SUMMARY OF COMMENTS & RESPONSES
DRAFT NITROGEN MANAGEMENT PROJECT PROTOCOL VERSION 1.1

2 sets of comments were received during the public comment period for the Climate Action Reserve (Reserve) draft Nitrogen Management Project Protocol (NMPP) Version 1.1. Staff from the Reserve summarize and provide responses to these comments below.

The comment letters can be viewed in their entirety on the Reserve website at http://www.climateactionreserve.org/how/protocols/nitrogen-management/dev/

COMMENTS RECEIVED BY:

1. Barbara Haya, Consultant for Union of Concerned Scientists **(UCS)**
2. Noel Gurwick, Smithsonian Environmental Research Center, and Christina Tonitto, Cornell University **(Gurwick/Tonitto)**

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3.5.1 Performance Standard Test

1. Considering the general trend towards improved nitrogen management in the country, it could be possible that a substantial portion of the projects listed under the protocol will be due to "business as usual" (BAU) improvements.

   What analyses will you perform and what indicators will you monitor to assure this protocol is registering a large majority of truly additional projects? And what actions will you take to modify the protocol if your analysis suggests a reasonable risk that a substantial portion of projects participating (perhaps over a fifth) may be due to BAU improvements in order to preserve the benefits of the protocol on fertilizer use, while also assuring credit buyers that the large majority of credits generated represent additional reductions? **[See UCS comment submission for further detail.] (UCS)**

   RESPONSE: In this Version 1.1 update, the Reserve is proposing no changes to the Performance Standard for the NMPP. During the development of Version 1.0, the Reserve carefully examined business-as-usual trends toward increased nitrogen-use efficiency, the likelihood of various actors improving nitrogen-use efficiency under these trends, and the potential role of the offset market in incentivizing change in nitrogen management practices. The NMPP requires projects to exceed the average nitrogen-use efficiency (RTA) of the state in which the project is located, which the Reserve believes demonstrates that a project goes beyond the anticipated baseline level of N-use efficiency improvements. Projects with significant N-rate reductions that do not exceed the average RTA threshold are not considered additional until they meet or exceed the state average threshold. Given these considerations, the Reserve is confident that the performance standard in this protocol ensures that credited GHG reductions are additional. As with all Reserve protocols, staff will continue to monitor business as usual trends in the industry (e.g. average N rates and yields, which serve as inputs to the RTA calculation and thresholds). As new data becomes available, the Reserve will update the protocol and the RTA thresholds accordingly so as to screen out non-additional projects (e.g. if data becomes available that demonstrates significant improvement to average RTAs at the state level).

5.1 Applicability Conditions for N Rate Reduction Projects

2. Point 4 in Section 5.1 allows for the application of the MSU-EPRI equations across tile-drained landscapes, and we see no justification for this extension across the entire Corn Belt. We understand that some of the fields studied by the MSU team may have had tile drains, but we do not believe this observation justifies the extension of their findings to the fine-textured soils that characterize much of the Corn Belt. A key point is that tile drainage in more sandy soils tends to be used in specific areas whereas tile drainage in fine-textured soils dramatically alters the hydrology of entire landscapes.

   The MI field sites used to develop the MSU-EPRI relationship are sandy loam and loam soils (Hoben et al., 2010). Soils in the extensively tile-drained regions of the Corn Belt are commonly silty clay loams or silt loams. The field sites sampled in MI (sandy loam and loam) have a much lower clay content than silty clay loams and lower silt content than silt loams that are common in the extensively tile-drained Corn Belt regions. The hydrology of the fine-textured soils of the extensively tile-drained Corn Belt is different than the coarser textured soils of MI. We would expect different patterns of drainage surrounding extreme precipitation events, which are the main drivers of N_2O flux.

In order to apply a Tier 2 empirical function to fine-textured, tile-drained Corn Belt regions, field data should be collected to define the shape of the relationship between N fertilizer applied and N_2O loss, similar to the data that is reported in Millar et al. (2010) in Figures 1 & 2.

As a first cut, we suggest you apply the MSU-EPRI equations to test whether the equation can predict the N_2O flux observed from tile-drained Mollisols by Smith et al. (in press).

One issue with N_2O observations from tile-drained Mollisols is the large inter-annual differences in cumulative N_2O flux (Smith et al., in press). We do not understand the extent to which the observed inter-annual difference in N_2O flux from these tile-drained systems results from N applied (with loss patterns fitting the MSU-EPRI equation), versus to what extent inter-annual differences result from weather and environmental conditions.

