Final BMP Panel Report

Definitions and Recommended Nutrient Reduction Efficiencies of

Nutrient Management Practices

For Use in Phase 6.0 of the
Chesapeake Bay Program Watershed Model

Recommendations for Approval by the Water Quality Goal Implementation Team's
Watershed Technical and Agricultural Workgroups

Submitted by the Phase 6.0 Nutrient Management BMP Expert Panel

Submitted to:
Agriculture Workgroup
Chesapeake Bay Program

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Final October 18, 2016
Approved as Amended by Agriculture Workgroup October 20, 2016 (see Appendix G)

Contents

Preface

The Phase 6 Nutrient Management BMP Expert Panel presented its final report on nutrient management practices for use in Phase 6.0 of the Chesapeake Bay Program Watershed Model (dated October 18, 2016) to the Agriculture Workgroup for approval on October 20, 2016. The Agriculture Workgroup approved the report with amendments added by the workgroup. These Agriculture Workgroup implemented amendments to the Panel's report divided both the Nitrogen Core Nutrient Management and Phosphorus Core Nutrient Management BMPs into two components reflecting whether on-site specific manure analysis for nitrogen, and both soil and manure analysis for phosphorus; or estimated (a.k.a. book value) manure analysis for nitrogen, and both soil and manure estimated analysis for phosphorous is used to determine nitrogen or phosphorus application rates respectively. These Agriculture Workgroup modifications resulted in the need to make multiple changes in the Panel's final report.

The Phase 6 Nutrient Management BMP Expert Panel final report (dated October 18, 2016) is contained here as the cover page through page 40 (References), plus Appendices A-F and H, minus this Preface and the Preface to Appendices on page 41.

The final Panel Report as updated in response to the Agriculture Workgroup amendments is contained in Appendix G, which supersedes the original Panel Report for implementation by the CBP partnership in all aspects as approved. Appendices B-F for the Panel Report (dated October 18, 2016) were not affected by the approved amendments and are therefore not included in Appendix G with the amended report. Appendices A and Appendix H were affected by the approved amendments and updated versions of these two appendices are included with the amended report in Appendix G, and also supersede their original counterparts in all aspects as approved. The original versions of Appendix A and Appendix H are also provided here for context.

Acronyms and Abbreviations

AAPFCO	Association of American Plant Food Control Officials
ac.	Acre
AgWG	Agriculture Workgroup
ARS	USDA Agricultural Research Service
BMP	Best Management Practice
bu.	Bushel
bu./ac.	Bushels per Acre
CBP	Chesapeake Bay Program
CBPO	Chesapeake Bay Program Office
CBPWM	Chesapeake Bay Program Watershed Model
CBW	Chesapeake Bay Watershed
CEAP	Conservation Effects Assessment Project
CRC	Chesapeake Research Consortium
CSNT	Corn Stalk Nitrate Test
DE	Delaware
DRP	Dissolved Reactive Phosphorus
EOF	Edge of Field
EONR	Economic Optimum N Rate
FSNT	Fall Soil Nitrate Test
ft.	Feet
ha	Hectare
HUC	Hydrologic Unit Code
ISNT	Illinois Soil Nitrogen Test
kg	Kilogram
lbs.	Pounds
LGU	Land-Grant University
MD	Maryland
N	Nitrogen

N Core NM BMP	Nitrogen Core Nutrient Management Best Management Practice
N Supplemental NM BMP	Nitrogen Supplemental nutrient management Best Management Practice
NEIEN	National Environmental Information Exchange Network
NM	Nutrient Management
NMP	Nutrient Management Plan
NO_3-N	Nitrate N
NRCS	USDA Natural Resources Conservation Service
NRI	National Resources Inventory
NY	New York
P	Phosphorus
P Core NM BMP	Phosphorus Core Nutrient Management Best Management Practice
P Supplemental NM BMP	Phosphorus Supplemental nutrient management Best Management Practice
PA	Pennsylvania
PAN	Plant Available N
Panel	Nutrient Management Expert Panel
PET	Phosphorus Environmental Threshold
PSNT	Pre-sidedress Nitrate Test
QAPP	Quality Assurance Project Plan
TN	Total Nitrogen
TP	Total Phosphorus
USDA	U.S. Department of Agriculture
VA	Virginia
VTCA	Virginia Tech Corn Algorithm
WTWG	Watershed Technical Workgroup
WQGIT	Water Quality Goal Implementation Team
WV	West Virginia

Summary of Recommendations

1 Introduction

Nutrient management practices are implemented on millions of acres of agricultural lands across the Chesapeake Bay Watershed (CBW). It is one of the oldest best management practices (BMPs) in agriculture and is the cornerstone of stewardship efforts by conservation groups, producers and jurisdictions. This document summarizes the recommendations of the Phase 6 Nutrient Management Expert Panel (the Panel) for revised definitions and credits for nutrient management practices. The Panel, whose members are identified in Table 1, proposes that the Chesapeake Bay Program's (CBP) existing definitions and credits associated with implementation of Nutrient Management Plans (NMPs) be replaced by independent sets of practice elements for nitrogen (N) and phosphorus (P) management due to the marked difference in the use, fate, and transport of these nutrients in agricultural systems. The structures for both N and P nutrient management are similar, however, with supplemental management elements stacked onto a required core set of management elements.

Table 1. CBP Phase 6.0 Nutrient Management Expert Panel Membership

Name	Jurisdiction	Affiliation	Role
Frank Coale	Maryland	University of Maryland	Panel Chair
Deanna Osmond	North Carolina	North Carolina State University	Panel Member
Doug Beegle	Pennsylvania	Penn State University	Panel Member
Jack Meisinger	Maryland	USDA-Agriculture Research Service	Panel Member
Tom Fisher	Maryland	University of Maryland Center for Environmental Science	Panel Member
Quirine Ketterings	New York	Cornell University	Panel Member
Chris Brosch	Delaware	Delaware Department of Agriculture	Watershed Technical Workgroup representative
Matt Johnston	Maryland	University of Maryland, CBPO	Modeling Team representative
Technical support provided by Mark Dubin (University of Maryland, CBPO), Lindsey Gordon (CRC Staffer), and Steve Dressing (Tetra Tech).			

CBPO – Chesapeake Bay Program Office; CRC – Chesapeake Research Consortium; USDA – U.S. Department of Agriculture

2 Practice Definitions

Nutrient management has four basic components: the nutrient source, rate, timing, and placement. Each of these four components of NM are managed at the field or sub-field scale in a manner to support crop productivity, achieve high nutrient use efficiency by the growing crop, and to minimize nutrient loss to the environment. The four components of NM planning interact with each other on a site-specific basis and are modified by site-specific field management, soil properties, and weather conditions. Thus, the Panel defines Nutrient Management as the implementation of a site-specific combination of nutrient source, rate, timing, and placement into a strategy that seeks to optimize agronomic and environmentally efficient utilization N and P. Improvement in nutrient-use efficiency necessitates documentation of NM implementation strategies that are suitable for independent verification.

Nutrient management also provides other important benefits to the agricultural and the environmental communities. These benefits include long-standing educational opportunities conducted in various venues for a wide variety of audiences that convey the fundamentals of NM and state-of-the-science practices and assessment tools. It is essential that an initial baseline for NM implementation is established that allows estimation of progress over time. Application of NM BMPs will

interrelate with other agricultural nonpoint source BMPs and communication with other BMP Expert Panels is essential to define appropriate implementation and crediting.

Nutrient management for Phase 6.0 of the Chesapeake Bay Program Watershed Model (the Phase 6 model) is separated into independent sets of practice elements for N and P management due to the marked difference in the use, fate, and transport of these nutrients in agricultural systems. The structures for both N and P nutrient management are similar, however, with supplemental management elements stacked onto a required core set of management elements.

Practice Name(s)

- Nitrogen (N) Core Nutrient Management BMP
- Phosphorus (P) Core Nutrient Management BMP
- Nitrogen (N) Rate Supplemental Nutrient Management BMP
- Nitrogen (N) Placement Supplemental Nutrient Management BMP
- Nitrogen (N) Timing Supplemental Nutrient Management BMP
- Phosphorus (P) Rate Supplemental Nutrient Management BMP
- Phosphorus (P) Placement Supplemental Nutrient Management BMP
- Phosphorus (P) Timing Supplemental Nutrient Management BMP

Core Nutrient Management BMPs

The elements of the N Core Nutrient Management BMP are found in Table 2. Application of a N Core NM BMP application rate multiplier modifies the crop- and land-use-specific N application rate goal, which is based on Land-Grant University (LGU) crop fertilization recommendations, as modified by the CBP partnership. In an effort to determine the most practicable methodology for allocating fertilizer N to satisfy crop- and land-use-specific N application rate goals, the Agriculture Workgroup compared the modified LGU recommendations for application of supplemental inorganic N fertilizer to an alternative approach based on county-level redistribution of Association of American Plant Food Control Officials (AAPFCO) N fertilizer sales data. This methodological comparison indicated that there were relatively small differences between the two methods for estimating supplemental N fertilizer applications, leading the Agriculture Workgroup to approve use of the redistributed AAPFCO fertilizer sales methodology in the Phase 6 Model. The Panel recommends that similar comparative analyses be conducted in the future to evaluate newly available fertilizer sales data and to further evaluate the redistributed fertilizer sales methodology's forecasting ability. Inconsistencies between estimates generated by the two methods should be investigated and rectified based on data source quality and consistency using contiguous or regional county-level data.

Table 2. Elements of the N Core Nutrient Management BMP

NITROGEN Core Nutrient Management BMP (ALL applicable core elements required to be implemented and verified)
N rate according to LGU recommendations at field management unit level
Manure analysis and volume
Spreader/applicator calibration
Yield estimates and cropping plan at field management unit level
Cropping and manure history at field management unit level

The elements of the P Core Nutrient Management BMP are found in Table 3. Application of a P Core NM BMP application rate multiplier modifies the crop- and land-use-specific P application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. A significant modification imposed by the CBP partnership was the assumption that all agricultural acres in the CBW had a soil-test P concentration that corresponded with the "medium" soil test interpretive category. The Panel recognized that, in the absence of soil-test P concentration data, assumed soil-test P concentrations were necessary to facilitate CBP model processes. However, the Panel also recognized that implementation

of the universal "medium" soil-test P assumption infused a high level of site-specific uncertainty into the modeled P application rate. In general, the inherent uncertainty in P application rate resulting from the adoption of the universal "medium" soil-test P concentration assumption is expected to be similar to or greater than the magnitude of the P application rate modifications resulting from implementation of P Core NM BMP application rate multipliers.

In practice, LGU recommendations for P application are based on crop- and site-specific soil-test P concentration. Currently, soil-test P concentration data are not available to the CBP. The Panel recommends that, in the future, crop- and site-specific soil-test P concentration data should be collected, aggregated to the appropriate scale, summarized to eliminate disclosure of confidential business information, and utilized as the foundation for determining P application rate goals and the appropriate application of P Core NM BMPs. In the absence of soil-test P data and soil-test P based application rate goals, soil-test P concentration must be assumed and, in turn, utilized to create artificial P application rate goals. Additionally, in the absence of soil-test P data, county-level redistribution of CBW AAPFCO P fertilizer sales data may serve as a useful surrogate for determining P application rate goals.

Field management shall be considered compliant with P fertilization recommendations when P application recommendations resulting from site-specific environmental risk assessments (i.e. P Index, P Site Index, P Management Tool, etc.) allow higher P application rates than the standard LGU soil-test based recommendations, after accounting for the site-specific potential for P loss to streams. In another example, Virginia nutrient management planners may utilize a more restrictive method known as the Phosphorus Environmental Threshold (PET) in lieu of soil-test P based recommendations when evaluating application of organic nutrient sources. Using the PET method, P from organic sources may be applied to fields that test less than a regionally-specified degree of soil P saturation, as quantified by Mehlich 1 soil-test P concentration. By physiographic region, the PET soil-test P thresholds are: 135 ppm – Eastern Shore & Lower Coastal Plain; 136 ppm - Middle & Upper Coastal Plain & Piedmont; and 162 ppm - Ridge and Valley. Nitrogen applications cannot exceed crop N needs when using PET. Additional details may be found in "Virginia Nutrient Management Standards and Criteria", as revised July 2014. Other examples may be similarly applicable.

