand correctly these scenarios are hypothetical – I assume the PP creates these scenarios from suitable documentation etc and runs the DNDC model with his/her generated input data? • In this context, what is meant by 'adoption of precision agriculture' – I think there is a need for more explanation and clarity here. I assume this is referring to the application of N according to quantified field variability, such as digitized soil maps, grid sampling, satellite imagery, real time crop sensors, as well as in season crop monitoring for N management modification? • The protocol outlines a minimum of four alternative credible scenarios to be generated. Is there a maximum number that should be considered? The use of precision agriculture techniques and crop type alteration could lead to a large number of alternative strategies. • The sentence *'If fertilizer management as modeled under the project but in the absence of registration as an ALM ACR project activity is not excluded, then the project is not additional'* is unclear to me. Does this mean that the project scenario without registration	would be part of an expected land use change scenario to ensure that the projects are additional. This language is standard across CDM methodologies. There is no requirement to conduct DNDC modeling at this stage [for baseline scenarios], just for users to evaluate alternatives and discard non-additional activities. This is largely financial so a projection of yields and incomes and baseline fertilizer costs. I believe precision agriculture is an accepted term. There is no maximum but clearly it would not be in the project's interest to provide endless alternatives for financial analysis. The sentence quoted is very standard in offset methodologies. The purpose is to		

	Comment	Response	2nd Comment	2nd Response
	must be less economically feasible to adopt than with project registration and ERT credits – i.e., the only difference being project document preparation, registration costs etc?	demonstrate that the project would not go ahead as part of business as usual. Either economics or barriers are preventing the project from happening. Carbon offsets overcome either or both of the negative economics or the barriers.		

II.4. Modeling Approach to Direct and Indirect Emissions from Fertilizer Management

	Comment	Response	2nd Comment	2nd Response
1	Table 2. Soil properties are by layer, correct? This should be indicated.	The current version of DNDC available to download requires soil parameters for the top soil layer only. Now indicated under Table 2.	(No further comment)	(No further comment)
2	Page 15, 1st bullet. What are "optimum growing conditions"? Do these include fertilizer N application? Please explain.	By optimum we mean the maximum biomass achievable without N, water, growing degree day limitations. Text added: "(namely, maximum biomass assuming no N,	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
		water or growing degree day limitations)”		
3	Page 15, 2nd bullet. Are these ratios fixed or variable throughout the growing cycle?	They are not fixed, but these inputs should reflect the ratios when the crop reaches maturity.	(No further comment)	(No further comment)
4	Page 15, 3rd bullet. Are these ratios fixed?	Yes, the inputs are fixed and should reflect the ratios at maturity.	(No further comment)	(No further comment)
5	Page 15, 5th bullet. What is the procedure to calculate “air temperatures”?	Inputs from climate data.	(No further comment)	(No further comment)
6	Page 16 (Figure 1). In setting maximum yields, what is the role of literature values if available?	It is fine to use literature values if local values are not available.	(No further comment)	(No further comment)
7	Page 17, Note. How do you select the parameters: by expert knowledge or optimization?	Literature and expert knowledge.	(No further comment)	(No further comment)
8	Table 3. Shouldn’t it be ±0.1 Mg/m^3? (Notice Mg instead of kg)	Yes. We now use g/cm^3.	(No further comment)	(No further comment)
9	Page 12. Suggest including some specific boundaries under the statement “Used only in scenarios relevant to the scope for which the model was developed and evaluated.” It would be valuable to describe/list the limits of those scenarios, otherwise the reader may have to examine the literature to figure this out, and that could be challenging.	We now explicitly exclude production on histosols (organic soils).	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
10	Page 12. "The output of the model…." Should have kg NO_3^--N and kg NH_3-N. Should not this also include kg NO-N?	Now reads: "The output of the model must be the direct N_2O emissions ($NL_{DIRECT,j,i,t}$) in kg N_2O-N, the nitrate leaching loss ($NL_{LEACH,j,i,t}$) in kg NO_3^--N and the ammonia volatilization ($NL_{LEACH,j,i,t}$) in kg NH_3-N, by strata, in both the baseline and project scenarios through the duration of the project."	My point was: Why are nitric oxide (NO) emissions not considered as an indirect N2O source as they are in IPCC Tier 1 ?	NL_{volat} includes both ammonia volatization and nitric oxide emissions. See page 17 of the methodology. We have corrected the omission in section 4.1.
11	Page 16, Figure 1. Would it be better if the caption was on the same page as the figure?	Yes, change made.	(No further comment)	(No further comment)
12	Page 18 (STEP 3). For how many years should this be done – is there a minimum recommendation? If so, suggest to include that information in the figure.	This should be done for the same duration as the project. For 1 year projects, then the Monte Carlo simulation should run for 1 year, 2 year projects for 2 years.	(No further comment)	(No further comment)
13	Section 4.1 • Last paragraph. Replace output with 'outputs'. • Are the terms for the equations needed here – they are introduced in subsequent sections.	Terms should be introduced where they are used in the equations. This is standard for GHG methods under CDM, the	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
		VCS and the ACR.		
14	Section 4.3: Do the terms for the equations relate to a one year time period? The output from DNDC indicates this, but seemed unclear in subsequent terms.	DNDC outputs data on a daily and annual basis. These terms represent annual data. If projects are to span multiple years, then the user will run the model for multiple years and sum up annual emissions and reductions.	(No further comment)	(No further comment)
15	I may have missed it – is there sentence defining the use of the term 't' as metric ton?	Yes metric tons. Now indicated immediately before equation 1.	(No further comment)	(No further comment)
16	Subscript $_{BSL}$ for baseline – would $_{B}$ be more appropriate in line with $_{P}$ used for Project?	BSL is consistent with other existing methodologies.	(No further comment)	(No further comment)
17	The use of the NL prefix for outputs from the Monte Carlo mode runs – I may have missed this, but why is NL used – default output file name from DNDC? I originally thought NL referred to nitrate leaching. Maybe consider alternative for clarity.	NL refers to N Losses, whether direct N_2O emissions or N leaching or NH_3 volatization.	(No further comment)	(No further comment)
18	The period (full stop) following –N. in the terms. Is this commonplace terminology?	Parameters are always somewhat arbitrary. The important thing is for them to be clearly defined.	(No further comment)	(No further comment)
19	Consistency in the use of ha^{-1} (e.g., CO_2–e/ha	Ok. Now consistent.	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
	used on page 19, line 3).			
20	The terms for equations (1) through (4) are not matched in the equations. For example $GHG_{BSL,N2O,E,j,i}$ and $GHG_{BSL\_N2O,E,j,I}$	Ok. Now consistent.	(No further comment)	(No further comment)
21	The equations are in a different font type to the descriptions.	This is somewhat limited by the programs used. However, this is an aesthetic point that should be up to the registry who ultimately has control of publication.	(No further comment)	(No further comment)
22	Is it possible to replace subscript N2O with N_2O where appropriate?	Changes have been made where possible. However, this is not possible in all situations within Microsoft Office.	(No further comment)	(No further comment)
23	Consistency with italic use in the subscripts in some of the equations (e.g., variation in equation (5) and (6) for subscript N2O (*N2O* and *N*2O).	Ok. Changes have been made where possible.	(No further comment)	(No further comment)