We previously documented our concern with extrapolating measurements from five fields in MI to 12 states in the Corn Belt. Our original comments are pasted below. **[See Gurwick/Tonitto comment submission for further detail.] (Gurwick/Tonitto)**

RESPONSE: The Reserve agrees that additional field level research and data collection will continue to improve and refine the existing quantification methodology in this protocol, as well as create opportunities for developing new Tier 2 emission factors for additional regions and crop systems. The Reserve also recognizes that as new data becomes available, we may be able to better quantify the variations in N_2O emissions within a region like the NCR, due to differences in soil types and management practices across the landscape. There is not sufficient data available at this time to develop regional Tier 2 emission factors specific to finer-textured, tile-drained Corn Belt soils, but the Reserve believes that the MSU-EPRI emission factor is the best currently available to quantify direct N_2O emission reductions from reducing N applied in the region. Further, the Reserve believes that the MSU-EPRI emission factor, combined with the conservative accounting measures and assumptions included in the quantification section (Section 5) of the protocol, is sufficiently conservative to be applied to finer-textured tile-drained soils in the NCR.

Recognizing ongoing stakeholder concerns about the applicability of the MSU-EPRI emission factor, the Reserve has taken a conservative approach to geographic eligibility in V1.0 and V1.1. In response to stakeholder feedback during the development of NMPP Version 1.0, the Reserve conservatively excluded certain counties in the NCR region from eligibility and introduced a significant uncertainty deduction for project fields outside of Michigan to address these applicability concerns.

Finally, as suggested by the commenter, the Reserve compared Smith et al.'s N_2O emissions measurements to the estimated emissions calculated with the direct N_2O equation used in the NMPP (uncorrected for uncertainty). The N_2O emissions reported in Smith et al. (specifically, two data points representing annual averages for N_2O emissions from corn in 2009 and 2011) are larger than the direct N_2O emissions calculated using the NMPP equations for the same N-rate. However, the NMPP equations appear more accurate in quantifying the direct N_2O emissions for years of average or below average precipitation than for years with above average precipitation (e.g., the

NMPP equations more accurately estimated absolute emissions in 2011 than in 2009, a year with very high precipitation). It is important to note that the equations in the protocol are designed to be used to calculate emission *reductions* stemming from reductions in N-applied, as opposed to absolute emissions. As such, if the NMPP equations are likely to underestimate the absolute emissions from a fine-textured tile drained soil, the NMPP equations are likely to conservatively underestimate both the project and baseline emissions from the same field and soil type by approximately the same degree, resulting in a reasonably accurate estimate of emission reductions.

5.3 Determining Primary Effect N_2O Emission Reductions

3. Equation 5.11 appears to be incorrect, yielding absurdly high values for N_2O emissions. For example, applying 200 kg N per ha would result in emissions of 2.42×10^{84} kg N_2O-N per ha. The source of these very high values for emissions is the values of the emission factor $EF_{dir,P,f.}$ At 200 kg N per ha, this EF takes on a value of 2.42×10^{84}.

   It is not clear to us exactly how to correct this problem because it is not clear how the math in the relationships derived from Hoban et al. and reported by Millar et al. is intended to be applied here. The use of an emission factor – any emission factor – seems unnecessary if the intention is to apply a non-linear relationship in which N_2O emissions are calculated as a function of N fertilizer application rate. **[See Gurwick/Tonitto comment submission for further detail.] (Gurwick/Tonitto)**

   RESPONSE: Thank you for calling attention to this error in Equation 5.11, which was overlooked in the same equation in NMPP Version 1.0 as well.[1] A coefficient of 0.0067 was missing in the term to which the exponential function (*e*) was raised and has been corrected. Further, additional parentheses and brackets have been added to increase clarity as to the order of operations in calculating the emission factor.

   To clarify the relationship between Equation 5.11 and the Hoben/Millar et al. studies, over the course of protocol development, the Reserve realized that lacking independent data to validate the model, re-running the statistical analysis from these studies and employing the "leave one out" statistical approach would be the best way to assess the structural uncertainty of the model. As discussed in Box 5.2 of the NMPP, the "leave one out" approach left out one set of data points from Hoben et al.'s rate trials when recalculating the emission factor, allowing for the "left out" dataset to be used for independent model validation. The Reserve worked with two of the studies' authors at Michigan State University, Neville Millar and Phil Robertson, to obtain the recalculated emission factors using this approach.

   Equations 5.10 and 5.11 have also been further simplified.