The P Core NM BMP requires a P soil test at the field management unit level. This required element may be waived if, as in the case of Pennsylvania's manure management guidelines, restrictions on manure application (rates, timing, and placement) are imposed that limit total P application rates and management to the same degree as if the site was in the high P soil test interpretive category.

Table 3. Elements of the P Core Nutrient Management BMP

PHOSPHORUS Core Nutrient Management BMP (ALL applicable core elements required to be implemented and verified)
P rate according to LGU recommendations at field management unit level
P soil tests at field management unit level
Manure analysis and volume
Spreader/applicator calibration
Yield estimates and cropping plan at field management unit level
Cropping and manure history at field management unit level

Supplemental Nutrient Management BMPs

The Nitrogen Supplemental Nutrient Management BMPs (N Supplemental NM BMPs) involve applying a loss-reduction multiplier for the N Supplemental NM BMP elements only after satisfactory implementation of the N Core NM BMP. Multiple advanced site assessments and N management tools may be utilized to inform the application of the appropriate N adjustment practices, but do not represent a N loss reduction credit in and of themselves. A list of example N site assessments and N management tools is given in Table 4. This list is not intended to be exhaustive. Rather, Table 4 presents examples of current techniques and tools that the Panel deems potentially useful in supporting crediting of changes in N management and recognizes that this listing will need to be updated over time as new tools and procedures are developed.

Advanced site assessments and application of N management tools that result in a verifiable implementation of a change in planned N application rate, N application timing or N application placement may result in a N Supplemental NM BMP loss reduction credit. The actual crediting of the Supplemental NM BMPs requires placing a given BMP into a N Rate, N Timing, or N Placement Supplemental NM BMP category (Tables 5 through 7). One single N Supplemental NM BMP loss reduction multiplier may be credited for each of the N Rate, N Timing, and N Placement categories. The actual values for these Supplemental NM BMP loss reduction multipliers are presented later in this report (Table 14). Supplemental N NM BMP loss reduction credits for N rate, N timing, and N placement are stackable, e.g., multiplicative with diminishing returns for reducing environmental loss.

Table 4. Examples of advanced N site assessments and N management tools that may be used to support implementation of changes in originally planned N application rate, N application placement, and/or N application timing. Additional assessment techniques and tools may be utilized to support implemented changes in N management.

Advanced N Assessment Tools
Pre-sidedress Nitrate Test (PSNT)
Manure analysis ≤ 1 year old
On-farm replicated research
Corn Stalk Nitrate Test (CSNT)
N-loss risk assessments & models - Ammonia loss
Yield mapping
Illinois Soil Nitrogen Test (ISNT)
On-farm strip trials
N-loss risk assessments & models - Leaching loss
Fall Soil Nitrate Test (FSNT)
N-loss risk assessments & models - Denitrification losses
Whole farm balances
In-season sensors/remote sensing in general
Geo-spatial mapping

Example elements of the N Rate Supplemental NM BMP are listed in Table 5. Additional N management practices that result in reductions in the rate of applied N may be applicable.

Table 5. Elements of the N Rate Supplemental Nutrient Management BMP

N Rate Adjustment Practice (implementation of one or more BMPs required)
N rate less than LGU recommendations
Split N applications for reduced total rate
Variable rate N application at sub-field management unit level

Example elements of the N Placement Supplemental NM BMP are listed in Table 6. Subsurface injection or incorporation applies only to inorganic fertilizer N. Incorporation or injection of manure is addressed by the Phase 6 Manure Incorporation and Injection Expert Panel report with the following practices: Manure Injection, Manure Incorporation High Disturbance, and Manure Incorporation Low Disturbance. Additional N management practices that result in purposeful physical placement of N sources such that the potential for N loss to the environment is reduced and/or crop N-use efficiency is improved may be applicable.

Table 6. Elements of the N Placement Supplemental Nutrient Management BMP

N Placement Adjustment Practice (implementation of one or more BMPs required)
Subsurface injection or incorporation of applied Inorganic N
N application setbacks from water

Example elements of the N Timing Supplemental NM BMP are listed in Table 7. Additional N management practices that result in the enhanced precision of the timing of application of N sources that reduces the potential for N loss to the environment and/or improves crop N-use efficiency may be applicable.

Table 7. Elements of the N Timing Supplemental Nutrient Management BMP

N Timing Adjustment Practice (implementation of one or more BMPs required)
Split N applications
PSNT

The Phosphorus Supplemental Nutrient Management BMPs (P Supplemental NM BMPs) involve applying a loss-reduction multiplier for the P Supplemental NM BMP elements only after satisfactory implementation of the P Core NM BMP. Multiple advanced site assessments and P management tools may be utilized to inform the application of the appropriate P adjustment practices, but do not represent a P loss reduction credit in and of themselves. A list of example P site assessments and P management tools is given in Table 8. This list is not intended to be exhaustive. Rather, Table 8 presents examples of current techniques and tools that the Panel deems potentially useful in supporting crediting of changes in P management and will need to be updated over time as new tools and evaluative procedures are developed.

Advanced site assessments and application of P management tools that result in a verifiable implementation of a change in planned P application rate, P application timing or P application placement may result in a P Supplemental NM BMP efficiency credit. The actual crediting of the Supplemental NM BMPs requires placing a given BMP into either a P Rate, or P Timing, or P Placement Supplemental NM BMP category (Tables 9 through 11). One single P Supplemental NM BMP loss reduction multiplier may be credited for each of the P Rate, P Timing, or P Placement categories. The actual values for these Supplemental NM BMP loss reduction multipliers are presented later in the report (Table 15). Supplemental NM BMP loss reduction credits for P rate, P timing, and P placement are stackable, e.g., multiplicative with diminishing returns for reducing environmental loss.

Table 8. Examples of advanced P site assessments and P management tools that may be used to support implementation of changes in originally planned P application rate, P application placement, and/or P application timing. Additional assessment techniques and tools may be utilized to support implemented changes in P management.

Advanced P Assessment Tools
Soil-test P remediation/declining
P Index assessment
Grid soil sampling
Manure analysis ≤ 1 year old
On-farm replicated research
Yield mapping
On-farm strip trials
Whole farm balances
Geo-spatial mapping

Example elements of the P Rate Supplemental NM BMP are listed in Table 9. Additional P management practices that result in reductions in the rate of applied P may be applicable.

Table 9. Elements of the P Rate Supplemental Nutrient Management BMP

P Rate Adjustment Practice (implementation of one or more BMPs required)
P-based manure rate based on annual crop P removal
P rate less than LGU recommendations
Variable rate P at sub-field management unit level

Example elements of the P Placement Supplemental NM BMP are listed in Table 10. The P placement practices of subsurface injection or incorporation apply only to inorganic fertilizer P. Incorporation or injection of manure P is addressed by the Phase 6 Manure Injection & Incorporation Expert Panel report with the following practices: Manure Injection, Manure Incorporation High Disturbance, and Manure Incorporation Low Disturbance. Additional P management practices that result in the purposeful physical placement of P sources such that the potential for P loss to the environment is reduced may be applicable.

Table 10. Elements of the P Placement Supplemental Nutrient Management BMP

P Placement Adjustment Practice (implementation of one or more BMPs required)
Subsurface injection or incorporation of applied inorganic P
P application setbacks from water

Example elements of the P Timing Supplemental NM BMP are listed in Table 11. Additional P management practices that result in the enhanced precision of the timing of application of P sources that reduces the potential for P loss to the environment may be applicable.

Table 11. Elements of the P Timing Supplemental Nutrient Management BMP

P Timing Adjustment Practice (implementation of one or more BMPs required)
P application in lower P-loss risk season
Split P applications

Figure 1 illustrates how the N Core NM BMP and the N Supplemental NM BMPs are combined for credit. As described above, N Supplemental NM BMPs can only be credited if the N Core NM BMP is implemented and verified. The N Supplemental NM BMPs do not result in additional credit unless implementation of adjustments in N rate, N placement, or N timing is verified. The N Supplemental NM BMPs are assigned to three categories: N Rate Adjustment Practices, N Placement Adjustment Practices, and N Timing Adjustment Practices. The Supplemental NM BMP loss reduction credit for each of these three categories can be obtained if implementation of at least one effective practice from each category is verified. For example, if implementation of the N Core NM BMP is verified and implementation of both N application setbacks from water (a N placement adjustment) and variable rate N application (a N rate adjustment) are verified, the application rate multiplier credit may be claimed for the N Core NM and additional loss reduction multiplier credits may be claimed for both the N Placement Supplemental NM BMP and the N Rate Supplemental NM BMP. In this example, no additional loss reduction multiplier credit may be claimed for the N Timing Supplemental NM BMP.

Figure 2 illustrates how the P Core NM BMP and the P Supplemental NM BMPs are combined for credit. As described above, P Supplemental NM BMPs can only be credited if the P Core NM BMP is implemented and verified. The P Supplemental NM BMPs do not result in additional credit unless implementation of adjustments in P rate, P placement, or

P timing is verified. The P Supplemental NM BMPs are assigned to three categories: P Rate Adjustment Practices, P Placement Adjustment Practices, and P Timing Adjustment Practices. The Supplemental NM BMP loss reduction credit for each of these three categories can be obtained if implementation of at least one effective practice from each category is verified. For example, if implementation of the P Core NM BMP is verified and implementation of both P application setbacks from water (a P placement adjustment) and P-based manure rate based on annual crop P removal (a P rate adjustment) are verified, the application rate multiplier credit may be claimed for the P Core NM and additional loss reduction multiplier credits may be claimed for both the P Placement Supplemental NM BMP and the P Rate Supplemental NM BMP. In this example, no additional loss reduction multiplier credit may be claimed for the P Timing Supplemental NM BMP.