II.5. Baseline Net GHG Emissions

	Comment	Response	2nd Comment	2nd Response
1	Page 21. How do you account for the carbon emissions associated with fertilizer manufacturing?	Now included in new sections 5.3 and 6.3.	Interesting issue: NH_3 requires less CO_2 and energy to manufacture than urea, so this would now be accounted for. But it also is	Yes interesting. Should be fully accounted under the methodology.

	Comment	Response	2^{nd} Comment	2^{nd} Response
			almost twice as dense in terms of N content per unit weight, so the transportation costs (in CO_2 units) would also be considerably less per unit N than urea.	
2	What about changes in tillage practices? How does the methodology account for these changes with respect to carbon emissions?	The DNDC model accounts for the impact a various tillage practices on soil C and N cycling. So the methodology does address management impacts tillage practices on nitrous oxide emissions, but not on soil carbon stocks since changes are assumed to be *de minimis.*	So reduced tillage practices are given no credit for reduced CO_2 emissions? I don't know about this assumption. It is a coupled and interacting system so I would expect some feedback.	We know that C and N are inexorably linked. The model does capture this linkage where changing tillage practices changes soil C dynamics which in turn impact N_2O. So we are accounting for the soil C impact on N_2O, but the methodology is only tracking N_2O impacts. Ultimately a methodology could keep extending its boundaries capturing every possible interaction and greenhouse gas emission reduction but we have to draw the line somewhere. What

	Comment	Response	2nd Comment	2nd Response
				we need to do is make sure we are being conservative while potentially leaving some greenhouse gas emissions on the table, that if a user wanted to capture, he or she would have to use a second methodology for accounting. In this case we capture all impacts on N_2O emissions but we could miss the emission reductions where decreasing tillage is paired with fertilizer emission reduction activities. Including carbon gains from decreasing tillage would require introduction of permanence issues etc. To make sure we are being conservative in this matter we have added the following applicability condition: On organic soils project