4. Equation 5.12 is incorrect as written but can be fixed with minor edits. We note, for example, that N_2O emissions from $NR_{B,S,f,t}$ should be $NR_{B,S,f,t} \times 0.10 \times 0.01$ (10% of synthetic fertilizer estimated to leach, and 1% of that estimated to leave the system as N_2O). As currently written, the 1% multiplier does not apply to $NR_{B,S,f,t}$. Also, 4428 should be "44/28" **(Gurwick/Tonitto)**

[1] The Reserve plans to issue an Erratum to address this error in Version 1.0 if projects are submitted for listing under Version 1.0 of the protocol.

RESPONSE: Thank you for calling attention to the error with the molecular weight conversion (4428 instead of 44/28); it has been corrected. The Reserve has also added additional parentheses and brackets in Equations 5.12 and 5.13 to ensure clarity as to the order of operations while performing each calculation.

5. Regarding the following text and associated footnote 66 in Box 5.1:

   "More specifically, all fields without tile-drains, including those fields on which emergency irrigation is permissible (as defined in Section 5.1)[66] shall apply the $Frac_{LEACH}$ for the county (counties) in which the field is located, as calculated by the Reserve. $Frac_{LEACH}$ values are published in map-form annually on the Reserve website."

   "Footnote 66: In years of severe or extreme drought, emergency irrigation is not expected to make up the full precipitation deficit; as such, (precipitation + irrigation volume) is not expected to exceed (potential evapotranspiration), and leaching is not expected to occur (i.e. $Frac_{LEACH}$ = 0), making this methodology consistent with IPCC guidelines for determining $Frac_{LEACH}$, even though the IPCC recommended default $Frac_{LEACH}$ value of 0.3 for irrigated fields is not applied."

   The assumption in fn 66 is likely incorrect in many if not most years. Excess precipitation leading to high N loss rates through tile drains – and consequently high N_2O emissions from leached N – is most likely to occur in the spring, coincident with fertilizer application. On the other hand, emergency irrigation is most likely to occur in mid-to-late summer, when plant N demand is low, fertilizer N is not being applied, and soil is not saturated with N. We recommend this provision be changed to apply only within six weeks of first planting. **(Gurwick/Tonitto)**

   RESPONSE: The protocol has been revised to more clearly define the circumstances under which emergency irrigation is permissible (i.e. when a state of emergency is declared due to drought in the county the project field is located). The protocol has also been revised to clarify that no irrigation shall be allowed within the six weeks of planting. However, the methodology in NMPP V1.1 also conservatively assumes that whenever a project field is underlain with tile drains, leaching will occur in all years, regardless of that year's precipitation and evaporation data and regardless of when the heaviest precipitation and leaching occurs (i.e. all tile drained sites must use a default $Frac_{LEACH}$ of 0.3, derived from the IPCC $Frac_{LEACH}$ methodology[2]).The Reserve believes this conservative assumption, combined with the revisions noted above, guard against the risk of underestimating leaching from tile drains.

6. We are concerned with the application of the Millar et al. 2010 relationship at the tail ends of N applied. At the low end of N input, the Millar relationship predicts a very high percent of N applied is lost as N_2O. This is a result of residual soil N loss; it does not adequately capture the N_2O loss due to fertilization. Similarly, the observations are highly variable at the high end of application, indicating that N applied is not the only control on N_2O loss.

[2] This methodology was demonstrated to be applicable to tile drains in the NCR region in an analysis performed by the co-chair of the IPCC Expert Group on Indirect N_2O Emissions from Nitrogen Used in Agriculture, Cynthia Nevison. See Nevison, C. "Background Paper on Indirect N_2O Emissions from Agriculture," G*ood Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, Background paper published 2003 to inform the 2006 update to the Revised 1996 National Inventory Guidelines, Available at: http://www.ipcc-nggip.iges.or.jp/public/gp/bgp/4_6_Indirect_N2O_Agriculture.pdf; and Nevison, C., (2000) "Review of the IPCC Methodology for estimating nitrous oxide emissions associated with agricultural leaching and runoff," *Chemosphere – Global Change Science*, Vol. 2, pp 493-500.