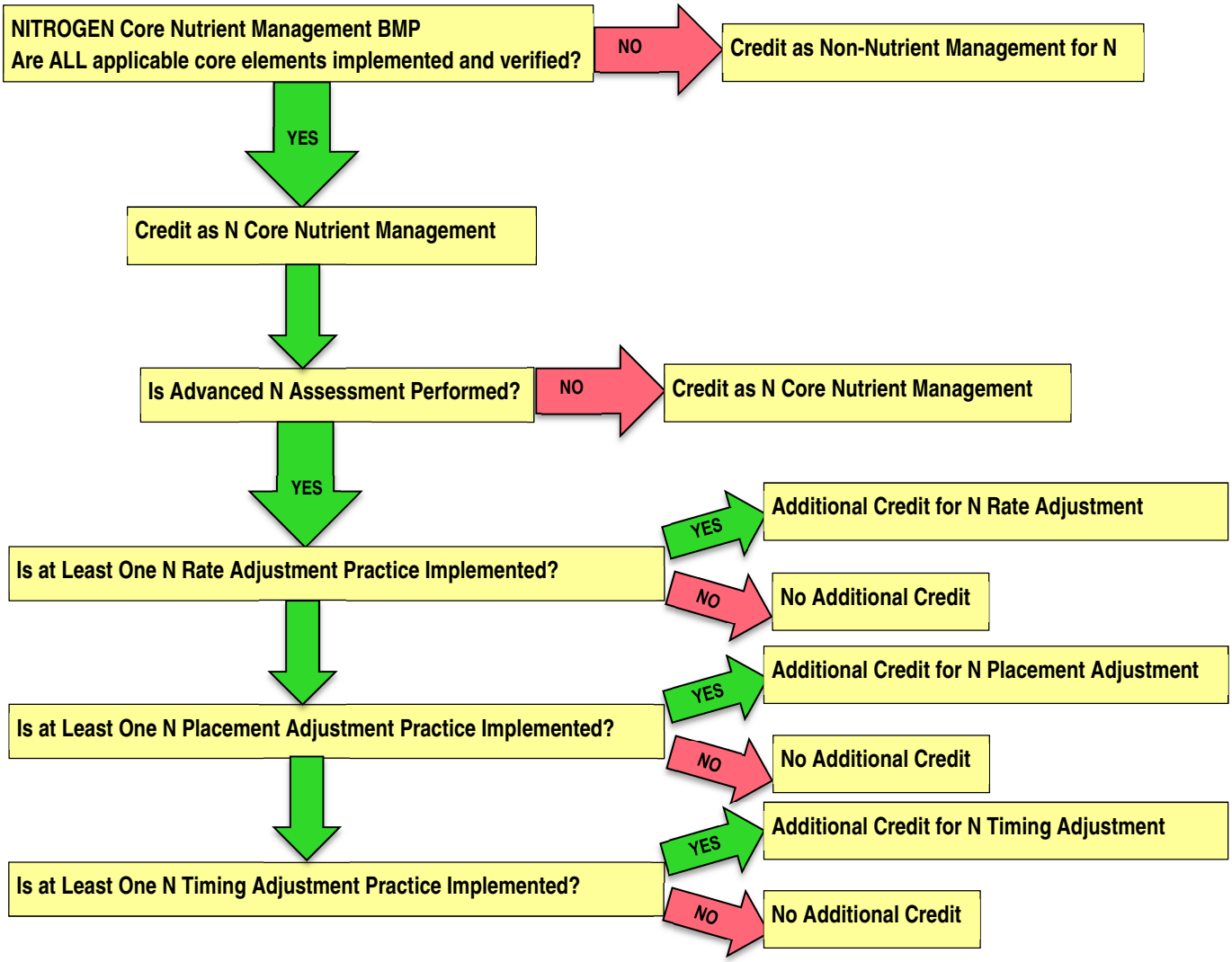

Figure 1. Linkage of Core and Supplemental N Nutrient Management Practices

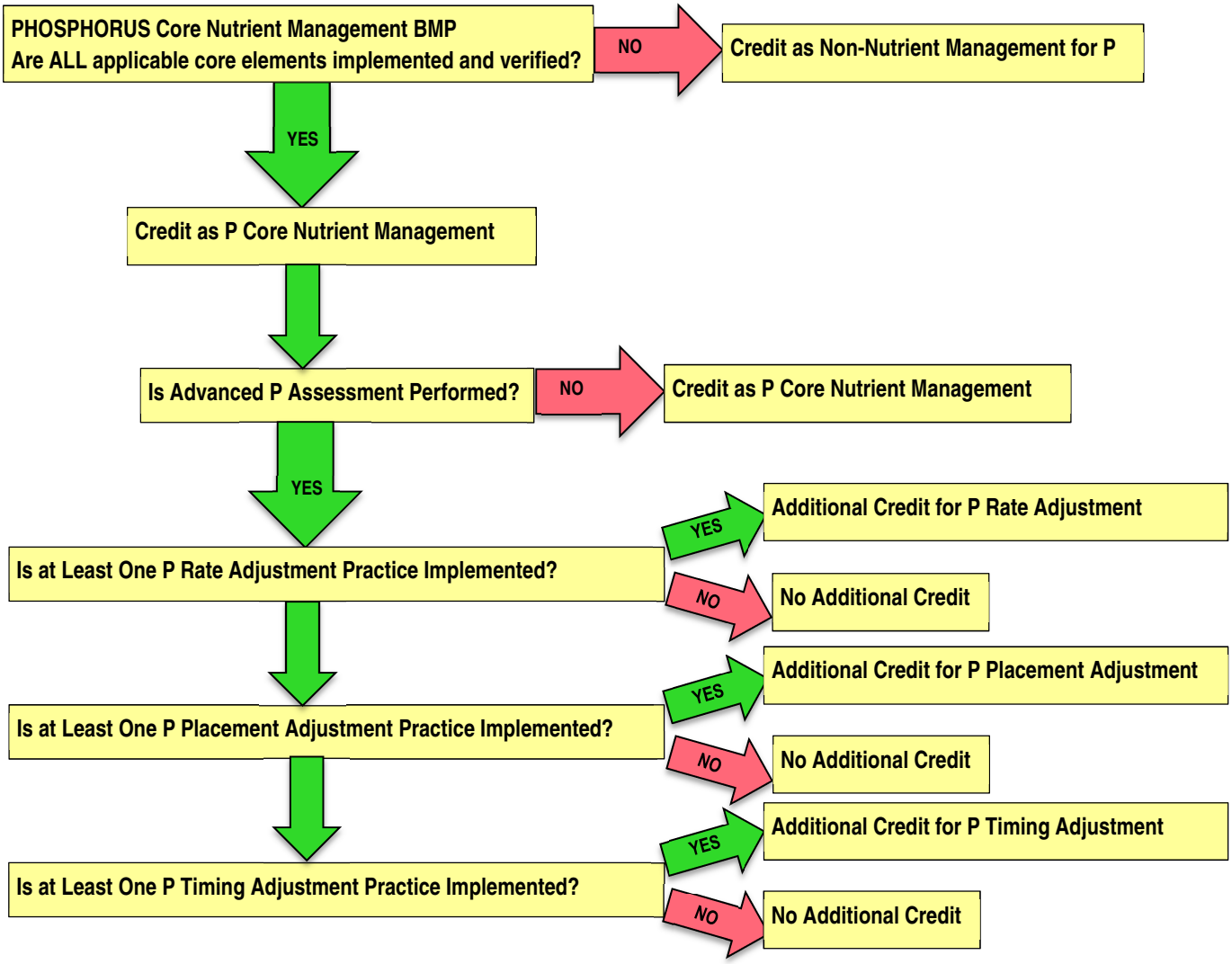

Figure 2. Linkage of Core and Supplemental P Nutrient Management Practices

2.1 NM Core and Supplemental Element Detailed Definitions

To better enable the CBP partnership and state agency partners to understand and apply the recommendations of the NM Panel to their unique programs and production systems, the following section provides additional descriptive details to each of the NM Core BMPs and Supplemental NM BMPs.

2.2 Nitrogen Core NM BMP Elements

- All five elements, as applicable to the agricultural operation, are required to be implemented and verified at the field management unit level to receive credit.
- N rate according to LGU recommendations at field management unit.
  - The elements of the N Core Nutrient Management BMP are found in Table 2. Application of a N Core NM BMP efficiency modifies the crop- and land-use-specific N application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. In an effort to determine the most practicable methodology for allocating fertilizer N to satisfy crop- and land-use-specific N application rate goals, the Agriculture Workgroup compared the modified LGU recommendations for application of supplemental inorganic N fertilizer to an alternative approach based on county-level redistribution of AAPFCO N fertilizer sales data. This methodological comparison indicated that there were relatively small differences

between the two methods for estimating supplemental N fertilizer applications, leading the Agriculture Workgroup to approve use of the redistributed AAPFCO fertilizer sales methodology in the Phase 6 Model. The Panel recommends that similar comparative analyses be conducted in the future to evaluate newly available fertilizer sales data and to further evaluate the redistributed fertilizer sales methodology's forecasting ability. Inconsistencies between estimates generated by the two methods should be investigated and rectified based on data source quality and consistency using contiguous or regional county-level data.
    - If applied N application rates are below the applicable CBP partnership modified application rates, the N application system may still qualify for credit as an equivalent N Core system if it meets the remaining four N Core elements.
    - A "field management unit" is described by the NM Panel as a common land management unit defined by the farm operator that includes similar annual crop production and management systems, and associated nutrient application system. The field management unit can represent any field, collection of multiple fields, or sub-portions of a single field that are managed the same way, with similar history and cropping practices.
- Manure analysis and volume.
    - Estimation of manure produced and nutrient analysis of that manure must be used in the planning process.
    - It is strongly preferred that manure nutrient analyses be derived from manure sample testing using standard laboratory protocols.
    - In the absence of laboratory manure analysis data, published manure nutrient analyses from LGUs, national agricultural agencies (e.g., USDA-ARS, USDA-NRCS), national or regional farm service organizations, or historical analyses generated from very similar, local and consistently managed industry-contracted operations may be used.
    - If a laboratory manure analysis is used to adjust the nutrient application, the laboratory analysis must be less than three-years old.
    - If laboratory analysis of manure is not available, as in the case of new, expanded or modified livestock and poultry operations, or is not required under state-specific regulations, published book values (as described above) may be used for a maximum of three years, after which time laboratory analysis data is strongly recommended to be utilized to satisfy N Core NM BMP requirements.
- Spreader/applicator calibration.
    - The equipment being used to perform the nutrient applications by the farm operator needs to be documented and verified that the machine(s) have been calibrated either according to manufacturer specifications or by standard calibration practices, preferably within one year of the application.
    - The custom applicator and equipment calibration certifications for commercial applicators can be used as an equivalent verification documentation for calibrated nutrient applications.
- Yield estimates and cropping plan at field management unit level.
    - Annual yield estimates for field management units should be based on field yield samples, calibrated electronic yield monitors, or field specific grain elevator receipts.
    - Historic yield goals are determined using a standardized method of averaging annual yields over time to account for annual variability (e.g. average yield is based on best three out of the past five years).
    - A less preferred but equivalent method is to use standard USDA soil productivity book values for estimating applicable yields.
    - The cropping plan refers to the planting and harvesting of the specific crop(s) for which the field nutrient applications were based. An example of a field that would <u>not</u> qualify under this required element is when the nutrient application was based on the plant requirements for grain corn but, due to in-season management decisions, the field was planted to soybeans instead.
- Cropping/manure history at field management unit level.
    - As part of developing a planned nutrient application rate, the farm operator or custom applicator considered legume residual N credits based on LGU or national agricultural service (e.g., USDA) recommendations.
    - The manure application history during the crop rotation must be considered, including appropriate manure mineralization crediting.
    - Verified documentation of manure mineralization N credits are included as part of the nutrient balance to account for at least the three prior years.
    - Legume residual N credits are included as part of the nutrient balance to account for at least the immediately preceding year.

- Nutrient management practice documentation.
  - The NM Panel defined the N Core NM BMP to require full implementation of a defined and applicable set of fundamental elements in order to receive the BMP credit. Independent documentation and verification that all of the required elements of the N Core NM BMP were implemented is required.
  - The five elements that constitute the N Core NM BMP may or may not be components of a formal Nutrient Management Plan. The required nutrient management documentation could be in the form of a formal federal-, state-, or county-reviewed and certified nutrient management program plan, a non-certified formal nutrient management plan developed by a federal- or state-certified plan writer, or detailed documentation and an informal management plan compiled by an operator or private consultant that met the Panel's BMP recommendations.
- Equivalent Practices
  - States may propose equivalent practices to satisfy these requirements that must be approved by the Agriculture Workgroup.

2.3 Phosphorus Core NM BMP Elements

- All six elements, as applicable to the agricultural operation, are required to be implemented and verified at the field management unit level to receive credit.
- P application rate according to LGU recommendations at field management unit level.
  - P application rate recommendations that are higher than the CBP Partnership-modified P application rates are allowable when the recommended rate is the outcome of a P-loss risk assessment tool that describes the risk of P loss to be low.
  - Application of a P Core NM BMP application rate multiplier modifies the crop- and land-use-specific P application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. In practice, LGU recommendations for P application are based on crop- and site-specific soil-test P concentration. Currently, soil-test P concentration data are not available to the CBP. The Panel recommends that, in the future, crop- and site-specific soil-test P concentration data should be collected, aggregated to the appropriate scale, summarized to eliminate disclosure of private confidential business information, and utilized as the foundation for determining P application rate goals and the appropriate application of P Core NM BMPs.
  - In the absence of soil-test P based application rate goals, county-level redistribution of CBW AAPFCO P fertilizer sales data may serve as a surrogate.
  - If applied P application rates are below the applicable LGU prescribed rates, and/or the CBP partnership modified application rates, the P application system may still qualify for credit as an equivalent P Core NM system if it meets the remaining five P Core elements.
  - A "field management unit" is described by the NM Panel as a common land management unit as defined by the farm operator with a similar annual crop production and management systems, and associated nutrient application system. The field management unit can represent any field, collection of multiple fields, or sub-portions of a single field that are managed the same way, with similar history and cropping practices.
- P soil tests at field management unit level. The requirement for having a P soil test may be waived if restrictions on manure application (rates, timing, placement), are imposed that limit P application rates and management to the same degree as if the site's soil was in the high soil-test P interpretive category.
  - A soil laboratory analysis is required to be obtained from the field management unit using standard soil testing protocols.
  - If a laboratory soil analysis being used to adjust the nutrient application, it must be less than three-years old.
  - In the absence of an available soil P laboratory analysis, P nutrient applications may be based on annual crop removal at the field management unit level as an equivalent P Core element, assuming the site's soil was in the high soil-test P interpretive category.
- Manure analysis and volume.
  - Estimation of manure produced and nutrient analysis of that manure must be used in the planning process.
  - It is strongly preferred that manure nutrient analyses be derived from manure sample testing using standard laboratory protocols.
  - In the absence of laboratory manure analysis data, published manure nutrient analyses from LGUs, national agricultural agencies (e.g., USDA-ARS, USDA-NRCS), national or regional farm service organizations, or historical analyses generated from very similar, local and consistently managed industry-contracted operations