	Comment	Response	2nd Comment	2nd Response
				activities may not lead to an increase in tillage relative to baseline practices. Following the IPCC: Soils are organic if they satisfy the requirements 1 and 2, or 1 and 3 below: 1. Thickness of 10 cm or more. A horizon less than 20 cm thick must have 12 percent or more organic carbon when mixed to a depth of 20 cm; 2. If the soil is never saturated with water for more than a few days, and contains more than 20 percent (by weight) organic carbon (about 35 percent organic matter); 3. If the soil is subject to water saturation episodes and has either: (i) At least 12 percent (by weight) organic carbon (about 20 percent organic matter) if it has no clay; or (ii) At least 18 percent (by weight) organic carbon (about 30 percent organic matter) if it has 60 percent or more clay; or (iii) An intermediate, proportional amount of organic carbon for

	Comment	Response	2nd Comment	2nd Response
				intermediate amounts of clay. The concept here is soils that have been tilled historically are not still losing soil carbon unless the soils are organic.

II.7. LEAKAGE

	Comment	Response	2nd Comment	2nd Response
1	An important opportunity may be missed here. It is possible that instead of reducing yields, alternative N fertilizer practices such as better timing or placement of applications may actually increase yields, yet there is no mention of or accounting for this possibility. Referring back to the comment above, if emissions were expressed per unit yield, then it appears this could be accounted.	Increases in yield are in the interest of the farmer. They potentially lead to "positive leakage" but this is not something that is creditable under ACR rules. The additionality section requires an assessment of whether the project could be business as usual. If it can be shown it is not, then an increase in yield is a good side effect for project implementation.	But the possibility of this outcome should be emphasized.	Text now reads: "Total yield shall not be decreased in the with-project scenario relative to the baseline scenario by more than 5% in any given year. It is possible that yields will increase in the project scenario relative to the baseline potentially leading to *positive leakage*. This increases the benefit of the project and the conservativeness of

	Comment	Response	2nd Comment	2nd Response
				estimates but the greenhouse gas benefits of positive leakage are not quantified or credited."
2	'*Under the applicability conditions of this methodology yields may not be decreased as a result of project implementation*. As a result there can be no shifting of activities nor any market impacts of the project. Leakage under this methodology is therefore equal to zero. This shall be demonstrated through a comparison of the yield estimations by DNDC across the project for the baseline case against the with-project case. *Total yield shall not differ between the baseline and with-project scenarios by more than 5% in any given year*.' • The two highlighted sentences appear contradictory. • Regarding 'there can be no shifting of activities' does this criterion apply even if the activity shift was likely to cause a decrease in GHG emissions or increase in C sequestration during the project period? It would appear to be a very prohibitive stipulation, particularly for producers who may want to alter their management	There has to be a quantification of yields may not be decreased. A decrease of 0.0001% is still a decrease. Here we set a 5% limit to allow the statement that yields are not decreased. There can be no shifting of activities. In this context this means that fertilizer may not be decreased at one location and increased at another. The stipulation is not so limiting as to mean how other fields are managed is constrained.	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
	practices based upon events beyond their (and ACRs) control.			
3	Are there any contingencies for ‘unexpected’ but essential alterations in management practice that increase GHG emissions beyond the baseline scenario, or in some other way contravene the project contract? See comment above relating to ‘*This methodology therefore requires no buffer or other risk mitigation mechanism.’*	This is no different to a project in any other sector. As another example, a power plant burning coal and biomass could in the future switch to all coal but we don't have an expectation that this will happen. The registry sets requirements for what would happen in the case of intentional reversals which is what the reviewer is really referring to here. It seems like the reviewer wishes the methodology to either set its own standards or be able to stand alone but that is not	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
		how the system works.[1]		

II.8. NET GHG EMISSIONS (INCLUDING UNCERTAINTY)