N applied	Millar (2010) N2O loss		Millar equation
kg N/ha	kg N2O-N/ha		% of N applied
1	2.5		247.8
10	2.6		25.6
20	2.6		13.2
50	3.0		6.0
100	3.7		3.7
120	4.1		3.5
150	4.9		3.3
180	5.8		3.2
200	6.6		3.3

(Gurwick/Tonitto)

RESPONSE: The Reserve believes the Millar et al. relationship and emission factor is sufficiently precise for quantifying the emission reductions in the NCR under this protocol. The Millar et al. relationship has been published in peer-reviewed studies, was considered appropriate for use in this protocol by the Nitrogen Management Science Advisory Committee, and underwent an extensive public review process, including a multi-stakeholder workgroup and public comment period, before being adopted by our Board in Version 1.0. While the Reserve acknowledges that the Millar relationship does not appear to perform as strongly at the lowest end of the spectrum, likely due to residual N in the soil, the Reserve disagrees that it is "highly variable" at the high end. Rather, the N_2O loss corresponds to the increasing exponential relationship of N-applied to N-lost as N_2O, reported in the Hoben et al. and Millar et al. studies, in which a larger proportion of N applied is lost as N rates increase.

It is also important to note that the equations in the protocol are designed to be used together to calculate emission *reductions* stemming from reductions in N-applied, as opposed to absolute emissions, and deductions to account for structural uncertainty of the model are designed to be applied to the emission reductions, not absolute emissions. The N rates in the table above represent N rates, as opposed to the change in N rates. The Reserve believes it is very unlikely that project participants will be applying N at rates at the lowest end of the spectrum (e.g. 10 kg/ha), either in the baseline or project.

8 Verification Guidance

7. On verifying the amount of fertilizer used. We understand that verification will include a number of sources of data about fertilizer use, including corn stalk nitrate tests (CSNT), fertilizer purchase records, farm management records, interviews with farm managers during site visits by an agronomist for some sites, and attestations made by farm managers of the veracity of the data. We also understand that fertilizer application rates in baseline and project years may not be recorded in verifiable records, and that while the CSNT test can point to wide disparities in actual and claimed rates, it does not accurately measure fertilizer application rates. Changes in documented purchases of fertilizer are a proxy for changes in application rates, but a farmer

may purchase fertilizer for all of their land, but only enlist a few fields in the offsets program. In these cases, changes in fertilizer purchases for the entire farm could not necessarily be attributed to the specific fields in the program. Also, the timing of fertilizer purchased may not match fertilizer applications, for example, if reserve fertilizer is purchased when prices are low.

With the increased verification requirements added to Version 1.1 of the protocol, how accurately can fertilizer application rates be verified, for baseline and project years, to ensure that excess reductions are not being claimed? Under what conditions is the verification considered sufficiently accurate? **(UCS)**

RESPONSE: To be clear, the Reserve has not added additional verification requirements to the NMPP Version 1.1. A few paragraphs (Sections 8.2 and 8.3.1) are erroneously highlighted in the redlined version of the protocol due to minor formatting changes, but in fact have not undergone any content changes from NMPP V1.0. The Reserve did also make a number of clarifications and updates to Tables 8.1 – 8.4, which may have been interpreted as additional verification requirements. However, the new line items in these tables were implicitly required for verification in Version 1.0, as noted elsewhere in Section 8 and throughout the protocol, and have simply been made more explicit for clarity.

That said, the protocol (both Versions 1.0 and 1.1) requires extensive field-level management records be kept by the project participant for each field enrolled in a project, which are the primary data the verifier must review in verifying the project activity. After examination of these records, sales receipts and CSNT tests are reviewed by the verifier to further support the assertions about management practices, amounts, dates, etc., reported by the project participant. Though assessment of any single reporting requirement (such as CSNT or farm management records) may not be sufficient to identify any falsifications, the Reserve believes that consideration of *all* the reporting requirements by a trained lead verifier with the assistance of an agronomist will allow for the triangulation and corroboration of data to a reasonable level of assurance, sufficient to issue a positive verification.

To address the commenter's concern under what conditions verification is considered sufficiently accurate, all Reserve projects reporting less than or equal to 25,000 tons of CO_2e in emission reductions/removals per year are considered accurately verified to a "reasonable level of assurance" at the 95% accuracy level (in other words, less than 5% error). Verification to a reasonable level of assurance at 95% accuracy, which is also the level of assurance applied in the California compliance regulations, confirms the accuracy of the GHG assertion made, while allowing for the professional judgment and sampling employed in NMPP verification. In the NMPP, this 95% accuracy level is applied at the individual field level, as well as at the aggregate level, and corrective actions are expected to be taken wherever possible. If verification is unsuccessful on any given field within the aggregate, additional fields must be verified successfully, according to the guidelines in Section 8.9 of the NMPP.