may be used.
    - If a laboratory manure analysis is used to adjust the nutrient application, the laboratory analysis must be less than three-years old.
    - If laboratory analysis of manure is not available, as in the case of new, expanded or modified livestock and poultry operations, or is not required under state-specific regulations, published book values (as described above) may be used for a maximum of three years, after which time laboratory analysis data is strongly recommended to be utilized to satisfy P Core NM BMP requirements.
- Spreader/applicator calibration
    - The equipment being used to perform the nutrient applications by the farm operator needs to be documented and verified that the machine(s) have been calibrated either according to manufacturer specifications or by standard calibration practices, preferably within one year of the application.
    - The custom applicator and equipment calibration certifications for commercial applicators can be used as an equivalent verification documentation for calibrated nutrient applications.
- Yield estimates and cropping plan at management unit level
    - Annual yield estimates should be based on field yield samples, calibrated electronic yield monitors, or field specific grain elevator receipts.
    - Historic yield goals are determined using a LGU or state standardized method of averaging annual yields over time to account for annual variability (e.g. average yield based on the best three out of the past five years).
    - A less preferred but equivalent method is to use standard USDA soil productivity book values for estimating applicable crop yield.
    - The cropping plan refers to the planting and harvesting of the specific crop(s) for which the field nutrient applications were based. An example of a field that would <u>not</u> qualify under this required element is when the nutrient application was based on the plant requirements for grain corn but, due to in-season management decisions, the field was planted to soybeans instead.
- Cropping/manure history at field management unit level
    - As part of developing a planned nutrient application rate, the farm operator or custom applicator considered residual P credits based on LGU or national agricultural service (e.g., USDA) recommendations.
    - The manure application history during the crop rotation must be considered, including appropriate residual soil P crediting.
    - Residual soil P credits are included as part of the nutrient balance to account for at least the immediately preceding year.
- Nutrient management practice documentation.
    - The NM Panel defined the P Core NM BMP to require full implementation of a defined and applicable set of fundamental elements in order to receive the BMP credit. Rather, independent documentation and verification that all of the required elements of the P Core NM BMP were implemented is required.
    - The six elements that constitute the P Core NM BMP may or may not be components of a formal Nutrient Management Plan. The required nutrient management documentation could be in the form of a formal federal-, state-, or county-reviewed and certified nutrient management program plan, a non-certified formal nutrient management plan developed by a federal- or state-certified plan writer, or detailed documentation and an informal management plan compiled by an operator or private consultant that met the Panel's BMP recommendations.
- Equivalent Practices
    - States may propose equivalent practices to satisfy these requirements that must be approved by the Agriculture Workgroup.

2.4 Nitrogen Supplemental NM BMPs

- Advanced N Assessment Tools.
    - Documentation needed of the use of one or a combination of these tools.
    - These tools should guide implementation of N rate, placement, or timing.
    - Conducting these assessments or using these tools have no impact unless they lead to an informed change in implementation of N rate, N placement or N application timing.

- This list is not exhaustive or comprehensive, and only represents a selection of examples that would constitute tools resulting in an implementation change.

- N Rate Adjustment Practices.
  - By implementing one or more of the practices listed, an additional N credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
  - Within the N Rate Adjustment Practice, the rate of application can be less than the LGU recommendation or consistent with partnership approved rate applications, but in order to receive supplemental credit, the rate of application must be below the rate listed for the N Core NM BMP.
  - Split applications over time per crop. Total amount of N application may or may not change, but the application is divided into multiple, lower-rate applications throughout the year.
  - Variable rate N application implies that N is applied at a variety of different application rates at the sub-field scale within a management unit based on historical data of spatially variable crop response due to soil type, drainage, etc. or due to in-season data from optical crop sensors.
- N Placement Adjustment Practices.
  - By implementing one or more of the practices listed, an additional N credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
  - Where the N nutrient source is physically located or placed relative to the soil surface.
  - Subsurface injection or incorporation of applied inorganic N.
  - Immediate incorporation generally means within 24 hours of application.
  - N application setbacks from water: purposefully not applying N to cropped and hay land areas adjacent to surface water bodies. Setbacks must meet the minimum standards required under applicable local, state, or federal programs and laws.
  - Applies to both manure and fertilizer.
  - Credit applies to entire field management unit.
- N Timing Adjustment Practices.
  - By implementing one or more of the practices listed, an additional N credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
  - Split applications over time per crop. Total amount of N does not change, but application is divided into multiple applications throughout the year.

2.5 Phosphorous Supplemental NM BMPs

- Advanced P Assessment Tools.
  - Documentation needed of the use of one or a combination of these tools.
  - These tools should guide implementation of rate, placement, or timing.
  - Conducting these assessments or using these tools have no impact unless they lead to an informal change in implementation of rate, placement, or timing.
  - This list is not exhaustive or comprehensive, and only represents a selection of example that would constitute tools resulting in an implementation change.
- P Rate Adjustment Practices.
  - By implementing one or more of the practices listed, an additional P credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
  - Within the P Rate Adjustment Practice, the rate of application can be less than the LGU recommendation or consistent with partnership approved rate applications, but in order to receive supplemental credit, the rate of application must be below the rate listed for the P Core NM BMP.

- Variable rate P application implies that P is applied at variety of different applications rates at the sub-field scale within the management unit based spatially variable crop response due to soil type, drainage, etc. or due to in-season data from optical crop sensors.
- A P-based manure application rate equivalent to annual crop P removal is an equivalent rate adjustment practice.

- P Placement Adjustment Practices.
  - By implementing one or more of the practices listed, an additional P credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
  - Where the P nutrient source is physically located or placed relative to the soil surface.
  - Subsurface injection or incorporation of applied inorganic P.
  - Immediate incorporation generally means within 24 hours of application.
  - Phosphorus application setbacks from water: purposefully not applying P to cropped and hay land areas adjacent to surface water bodies. Setbacks must meet the minimum standards required under applicable local, state, or federal programs and laws.
  - Applies to both manure and fertilizer.
  - Credit applies to entire field management unit.
  - Application of manure on different fields based on the P Index assessment that results in manure application on a lower P Index rated field rather than a higher P Index rated field.
- P Timing Adjustment Practices.
  - By implementing one or more of the practices listed, an additional P credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
  - Split applications over time per crop. Total amount of P does not change, but application is divided into multiple applications throughout the year.
  - P application in lower P-loss risk season.
  - Purposeful change the timing of manure application based on the P Index assessment that results in manure application at a time during the calendar year when the P Index assessment indicates a lower risk for P loss.
  - Split applications over time per crop. Total amount of P application may or may not change, but the application is divided into multiple, lower-rate applications throughout the year.

3 Effectiveness Estimates

This section begins with a brief summary of the recommended N and P multiplier values for N and P Core NM BMPs and for loss reduction multipliers for N and P Supplemental NM BMPs. This summary is followed by a discussion of the rationale and use of specific data values from the available literature to develop the recommended multiplier values. Finally, details are provided on how the recommended application rate multiplier values for Core NM BMPs and loss reduction multipliers for the Supplemental NM BMPs can be combined to reflect actual N and P management and overall effectiveness at a specific location.

3.1 Summary of Effectiveness Estimates

All numeric values for Core NM BMP application rate multipliers and Supplemental NM BMP loss reduction multipliers have been defined by the Panel. See section 3.3 for a detailed discussion of how these values are applied in the determination and crediting of overall NM BMP effectiveness for N and P.

3.1.1. N Core NM BMPs

The Panel's proposed application rate multipliers for N Core NM BMPs for each applicable agricultural land use category are given in Table 12. These application rate multipliers are based on state LGU recommendations, as modified by the CBP partnership, and apply to the nutrient application rate goal, or input side, of nutrient management modeling scheme. Each value represents a multiplicative modifier of the crop- and land-use-specific N application rate goal utilized in the CBP models.

Table 12. Core N Nutrient Management Application Rate Multiplier Values

Land Use	Nutrient Management BMP	
	Nitrogen Core *Non-Nutrient Management* BMP Application Rate Multiplier	Nitrogen Core *Nutrient Management* BMP Application Rate Multiplier
Full Season Soybeans	1.20	1.00
Grain w/ Manure	1.30	1.00
Grain w/o Manure	1.20	1.00
Legume Hay	1.20	1.00
Silage w/ Manure	1.40	1.00
Silage w/o Manure	1.20	1.00
Small Grains and Grains	1.20	1.00
Small Grains and Soybeans	1.20	1.00
Specialty Crop High	1.30	1.00
Specialty Crop Low	1.20	1.00
Other Agronomic Crops	1.10	1.00
Other Hay	1.00	1.00
Pasture	1.00	1.00

3.1.2. P Core NM BMPs

The Panel's proposed application rate multipliers for P Core NM BMPs for each applicable agricultural land use category are given in Table 13. These application rate multipliers are based on state LGU recommendations, as modified by the CBP partnership, and apply to the nutrient application rate goal, or input side, of the nutrient modeling scheme for both NM and non-NM acres. Each value represents a multiplicative modifier of the crop- and land-use-specific P application rate goal utilized in the CBP models. For crops and land uses in which manure is applied, manure applications that result in manure P application rates that are greater than or equal to the crop-specific P application need results in the prohibition of

application of additional fertilizer P. An exception to the prohibition of supplemental fertilizer P addition following manure application is the utilization of relatively small quantities of starter fertilizer P, typically applied subsurface in the planting row, according to LGU recommendations. For crops and land uses in which manure is applied, the total quantity of manure P associated with the total manure application rate should be allocated to the subject acreage.

Table 13. Core P Nutrient Management Application Rate Multiplier Values

Land Use	Nutrient Management BMP	
	Phosphorus Core *Non-Nutrient Management* BMP Application Rate Multiplier	**Phosphorus Core *Nutrient Management* BMP Application Rate Multiplier**
Full Season Soybeans	1.50	1.00
Grain w/ Manure	3.00	1.00
Grain w/o Manure	1.50	1.00
Legume Hay	1.00	1.00
Silage w/ Manure	3.00	1.00
Silage w/o Manure	1.50	1.00
Small Grains and Grains	1.50	1.00
Small Grains and Soybeans	1.50	1.00
Specialty Crop High	2.00	1.00
Specialty Crop Low	2.00	1.00
Other Agronomic Crops	1.50	1.00
Other Hay	1.00	1.00
Pasture	1.00	1.00

3.1.3. N Supplemental Nutrient Management BMPs

The Panel's proposed loss reduction multipliers for N Supplemental NM BMPs for each applicable agricultural land use category are given in Table 14. These values are multiplicative modifiers that apply to edge-of-stream delivery of N, on the output side of the CBP modeling scheme, and can only be applied if the requirements for N Core NM BMP are met.

Table 14. N Supplemental Nutrient Management BMP Loss Reduction Multiplier Values

Land Use	Nutrient Management BMP		
	N Rate *Supplemental* BMP Loss Reduction Multiplier	**N Placement *Supplemental* BMP Loss Reduction Multiplier**	**N Timing *Supplemental* BMP Loss Reduction Multiplier**
Full Season Soybeans	1.00	1.00	1.00
Grain w/ Manure	0.85	0.95	0.90
Grain w/o Manure	0.95	0.97	0.95
Legume Hay	1.00	1.00	1.00
Silage w/ Manure	0.85	0.95	0.90
Silage w/o Manure	0.95	0.97	0.95
Small Grains and Grains	0.95	0.97	0.90
Small Grains and Soybeans	0.95	0.97	0.90
Specialty Crop High	0.85	0.95	0.95
Specialty Crop Low	0.95	0.97	0.95
Other Agronomic Crops	0.95	0.97	0.95
Other Hay	1.00	0.97	0.95
Pasture	1.00	1.00	1.00

3.1.4. P Supplemental Nutrient Management BMPs

The Panel's proposed loss reduction multipliers for P Supplemental NM BMPs for each applicable agricultural land use category are given in Table 15. These values are multiplicative modifiers that apply to edge-of-stream delivery of P, on the output side of the CBP modeling scheme, and can only be applied if the requirements for P Core NM BMP are met.