	Comment	Response	2nd Comment	2nd Response
1	Uncertainty: uncertainty in model input parameters listed in Table 3 are accounted by performing a series of Monte Carlo simulations. However, uncertainty in weather, a key model driver, does not appear to be accounted. A bigger problem is that uncertainty in model structure is not accounted at all. This is important because model structural uncertainty was found to be responsible for the majority of overall uncertainty for national scale DayCent model simulations (Del Grosso et al. 2010). As DayCent and DNDC are not all that different, I would expect structural uncertainty to be significant for the DNDC model as well. Similarly, Ajami et al. (2007) conclude that "ignoring either input forcings error or model structural uncertainty will lead to unrealistic model simulations and	The issue of model structural uncertainty is important. However, availability of sufficient field observations across the wide range of cropping systems, soil, climate and crops limit our ability to define structural uncertainty with statistical rigor. As more field data that are suitable for independent model validation become available, model structural uncertainty will be quantified and	Agreed, but it is also suggested that, in the meantime, the section on uncertainty should state that the analysis is not complete due to limited availability of field data (it is good to point out data limitations for various reasons). It looks like the final sentence addressing "uncertainty in the IPCC factors used to convert N volatilization and NO_3 leaching to indirect N_2O emissions' was not addressed. This is	There will be a significant effort over the next 1-2 years to improve our understanding of model structural uncertainty. The requirement that the latest version be used means the methodology will constantly benefit from these improvements. Regarding the uncertainties in the indirect N_2O emissions. As stated these are less than ¼ of total emissions. Since the methodology is based on model estimates of the changes in N volatization

[1] Note from ACR: the methodology authors are correct in this. Per the *ACR Standard*, all GHG Project Plans must apply an approved methodology and also meet all applicable requirements of the *ACR Standard* and sector-specific standard, if any. These standards prescribe general project requirements, e.g. for issues such as reversals, that then do not need to be addressed in methodologies.

	Comment	Response	2nd Comment	2nd Response
	incorrect uncertainty bounds". Lastly, it is not clear if the uncertainty in the IPCC factors used to convert N volatilization and NO_3 leaching to indirect N_2O emissions is accounted. If not, it should be.	incorporated into future updates to the methodology. In the mean time, the methodology tries to reduce the impact of structural uncertainty by requiring the project aggregate at least 10 sites. In addition, the sources of the model structural uncertainties arise from how the model simulates the soil environment, crop growth, microbial community dynamics and reaction kinetics and biogeochemical processes. The use of the model for quantifying differences of N_2O emissions for alternative management practices for any given site will also tend to reduce	important because indirect often are ~25% of total N_2O emissions and the uncertainty in the IPCC factors should be accounted.	and NO_3 leaching, the uncertainties will be the same for the baseline and project estimates. We believe our approach to uncertainty captures the key uncertainties in the emission reductions achieved by the project and the areas in which the project can make changes to decrease uncertainty.

	Comment	Response	2nd Comment	2nd Response
		uncertainties (e.g. change fertilizer application rates will result in changes in N_2O emissions, we contend that the model will do a better job of quantifying differences in emissions than the absolute magnitude of emissions. Ultimately this methodology is taking the most exacting and precise approach to accounting fertilizer emissions short of putting chambers in fields. As such it should not be faulted for limitations in the science. Instead we propose an exacting and conservative approach.		
2	Page 26. Equations 18 and 19 are missing the square term in the deviation calculations.	Now added.	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
3	Page 26. Where does the factor 1.645 come from in eqns. 16 and 17?	T statistics for 2-tailed distribution for 90% confidence intervals.	(No further comment)	(No further comment)
4	Does the proposed procedure for calculating uncertainty account for the possible correlation between soil variables? For example, bulk density is inversely correlated with soil organic carbon.	Yes, in the sense that the correlation between soil parameters is captured in the biogeochemical modeling relationships and because the model outputs are used for the uncertainty calculations.	But, does DNDC account for the effect of changes in soil organic carbon on soil bulk density?	Yes. Initial soil bulk density is a user input for DNDC. DNDC then calculates bulk density over time based on the proportions of mineral and organic matter and standard density factors. As organic matter changes, DNDC adjusts bulk density accordingly.
5	*'Uncertainty at all times is defined as the 90% confidence interval as a percentage of the mean.'* I believe this statement should be more prominent and made earlier in the document – possibly prior to the baseline equations. NB I see it is made in Section 4, step 2.	This is again a registry factor, defined in ACR standards.	(No further comment)	(No further comment)
6	As is necessary, many of the sections read as a step by step manual for using the DNDC model. Are there appropriate online demonstration tools for new users to the DNDC model for familiarization, or good 'worked examples' of baseline and project	Such resources are being created but do not exist at this time. Such additions do not form part of methodology approval	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
	scenario creation? I think these would be helpful to include as Annexes.	but instead are a form of assistance for future methodology users.		