Table 15. P Supplemental Nutrient Management BMP Loss Reduction Multiplier Values

Land Use	Nutrient Management BMP		
	P Rate *Supplemental* BMP Loss Reduction Multipliers	**P Placement *Supplemental* BMP Loss Reduction Multipliers**	**P Timing *Supplemental* BMP Loss Reduction Multipliers**
Full Season Soybeans	0.95	0.90	0.99
Grain w/ Manure	0.90	0.80	0.80
Grain w/o Manure	0.95	0.90	0.99
Legume Hay	0.99	0.90	0.99
Silage w/ Manure	0.90	0.80	0.80
Silage w/o Manure	0.95	0.90	0.99
Small Grains and Grains	0.95	0.90	0.99
Small Grains and Soybeans	0.95	0.90	0.99
Specialty Crop High	0.95	0.90	0.99
Specialty Crop Low	0.95	0.90	0.99
Other Agronomic Crops	0.95	0.90	0.99
Other Hay	1.00	0.90	0.99
Pasture	1.00	1.00	1.00

3.2 Development of Application Rate Multipliers and Loss Reduction Multipliers for Core NM BMPs and Supplemental NM BMPs

The Panel developed the proposed Phase 6 NM application rate multiplier estimates and loss reduction multiplier estimates through a synthesis of applicable scientific literature (see References section) and the collective best professional judgment of the NM Panel members (see Table 1). The membership of the Panel represents over 150 years of direct involvement in research, implementation and education on agricultural nutrient management practices. The entire body of research represented by the citations presented in the References section provided the foundation for the Panel's professional assessment of the rate and loss reduction multipliers for the proposed NM BMPs. The multiplier values presented for the Core NM BMPs and the Supplemental NM BMPs represent either a collection of required elements or represent the impact of numerous applicable on-site management practices. Therefore, in order to develop broadly pertinent NM BMP multiplier values, multiple sources of information and data were necessarily synthesized through the expert lens of the Panel.

For both N and P BMPs, nutrient management practices are implemented at either the field or sub-field level. The diverse landforms, hydrology, climate and cropping systems of the agricultural landscapes in the CBW have a multitude of impacts on biogeochemical transformations of N and P in the agro-ecosystem. Changes in hydrological pathways alone can have dramatic effects on nutrient loads to streams when viewed from the Atlantic Coastal Plain to the Appalachian Plateau. Therefore, site-specific physical conditions and management factors have a strong influence on the effectiveness of imposed conservation practices. Nutrient management BMP effectiveness must represent the average condition over a wide range of real-world scenarios. Thus, it was incumbent upon the Panel to distill numerous lines of evidence to arrive at a single multiplier value for each of the N and P BMPs that could be applied equitably across the CBW.

Below are examples of specific analyses that were used to inform the NM Panel in its application of best professional judgment to determine NM BMP application rate multipliers and loss reduction multipliers.

N Core and P Core NM BMPs

The reduction in nutrient application rates for N Core and P Core NM BMPs were determined based on historical (i.e., before the Chesapeake Bay Program Watershed Model (CBPWM) simulation period of 1985) and modern LGU agronomy guides (i.e., during the calibration period of the CBPWM (Table 16). Historical LGU agronomy guides (pre-1985) evaluated by Phase 5.3.2 NM Panel members recommended a range of 15–40 percent more plant-available N than CBPWM calibration period LGU guides. In addition, the principal basis for application rate difference between non-NM and NM for N is a reduction in the fertilizer N requirement for corn from 1.2 lbs. N/bu. of expected yield in earlier LGU recommendations to 1.0 lbs. N/bu. of expected yield in current LGU recommendations. This reduction is supported by data from Coale (2000) who examined corn yield response to fertilizer N rate with the associated post-harvest fall soil residual NO_3-N concentration. These findings are reflected in the values for grain and silage found in Table 12 for N Core NM BMPs. Because other crops of significant acreage did not have consistently or significantly lower recommended N application rates when the historical (pre-1985) and current from LGU agronomy guides were compared, these agricultural land uses were assigned more conservative values in Table 12.

N Core NM BMP multiplier values for Other Hay and Pasture were set at 1.00 because the CBP Partnership's modification of the LGU N application recommendations created a uniform and much-reduced N application rate goal for these two agricultural land uses that included an assumed implementation rate of NM BMPs across the entire CBW. Therefore, the Panel could not apply a N application rate BMP multiplier other than 1.00 to these two land uses.

Table 16. LGU Agronomy Guide Recommendations for Corn N Fertilizer Application Rate Before and During CBPWM Calibration Period. Values Presented Are Pounds of Plant Available N (PAN) Per Bushel of Expected Corn Yield

Land Grant University	Pre-calibration Recommendation	Calibration period Recommendation
North Carolina State University	1.4 lbs. PAN[1]	1.0 lbs. PAN
Pennsylvania State University	1.3[2]	1.0[3]
University of Maryland	1.2[4]	1.0[5]

[1] North Carolina State University Extension. 1979 Agronomy Guide. North Carolina State University. Raleigh, NC.
[1] Penn State Extension. 1981 Agronomy Guide. The Pennsylvania State University, College of Agriculture Extension Service. University Park, PA.
[1] http://extension.psu.edu/agronomy-guide/cm/sec2/sec24e3
[1] Coop. Ext. Serv. 1981. Fertilizer Recommendations, sheet 3, corn for grain on medium textured soils without manure. Univ. MD Coop. Ext. Serv., College Park, MD.
[1] Coale, F.J. 1995. Plant nutrient recommendations based on soil tests and yield goals. Agronomy Mimeo No. 10, Coop. Ext. Serv. and Agronomy Dept. Univ. MD, College Park, MD

P application rate multiplier values for P Core NM BMPs are greater for land uses with manure versus the corresponding land use without manure. Historically (pre-1985), manure applications managed without attention to NM guidelines resulted in P application rates at least three times higher, and probably more, than would be expected under P-based nutrient management. For non-manured production systems operating outside of NM guidelines, fertilizer P over-application would not be expected to be nearly as great as when manure is the primary nutrient source. These findings are reflected in the values for grain and silage found in Table 13 for P Core NM BMPs. As for N Core NM, P Core NM BMP multiplier values for Other Hay and Pasture were set at 1.00 because the CBP Partnership's modification of the LGU P application recommendations created a uniform and much-reduced P application rate goal for these two agricultural land uses that included an assumed implementation rate of NM BMPs across the entire CBW. Therefore, the Panel could not apply a P application rate BMP multiplier other than 1.00 to these two land uses.

N Rate, N Placement, and N Timing Loss Reduction Multipliers

Several assessments of the PSNT have resulted in N reduction rates of 6 to 42 percent, with most demonstrating reductions of 17 percent or greater. A three-year study of corn/rye on a manured silt-loam soil in Vermont by Durieux et al. (1995) reported that use of the PSNT reduced nitrate leaching potential by resulting in an average reduction in fall residual NO_3-N (nitrate N) of 56 percent compared to N applications based on traditional LGU N recommendations. On average, fall N application was reduced by 29 percent (150 lbs. N/ac. to 107 lbs. N/ac.) due to application of the PSNT. This exceeds the largest credit (15 percent loss reduction) given for N Rate Supplemental BMPs (Table 14). The reduced potential for nitrate leaching due to PSNT application was confirmed by Guillard et al. (1999) in a two-year lysimeter study on a sandy-loam soil that demonstrated an average reduction in NO_3-N leaching of 63%, compared to corn fertilized according to standard LGU recommendations. Fall N leaching loss was reduced by an average of 42 percent, from 196 kg N/ha (175 lbs. N/ac.) to 113 kg N/ha (101 lbs. N/ac.), a change also greatly exceeding the N Rate Supplemental BMP credits shown in Table 14.

Data from quarterly or annual reports from in-field nutrient management consultants were used to summarize PSNT activities and results under the Maryland (Steinhilber 2015) and Virginia (Sexton 2015) Nutrient Management Programs. The Maryland summaries covered three years, encompassing a total of 2,690 ac. from the Piedmont and 27,850 ac. from the Coastal Plain. The average estimated reduction in total fertilizer N application resulting from implementing the PSNT, compared to using university recommendations without the PSNT, was 20% and 6% for the Piedmont and Coastal Plain regions, respectively. Sexton (2015) reported on a 5,325-ac. evaluation of the PSNT conducted in Virginia's Shenandoah Valley consisting of 1,246 PSNT tests that compared university recommendations with and without the PSNT (Fitzgerald and Baird 2014). The Virginia results showed that use of the PSNT resulted in an estimated average savings of 30 lbs. N/ac., or a 20% N fertilizer application reduction for 29% of the PSNT evaluations and a savings of 60 lbs. N/ac., or a 40% N fertilizer application reduction, for another 28% of the PSNT evaluations. The remaining 43% of the PSNT evaluations resulting in unchanged fertilizer N application rate recommendations. The average percent reduction of fertilizer N application across the Virginia Piedmont study was 17%, which is consistent with the Maryland Piedmont estimate. Additionally, a two-year study in New York on a loamy-sand soil that monitored tile drainage from silage corn grown in relatively large (18 m^2) isolated plots reported an average reduction in NO_3-N losses of 42% for the PSNT treatment,

compared to the non-PSNT standard LGU recommendation (Sogbedji et al. 2000). Fall N loss rates were reduced by 25% (134 kg N/ha to 100 kg N/ha or 120 lbs. N/ac. to 89 lbs. N/ac.) due to application of the PSNT.

Studies on the CSNT and ISNT showed results similar to those for the PSNT. In New York, results reported by Ketterings et al. (2014, 2011a, 2011b), Wharton et al. (2010), and Hong et al. (2010) suggest that about 40% of tested corn silage fields were rated in the excess category and following the recommendations of the CSNT would result in a 20 to 30% reduction in N application. Kyveryga et al. (2010) reported that of 215 fields receiving liquid swine manure, about 30% of fields were found to be unresponsive to additional N (beyond 25 lbs. N/ac. starter). Extending this percentage over all silage corn fields under CSNT, recommendations derived from CSNT would have resulted in 15 to 30 lbs. N/ac. application reduction annually, representing a 20 to 30% reduction over standard N rate recommendations. Results of multi-year N rate trials on silage corn in New York over three crop years showed that about 50% of tested fields were non-responsive to additional N fertilizer and, therefore, the ISNT assessment would recommend no additional N application beyond starter N at 25 lbs. N/ac. (Lawrence et al. 2009, Klapwyk et al. 2006, Lawrence et al. 2008, Ketterings et al. 2009). Because these fields would otherwise have received a recommended application of 75 to 125 lbs. N/ac., managing N applications based on the ISNT results reduced N applications on the affected fields by 50 to 100 lbs. N/ac. Discounting this reduction because only half of corn silage fields were determined to be non-responsive by ISNT gives an estimated 25 to 50 lbs. N/ac. reduction in N applications to silage corn, a reduction of 33 to 40% in total N applications.

Using unpublished data from studies conducted throughout Virginia, the Phase 5.3.2 Nutrient Management Expert Panel compared N application rates to corn for the Virginia Tech Corn Algorithm (VTCA) applied via the GreenSeeker® system versus the standard farmer's N rate methods (Phase 5.3.2 Nutrient Management Expert Panel 2015). Over 15 sites in 4 years, the average VTCA N rate was 24 kg/ha (approximately 20%) less than the standard farmer's rate, with no significant difference in grain yields. Additionally, data from field scale demonstrations from a total of 1600 ac. over two years demonstrated a 10% decrease in N rate applied with no difference in corn yields (Virginia NRCS CIG 69-33A7-1131, final report). These data demonstrate the ability to reduce N application rates while maintaining crop yields. Other Virginia data for wheat (Thomason et al. 2011 and Virginia NRCS CIG 69-33A7-1131, final report) suggest that N rates for wheat could be decreased by approximately 7% with no change in yield.

The FSNT provides an adaptive management tool for simultaneously improving economic production of small grains by identifying sites where small grains need starter N, and also reducing nitrate-N loss to groundwater by not fertilizing N sufficient sites just before the fall-winter-spring water-recharge season when most nitrate leaching occurs (Forrestal et al. 2014, Meisinger et al. 2015). The N reduction efficiency for the FSNT was estimated from four years of lysimeter nitrate-N leaching data (Pers. comm., J. Meisinger 2015) using the intact soil-column lysimeter described in Palmer et al. (2011) and following the sample collection and analysis methods described in Meisinger et al. (2015). The lysimeter treatments were replicated twice each year with winter wheat receiving either a starter-N application of 30 lbs. N/ac. or no starter-N. Lysimeter drainage monitored NO_3-N leaching continuously between planting and the "green-up" development stage. These treatments were repeated in 1997-98, 1998-99, 1999-2000, and 2009-2010 wheat growing seasons. The final lysimeter-based N loss reduction efficiency was estimated to be 10%.

In the long term, achieving a balance between nutrient imports and exports at the whole farm level (and later at the watershed level) is believed to be an effective way to minimize nutrient surpluses, manage soil nutrient levels, and reduce runoff and leaching losses. For livestock farms, the whole farm nutrient balance approach has been invaluable in identifying opportunities for reducing N and P imports, making better use of on-farm nutrient sources, identifying the need for more land for nutrient recycling, and increasing nutrient exports. As shown over several years of research on 54 New York dairy farms, nutrient balance reductions averaged 29% for N and 36% for P (Soberon et al. 2015, Cela et al. 2014a and 2014b). However, the observed reductions are attributable primarily to changes in feed formulation and management, rather than fertilizer management.

N reduction efficiencies from timing N applications were estimated by comparing corn yields from replicated N-response trials over many site-years (Fox et al. 1986, Fox and Piekielek 1993, Pers. Comm. J Meisinger 2015). These studies compared yield vs. N applied (as urea-ammonium-nitrate) at planting, or N applied just before the crop begins its rapid period of growth. Corn had the most N-response trials, which were summarized by fitting separate quadratic regression functions for each timing at each site-year of data, and then estimating the economic optimum N rate (EONR) for corn

grain valued at $4.00/bu. and N priced at $0.50 per pound. These regressions allowed estimation of the EONR and associated yield, which provided a method to compare optimum rates for N applied at planting vs. at a later time that was in harmony with crop N demand. A plot-based N reduction efficiency was estimated as the difference between the EONRs at planting vs. the delayed application, divided by the planting EONR. There were also adequate data from the Coastal Plain (21 site-years) and the Piedmont (18 site-years) regions to estimate separate N reduction efficiencies. These calculations produced a Coastal Plain estimated N reduction efficiency of about 16%, with the corresponding estimate for the Piedmont of 9%. The Coastal Plain higher N-timing reduction efficiency is likely due to the region having more coarse-textured soils and more shallow rooting depths than the Piedmont. These reductions support the N Timing Supplemental BMP Efficiency values in Table 14, as do the documented PSNT-based N reduction rates of 6 to 42% (with most demonstrating reductions of 17 percent or greater) described above.

N-timing reduction efficiencies for wheat were estimated from two-years of field-plot total N uptake data from a study that compared an all-at-green-up application with a 50-50 split of N between green-up and an application approximately one month later (Gravelle et al. 1988). Four years of lysimeter nitrate-N leaching data (Pers. comm., J. Meisinger 2015) were also used from intact soil-column lysimeters described in Palmer et al. (2011) following the sample collection and analysis methods described in Meisinger et al. (2015). The lysimeter treatments were replicated twice in each of the four years (1992-93, 1997-98, 1998-99, and 1999-2000) with winter wheat receiving either all the N at green-up, or with the same N rate applied one-third at green-up and two-thirds about a month later. These two data sources produced an average wheat N-timing reduction efficiency of about 15%, which is similar to the Coastal Plain value for corn and supportive of the N Timing Supplemental BMP Efficiency values in Table 14.

When the data summarized above are analyzed as a whole, the literature is supportive of the application of NM BMP N loss reduction multipliers within the ranges presented in Table 14. Overall, the proposed N loss reduction multipliers are numerically conservative and range from 3 to 15%, exclusive of the 0% N loss reduction multiplier that was defined for the Other Hay and Pasture land uses.

P Rate, P Placement, and P Timing Loss Reduction Multipliers

Kleinman and Sharpley (2003) packed soils into runoff boxes and broadcast with three manures (dairy, layer poultry, and swine) at six rates, from 0 to 150 kg total P (TP)/ha (0-134 lbs. TP/ac.). Manure analysis indicated that N-based manure application for silage corn of 300 kg total N (TN)/ha (268 lbs. TN/ac.)) would result in TP application rates of 70, 200, and 88 kg/ha (62, 178, and 78 lbs. TP/ac.) for the dairy, poultry, and swine manures, respectively. Application rates matching silage corn TP requirement of approximately 25 kg TP/ha (22 lbs. TP/ac.) would result in TN applications of 151, 53, and 119 kg TN/ha (135, 47, and 106 lbs. TN/ac). Application rate was related to runoff P (r^2=0.50 to r^2=0.98), due to increased concentrations of dissolved reactive phosphorus (DRP) in runoff; as application rate increased, so did the contribution of DRP to runoff TP. Assuming 150 bu./ac. yields, recommendations for silage corn are about 180 lbs. TN/ac. and 103 lbs. TP/ac. for low to optimum soil test levels (Roth and Heinrichs 2001). Rates for grain corn would be 160 lbs. TN/ac. and 76 lbs. TP/ac. The P rates applied by Kleinman and Sharpley (0-134 lbs. TP/ac.) bracket these rates, with the highest rate 1.3 and 1.8 times the silage and grain corn rates, respectively, for a 150 bu. /ac. yield.

The effect of flow time, flowpath length, and manure position on P loss in overland flow from two central Pennsylvania soils packed in boxes of varying length were examined by collecting runoff water samples from soil boxes with and without 75 kg P/ha applied as swine manure over 0.5 m of the box slope length at distances of 0 to 3.5 m from the downslope collection point (McDowell and Sharpley 2002). Dissolved reactive P concentration was more closely related to the proportion of clay in sediment of overland flow before (r =0.98) than after (r= 0.56) manure application. This was attributed to the transport of larger, low-density particles after applying manure. The concentration of dissolved P and particulate P fractions decreased with increasing flow-path length, due to dilution rather than sorption of P by surface soil during overland flow. Total P loss (mainly as particulate P) from the Watson channery silt loam was more than from Berks channery silt loam, even with manure applied. Thus, while P loss in overland flow is affected by where manure is applied relative to flowpath length, initial soil P concentration is very important when looking at areas of potential P loss within a watershed.

In the long term, achieving a balance between nutrient imports and exports at the whole farm level (and later at the watershed level) is believed to be an effective way to minimize nutrient surpluses, manage soil nutrient levels, and reduce

runoff and leaching losses. For livestock farms, the whole farm nutrient balance approach has been invaluable in identifying opportunities for reducing N and P imports, making better use of on-farm nutrient sources, identifying the need for more land for nutrient recycling, and increasing nutrient exports. As shown over several years of research on 54 New York dairy farms, nutrient balance reductions averaged 29% for N and 36% for P (Soberon et al. 2015, Cela et al. 2014a and 2014b). However, the observed reductions are attributable primarily to changes in feed formulation and management, rather than fertilizer management.

Application of a P Core NM BMP application rate multiplier modifies the crop- and land-use-specific P application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. A significant modification imposed by the CBP partnership was the assumption that all agricultural acres in the CBW had a soil-test P concentration that corresponded with the "medium" soil test interpretive category. The Panel recognized that, in the absence of soil-test P concentration data, assumed soil-test P concentrations were necessary to facilitate CBP model processes. However, the Panel also recognized that implementation of the universal "medium" soil-test P assumption infused a high level of site-specific uncertainty into the modeled P application rate. In general, the inherent uncertainty in P application rate resulting from the adoption of the universal "medium" soil-test P concentration assumption is expected to be similar to or greater than the magnitude of the P application rate modifications resulting from implementation of P Core NM BMP application rate multipliers or the P NM Supplemental BMP loss reduction multipliers.

In practice, LGU recommendations for P application are based on crop- and site-specific soil-test P concentration. Currently, soil-test P concentration data are not available to the CBP. The Panel recommends that, in the future, crop- and site-specific soil-test P concentration data should be collected, aggregated to the appropriate scale, summarized to eliminate disclosure of confidential business information, and utilized as the foundation for determining P application rate goals and the appropriate application of P Core NM BMPs. In the absence of soil-test P data and soil-test P based application rate goals, soil-test P concentration must be assumed and, in turn, utilized to create artificial P application rate goals.

3.3 Method for Applying Core and Supplemental Multiplier Values

The overall BMP efficiencies for N and P nutrient management are derived from a combination of application rate multipliers for the Core Nutrient Management BMPs (N or P) with their corresponding Supplemental Nutrient Management BMP (N or P) loss reduction multipliers. The N Core NM BMP and P Core NM BMP address the rate of nutrient application while the N Supplemental NM BMPs and P Supplemental NM BMPs address the transport of applied nutrients. The overall effectiveness values (one for N and one for P) are calculated as the combined effect of changes in nutrient application rate and nutrient transport caused by the implementation of Core and Supplemental NM BMPs. Specific details regarding how these combinations are calculated and applied are provided below.

Nitrogen

Application of the N Core NM BMP application rate multiplier credit modifies the crop- and land-use-specific N application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. These multipliers apply to the nutrient application rate goal, or input side, of CBP nutrient modeling scheme for both NM and non-NM acres. Each multiplier value represents a multiplicative modifier of the crop- and land-use-specific N application rate goal utilized in the CBP models.

Application of loss reduction multiplier credits for N Supplemental NM BMP elements requires satisfactory implementation of all respective N Core NM BMP elements. The N Supplemental NM BMP multipliers apply multiplicative modifiers to edge-of-stream delivery of N, on the output side of the CBP modeling scheme, and can only be applied if the requirements for N Core NM BMP are met. Multiple advanced site assessments and N management tools may be utilized to inform the application of appropriate N adjustment practices, but do not represent a N credit in and of themselves. Advanced site assessments and application of N management tools that result in implementation of a verifiable change in planned N application rate, N application timing, or N application placement may result in a N Supplemental NM BMP loss reduction multiplier credit. N Supplemental NM BMP credits for N rate, N timing, and N placement are stackable. Only one Supplemental NM BMP credit for N rate, one Supplemental NM BMP credit for N timing, and one Supplemental NM BMP credit for N placement may be applied.

Phosphorus

Application of the P Core NM BMP application rate multiplier credit modifies the crop- and land-use-specific P application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. These multipliers apply to the nutrient application rate goal, or input side, of the nutrient modeling scheme for both NM and non-NM acres. Each multiplier value represents a multiplicative modifier of the crop- and land-use-specific P application rate goal utilized in the CBP models. For crops and land uses in which manure is applied, manure applications that result in manure P application rates that are greater than or equal to the crop-specific P application need results in the prohibition of application of additional fertilizer P. For crops and land uses in which manure is applied, the total quantity of manure P associated with the total manure application rate is allocated to the subject acreage.

Application of the loss reduction multiplier credits for P Supplemental NM BMP elements requires satisfactory implementation of all respective P Core NM BMP elements. The P Supplemental NM BMP multipliers apply multiplicative modifiers to edge-of-stream delivery of P, on the output side of the CBP modeling scheme, and can only be applied if the requirements for P Core NM BMP are met. Multiple advanced site assessments and P management tools may be utilized to inform the application of the appropriate P adjustment practices, but do not represent a P credit in and of themselves. Advanced site assessments and application of P management tools that result in a verifiable implementation of a change in planned P application rate, P application timing, or P application placement may result in a P Supplemental NM BMP loss reduction multiplier credit. Supplemental BMP credits for P rate, P timing, and P placement are stackable. Only one Supplemental NM BMP credit for P rate, one Supplemental NM BMP credit for P timing, and one Supplemental NM BMP credit for P placement may be applied.

Summary

As described above and under *Practice Definitions*, there is one opportunity for crediting per each Supplemental NM BMP category for N and P. There are three such categories each for N and P Supplemental BMPs: rate, timing, and placement. Application of a loss-reduction multiplier for the N Supplemental NM BMP elements can only occur after satisfactory implementation of the N Core NM BMP. The N Supplemental NM BMP loss reduction credit for each of these three categories (rate, timing, and placement) can be obtained if implementation of at least one effective practice from each category is verified. Similarly, application of a loss-reduction multiplier for the P Supplemental NM BMP elements can only occur after satisfactory implementation of the P Core NM BMP. The P Supplemental NM BMP loss reduction credit for each of these three categories (rate, timing, and placement) can be obtained if implementation of at least one effective practice from each category is verified. N Supplemental NM BMP loss reduction credits for N rate, N timing, and N placement are stackable, as are P Supplemental NM BMP loss reduction credits for P rate, P timing, and P placement. The approach for applying both core and supplemental nutrient management multiplier values is summarized in Table 17. Figure 3 and Figure 4 illustrate the decision tree for assigning credits.