ANNEXES

	Comment	Response	2nd Comment	2nd Response
1	I think that the use of Annexes to detail some sections of the methodology and sources of data required to parameterize the model, would be worthwhile. For instance these could include: • An Annex with a 'simple' worked example of the procedure for developing a baseline in the DNDC model. This could use a fictional farm scenario, with screen shots for visualization of the process. I think if the more complex DNDC approach is adopted then this would be very useful, or at least more links to web tools or DNDC examples that would help the PP user. • The inclusion of an Annex with references and details of examples where DNDC has been used in similar agricultural ecosystems to those encountered in the US to effectively (or otherwise) estimate 'real' GHG emissions (e.g., Abdalla et al 2009, Geoderma 151:327–337). This request is in relation to the statement (page 5, 3rd paragraph) 'the present methodology uses DNDC – a peer reviewed, tested and highly parameterized model – ……' • The inclusion of an Annex with references	These are all good suggestions as good support materials. Support materials should exist alongside a methodology but not as part of the methodology. At this time we seek approval of the methodology. Through time we will make support materials available to facilitate the use of the methodology.	(No further comment)	(No further comment)

	Comment	Response	2nd Comment	2nd Response
	detailing why changes in soil carbon stock are not monitored as part of the methodology (see Section II, 1.2). • Annex with more information and references on definitions and descriptions of direct and indirect N_2O emissions – perhaps some schematic or diagram showing pictorially what emissions will be measured during baseline and project emissions.			

Note: Table 1 and Figure 1 below are not part of the proposed methodology. These are rather illustrations of potential alternate approaches suggested by one reviewer in GENERAL comment #8.

Table 1. Differentiation of 4-R N stewardship plans and BMPs for the levels of the NERP as revised by the decisions of the Consultation Workshop – last column were proposed placeholders. From Climate CHECK™ Decision Paper Results for Nitrous Oxide Emission Reduction Protocol to: Climate Change Central & Canadian Fertilizer Institute, July 23, 2009.

	Right Product	**Right Rate**	**Right Time**	**Right Place**	**Proposed Modifier**
Basic	Ammonium-based formulation.	Apply N according to recommendation of 4-R N stewardship plan, using annual soil testing and/or N balance to determine application rate.	Apply in spring, or split apply, or after soil cools in fall	Apply in bands	**0.8**
Intermediate	Ammonium-based formulation Use slow / controlled release fertilizers or inhibitors or stabilized nitrogen.	Apply N according to qualitative estimates of field variability (landscape position, soil variability)	Apply in spring, or split apply, or after soil cools in fall if using slow / controlled release fertilizer or inhibitors / stabilized nitrogen	Apply in bands	**0.6**
Advanced	Ammonium-based formulation Use slow / controlled release fertilizers or inhibitors or stabilized nitrogen based on quantified field variability	Apply N according to quantified field variability (e.g. digitized soil maps, grid sampling, satellite imagery, real time crop sensors.) complimented by in season crop monitoring	Apply in spring, or split apply, or after soil cools in fall if using controlled release fertilizer or inhibitor / stabilized nitrogen	Apply in bands	**0.5**

Total annual soil N_2O flux, kg N_2O-N/ha/yr	$F = \prod_{i=0}^{3} A_i + \prod_{j=1}^{2} B_j \frac{R_f}{\prod_{k=0}^{6} K_k + R_f}$
Coefficient equations	$A_0 = 1/(LU)$ $A_1 = 245C - 1.4385$ $A_2 = 1E{-}05(CN)^2 - 0.0053(CN) + 1.5254$ $A_3 = 0.9259e^{0.0005(M)}$ $B_1 = 0.2207e^{0.1858(T)}$ $B_2 = 21.704 * \ln C + 122.51$ $K_0 = 300$ $K_1 = 0.2356e^{0.1694(T)}$ $K_2 = 1E{-}05(F)^2 - 0.004\,(P) + 5.5656$ $K_3 = 1.0339e^{3.9509(CLAY)}$ $K_4 = 0.2029(PH)^2 - 2.7911(PH) + 10.568$ $K_5 = 0.0745e^{0.0166(CN)}$ $K_6 = -9E{-}05(M) + 0.9808$
Definitions	F: annual soil N_2O flux, kg N/ha/yr R_f: fertilizer application rate, kg N/ha/yr A_{0-3}: background N_2O flux coefficients, kg N/ha/yr B_{1-2}: saturated N_2O flux coefficients, kg N/ha/yr K_{0-7}: rate coefficients C: SOC content in top soil, kg C/kg soil CN: crop demand for N, kg N/ha M: manure application rate, kg C/ha T: mean annual air temperature, °C P: total annual precipitation, mm $CLAY$: soil clay fraction PH: soil pH LU: land-use type (cropland 1, rice paddy 2, grassland 3)

Figure 1. Equations derived from results of DNDC simulations to estimate N_2O emissions from soils in the US. From *Harnessing Farms and Forest in the Low–Carbon Economy, 2007, Nicholas Institute for Environmental Policy Solutions (Willey and Chameides, Eds)*.