Table 17. Summary of Method for Applying Nutrient Management Multiplier Values

Nutrient Management BMP	Action of BMP	How the math works
Nitrogen Core **Non-Nutrient Management** BMP	Modifies N application rate goal on the nutrient input side	Multiplier value is applied to the LGU N application rate goal
Nitrogen Core **Nutrient Management** BMP	Modifies N application rate goal on the nutrient input side	Multiplier value is applied to the LGU N application rate goal
N Rate Supplemental NM BMP	Modifies edge of field N loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field N load
N Placement Supplemental NM BMP	Modifies edge of field N loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field N load
N Timing Supplemental NM BMP	Modifies edge of field N loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field N load
Phosphorus Core **Non-Nutrient Management** BMP	Modifies P application rate goal on the nutrient input side	Multiplier value is applied to the LGU P application rate goal
Phosphorus Core **Nutrient Management** BMP	Modifies P application rate goal on the nutrient input side	Multiplier value is applied to the LGU P application rate goal
P Rate Supplemental NM BMP	Modifies edge of field P loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field P load
P Placement Supplemental NM BMP	Modifies edge of field P loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field P load
P Timing Supplemental NM BMP	Modifies edge of field P loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field P load

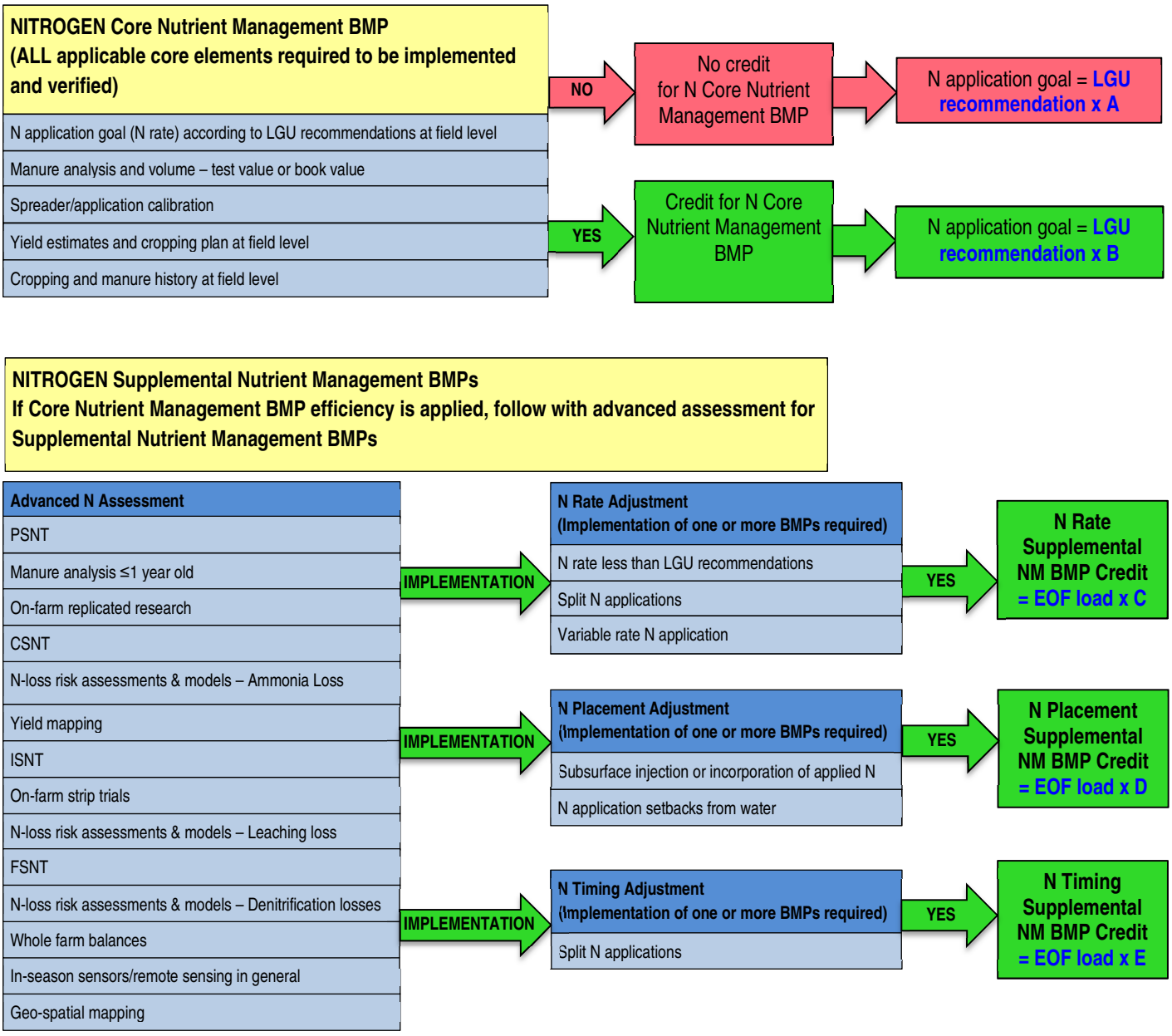

Figure 3. Assignment of N Nutrient Management Credits. Variables A and B refer to the land use specific N Core Non-Nutrient Management BMP application rate multiplier and the N Core Nutrient Management BMP application rate multiplier, respectively, as presented in Table 12. Variables C, D and E refer to the land use specific N Rate Supplemental NM BMP loss reduction multiplier, the N Placement Supplemental NM BMP loss reduction multiplier and the N Timing Supplemental NM BMP loss reduction multiplier, respectively, as presented in Table 14. EOF is edge of field.

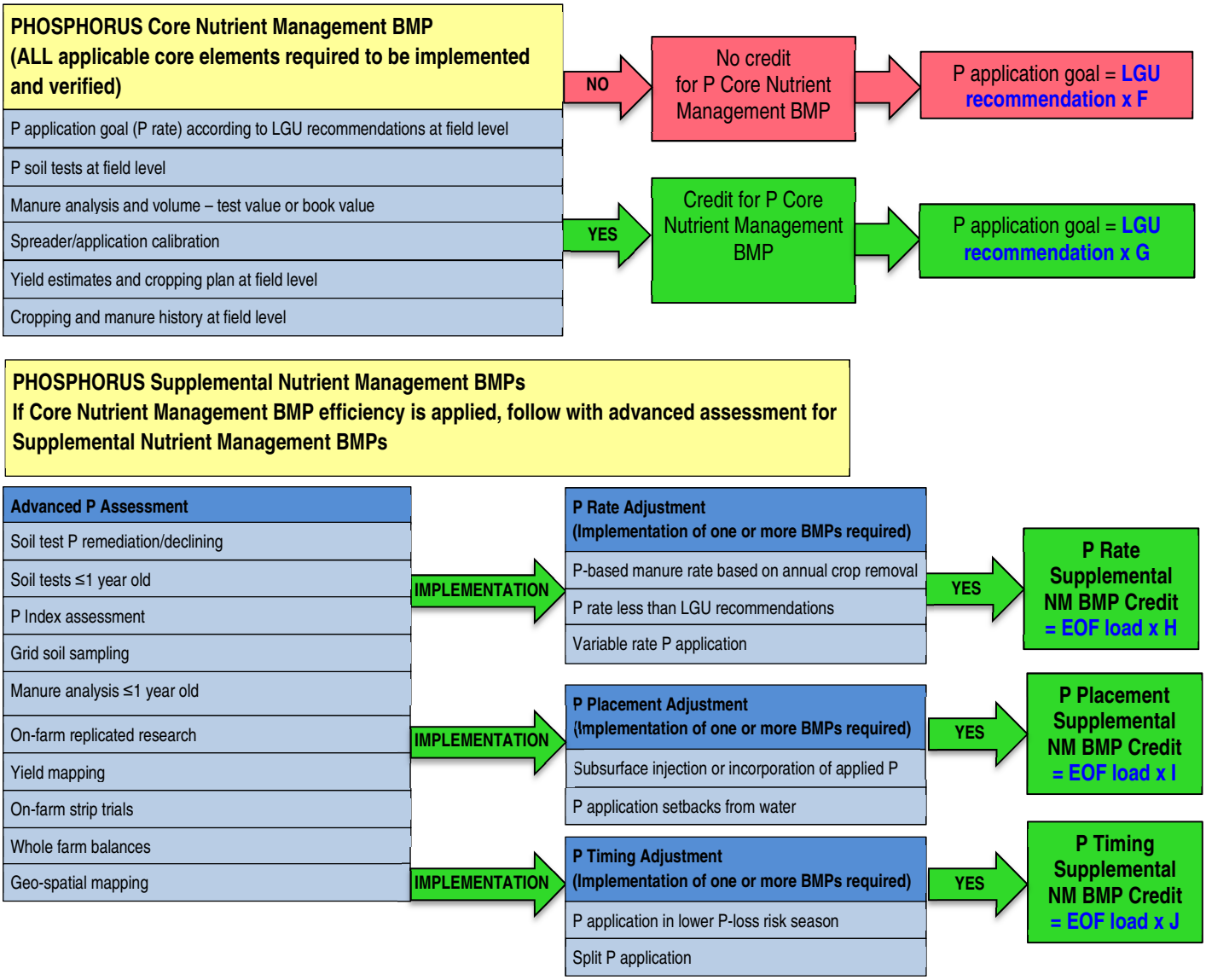

Figure 4. Assignment of P Nutrient Management Credits. Variables F and G refer to the land use specific P Core Non-Nutrient Management BMP application rate multiplier and the P Core Nutrient Management BMP application rate multiplier, respectively, as presented in Table 13. Variables H, I and J refer to the land use specific P Rate Supplemental NM BMP loss reduction multiplier, the P Placement Supplemental NM BMP loss reduction multiplier and the P Timing Supplemental NM BMP Loss reduction multiplier, respectively, as presented in Table 15. EOF is edge of field.

4 Review of Literature and Data Gaps

4.1 The Available Science for N BMPs

Crop- and land-use-specific N application rate goal should be based on LGU crop fertilization recommendations, as modified by the CBP partnership. In an effort to determine the most practicable methodology for allocating fertilizer N to satisfy crop- and land-use-specific N application rate goals, the Agriculture Workgroup compared the modified LGU recommendations for application of supplemental inorganic N fertilizer to an alternative approach based on county-level redistribution of AAPFCO N fertilizer sales data. This methodological comparison indicated that there were relatively small differences between the two methods for estimating supplemental N fertilizer applications, leading the Agriculture Workgroup to approve use of the redistributed AAPFCO fertilizer sales methodology in the Phase 6 Model. The Panel maintains that LGU recommendations should continue to serve as the foundation for crop and land-use-specific N application goals and suggests that similar comparative analyses be conducted in the future as new fertilizer sales data become available. Inconsistencies between estimates generated by the two methods should be further investigated and rectified based on data source quality and consistency with contiguous or regional county-level data.

Nutrient management practices are implemented at either the field or sub-field level. The diverse landforms, hydrology, climate and cropping systems of the agricultural landscapes in the CBW have a multitude of impacts on biogeochemical transformations of N in the agro-ecosystem. Changes in hydrological pathways alone can have dramatic effects on crop N utilization efficiency and N loads to streams when viewed from the Atlantic Coastal Plain to the Appalachian Plateau. Therefore, site-specific physical conditions and management factors have a strong influence on the effectiveness of imposed conservation practices. Nutrient management BMP effectiveness must represent the average condition over a wide range of real-life scenarios. Thus, it was incumbent upon the Panel to distill numerous lines of evidence to arrive at a single crediting value for N BMPs that could be applied equitably across the CBW.

4.2 The Available Science for P BMPs

Similar to N, crop and land-use-specific P application rate goal should be based on LGU crop fertilization recommendations, as modified by the CBP partnership. However, in practice, LGU recommendations for P application are based on crop- and site-specific soil-test P concentration. Currently, soil-test P concentration data are not available to the CBP. The Panel recommends that, in the future, crop- and site-specific soil-test P concentration data should be collected, aggregated to the appropriate scale, summarized to eliminate disclosure of private confidential business information, and utilized as the foundation for determining P application rate goals and the appropriate application of P Core NM BMPs. In the absence of soil-test P based application rate goals, county-level redistribution of AAPFCO P fertilizer sales data may serve as a surrogate. An essential assumption that must be imposed when county-level redistribution of AAPFCO P fertilizer sales data is utilized in lieu of site-specific soil-test P concentration data is the assumption of a county-average soil-test P concentration. Currently, a “medium” soil-test P condition was assumed for all situations and locations. Imposition of the “medium” soil-test P assumption across the entire CBW is a gross over-simplification of the complex site-specific biogeochemical processes and on-site management practices that determine P fate and transport in the agro-ecosystem. The CBP should strive to rectify this shortcoming in future iterations of the modeling suite.

As stated above relative to N, nutrient management practices are implemented at either the field or sub-field level. The diverse landforms, hydrology, climate and cropping systems of the agricultural landscapes in the CBW have a multitude of impacts on biogeochemical transformations of P in the agro-ecosystem. Therefore, site-specific physical conditions and management factors have a strong influence on the effectiveness of imposed conservation practices. Nutrient management BMP effectiveness must represent the average condition over a wide range of real-life scenarios. Thus, it was incumbent upon the Panel to distill numerous lines of evidence to arrive at a single crediting value for the P BMPs that could be applied equitably across the CBW.

5 Application of Practice Estimates

5.1 Load Sources

Nutrient management can be applied to specified land uses everywhere within the Chesapeake Bay watershed. The N Core BMP and the P Core BMP, as well as the N and P Supplemental NM BMPs, apply to each of the partnership approved Phase 6 agricultural land uses listed in Table 18.

Table 18. Land Uses to Which the Nutrient Management Practices Apply

Land Use	Description
Full Season Soybeans	Soybeans ineligible for double cropping
Grain with Manure	Corn or sorghum for grain eligible for manure application and ineligible for double cropping
Grain without Manure	Corn or sorghum for grain ineligible for manure application and ineligible for double cropping
Silage with Manure	Corn or sorghum for silage eligible for manure application and ineligible for double cropping
Silage without Manure	Corn or sorghum for silage ineligible for manure application and ineligible for double cropping
Legume Hay	Legume forage crops eligible for manure
Small Grains and Grains	Small grains and grains other than corn or sorghum eligible for manure and ineligible for double cropping
Small Grains and Soybeans	Soybeans double cropped with small grains and ineligible for manure
Specialty Crop High	Specialty crops with relatively high nutrient inputs with some crops eligible for manure
Specialty Crop Low	Specialty crops with relatively low nutrient inputs with some crops eligible for manure
Other Agronomic Crops	Other high commodity row crops such as tobacco, cotton, etc., with some crops eligible for manure
Other Hay	Non-legume forage crops eligible for manure
Pasture	Grazed land that receives direct manure deposition from animals

5.2 Practice Baseline

The Panel recommends that historic implementation on a state-by-state basis be based on the premise that the baseline of 1985 is set at zero, or near zero acres for N Core NM BMP implementation and the highest level of implementation be represented at 2015 reported implementation acreages. Similarly, the zero baseline for the P Core NM BMP should be set to the date when each state introduced P-based NM requirements and the highest level of implementation be represented at 2015 reported implementation acreages. Due to the differences between state Nutrient Management program initiation dates and implementation reporting for the six-state partnership, the “baseline” year is recommended to reflect these state partnership differences. Thus, the initial Nutrient Management implementation year for each state will be unique.

The increasing level of historic implementation between the state Nutrient Management Program initiation year and the 2015 reported implementation acreages represent two points in time on a state-by-state basis. The intervening annual representation of implementation acreages may be represented as a linear progression, in the absence of robust implementation data. Historic implementation estimation shall consider additional sources of N and P reduction credits commensurate with State Quality Assurance Project Plans (QAPPs) currently in place, given they are consistent with the BMPs and efficiency credits described by the Panel.

In cooperation with the CBPO, a state-by-state representation of reported NM implementation is included as Appendix A. The state-by-state representation was developed for historical N Core NM and P Core NM BMP implementation.

Historical N Core NM BMP implementation methodology:

- Assume straight-line interpolation between 2015 Progress acres and a starting year for each state.
- Starting year was evaluated by looking at historic NEIEN data to determine when states started reporting information.
- 2015 Progress has acres on crop, pasture and hay. Interpolation was made for each of these categories.
- Interpolation was made in each county.
- Assume all acres on crops for New York (NY), Pennsylvania (PA), and West Virginia (WV) only apply to crop acres eligible for receiving manure.
- Assume all acres on crops for Delaware (DE), Maryland (MD) and Virginia (VA) can be distributed to crop acres with or without manure.
- All acres assumed to qualify for N Core NM BMP.

Historical P Core NM BMP implementation methodology would be similar to the N Core NM BMP implementation methodology above, except for variable starting years for each state.

A second independent source of data representing historic Nutrient Management implementation has been requested from the USDA Natural Resources Conservation Service (NRCS) Conservation Effects Assessment Project (CEAP) based on the two existing reports published on the Chesapeake Bay Watershed. The requested information will be evaluated on a HUC-4 (4-digit Hydrologic Unit Code) scale based upon the CEAP program's methodology of interviewing producers at randomly selection field points from the Natural Resources Inventory (NRI) lists. To date, analysis of the CEAP data at the HUC-4 scale across the CBW has not been conducted.

In utilizing the Panel's practice recommendations for tracking and reporting practice implementation, the Panel recommends that acres, or percentage of acres, be reported by Phase 6 land use, or grouping of similar land uses, by year as an annual practice. N and P Core NM BMPs are stand-alone practices which should be tracked and reported separately. Likewise, advanced N and P Supplemental NM BMPs should be tracked and reported separately, but only when the corresponding N or P Core NM BMP elements have been met by the Panel's recommended practice definitions.

The Panel's recommendation for tracking and reporting NM BMP implementation is that acres, or percentage of acres, be reported by Phase 6 land use, or grouping of similar land uses, by year as an annual practice. The N Core NM BMP and P Core NM BMP are stand-alone practices which should be tracked and reported separately. Likewise, advanced N and P Supplemental NM BMPs should be tracked and reported separately, but only when the requirements for reporting the corresponding N or P Core NM BMP have been met.

5.3 Hydrologic Conditions

The Panel represented NM BMPs that can be applied across all hydrologic conditions in the CBW.

5.4 Sediment

Panel report specifically does not address sediment losses or reductions resulting from implementation of NM BMPs.

5.5 Species of Nitrogen and Phosphorus

The Panel report focused on total N and total P and did not specify species of N or P.

5.6 Geographic Considerations

The Panel report represented NM BMPs that can be applied across all geographic areas of the CBW.

5.7 Temporal Considerations

The Panel report represented NM BMPs that may or may not have temporal considerations depending on the sequence of BMP implementation within the constraints of farm management operations.

5.8 Practice Limitations

There are no limitations to the application of NM BMPs. These practices may be applied to all agricultural land use categories in the CBW.

5.9 Potential Interactions with other Practices

The Panel recognizes that NM BMPs interact with all other agricultural practices for all agricultural land use categories in the CBW.

6 Practice Monitoring and Reporting

6.1 Phase 6.0 Nutrient Management Tracking, Verification, and Reporting

The Panel recommends that NM BMP implementation tracking, verification, and reporting on a county-by-county or state-by-state basis be based on the premise that they represent annual Non-Visual Assessment BMPs. BMP implementation will be reported annually to the CBPO as the number of acres or percentage of acres meeting the definitions and qualifications set forth by the NM Panel in this report for Core N and P NM BMPs, as well as applicable N and P Supplemental NM BMPs.

Nutrient Management BMPs represent an historic and ever-changing suite of BMPs for the CBP modeling tools over the history of the Program. As such, NM BMPs are included in the jurisdiction's verification plans that were submitted to the CBP in late 2015. As with all BMPs, the jurisdictions will be expected to document their verification protocols and procedures in their QAPP for NM BMPs that are reported to the CBPO for nitrogen and phosphorous crediting reductions under the recommended BMPs. The jurisdictions will determine if modifications of those verification plans are required after this expert panel recommendation report is approved by the CBP partnership following the BMP Protocol, and before the jurisdictions are able to start submitting these BMPs in the Phase 6 modeling tools for annual progress implementation. As the states consider how to verify NM BMPs and as they document those procedures in their QAPP, state partners should follow the existing Agriculture Workgroup's BMP Verification guidance.

http://www.chesapeakebay.net/about/programs/bmp/additional_resources

The current verification guidance from the Agriculture Workgroup (AgWG) breaks BMPs into three general categories: Visual Assessment BMPs (Single Year), Visual Assessment BMPs (Multi-Year), and Non-Visual Assessment BMPs. The complete AgWG guidance is quite extensive (79 pages long, including all tables and its own appendices) and is not restated in this section. The panel is not proposing any new or unique aspects of BMP verification for purposes of the BMPs described in this report. This section simply explains how the recommended BMPs correspond to the existing BMP verification guidance.

As described in this report, nutrient management practices are often part of a larger nutrient management system or plan that often involves multiple management and physical components (e.g., animal waste storage, manure injection and incorporation, etc.) which can be visually assessed over time. NM practices also incorporate non-visual components (e.g. nutrient application rate, timing, and placement) in addition to management plans or other documentation as needed under applicable state or federal agricultural permits and/or programs. Thus, nutrient management practices can reasonably be verified using elements of both the Non-Visual Assessment and Visual Assessment (Multi-Year) categories described by the AgWG.

Each state will determine the most appropriate methods for verifying NM BMP implementation given their specific priorities, programs, needs, and capacity. For example, one state may leverage existing site visits to farms to also verify that the operation meets applicable NM BMP definitions as per the NM Panel recommendations. Or, the state may determine that available records are detailed enough to provide sufficient verification through spot-checks. Ideally the state will leverage multiple existing and perhaps new avenues to verify that nutrient management practices and operational are sufficient to meet the NM BMP criteria as determined by a trained and/or certified independent third-party, and that the data in the operation's records are accurate and up-to-date.

Jurisdictions can follow the AgWG's guidance for Non-Visual Assessment BMPs to verify the N and P core NM BMPs recommended in this report for N and P reduction credits in the Phase 6 CBWM. Verification for Non-Visual Assessment BMPs depend more on oversight and checks on operational records or documentation rather than visual assessment of a physical structure.

The N and P reductions for Core NM BMPs described in this report are to be based on the verified required elements of the N and P Core NM BMPs following the AgWG's guidance for Non-Visual Assessment BMPs. Because it is an annually reported BMP, the most important criteria (i.e. N and P Core NM elements) should be documented somewhere in records available to the applicable state agency. Given the close association between nutrient application management and other CBP-approved BMPs (e.g., animal waste storage systems, manure transport, etc.) the state agency can potentially verify the type and amount of nutrients that were managed via one or both of the Core NM practices described by the panel. If the state agency finds that even this basic information cannot be verified through its spot-checks or other annual BMP verification procedures described in its QAPP, then the BMP cannot satisfy the definitions and expected nitrogen reductions described in this report.

When the state agency has more detailed NM information available for both reporting and verification purposes, then they may be able to report the given nutrient application system under both the defined N and P Core NM BMPs, as well as one or more of the N and P Supplemental NM BMPs. By providing separate BMPs based on additional rate, timing, and placement application management systems for the higher nitrogen and phosphorous reductions, the panel provides a framework with additional built-in elements of BMP verification. If records available to the applicable state agency do not document the implementation of additional nutrient application changes for rate, timing, and/or placement described by the panel for the N and P Supplemental NM BMPs, then the given system should not be reported under the corresponding Supplemental NM BMP, but could potentially still meet the criteria of the N and/or P Core NM BMP using the more basic information that is available. By assigning lower estimated reductions when only basic information is available, it is less likely that a reported treatment system will not provide the estimated nitrogen and phosphorous reductions developed by the panel. This reinforces the basis of BMP verification, i.e. that the reported practice is implemented and operating as intended. With more detailed information about the nutrient application management factors, verified according to the AgWG's guidance, the partnership can have more confidence that the given nutrient application system is operating more effectively to limit excess nitrogen and phosphorous from the environment.

For more information about the CBP Partnership's BMP Verification Framework

The full CBP partnership BMP Verification Framework is available online (scroll down to October 2014 Basinwide BMP Verification Framework Document):

http://www.chesapeakebay.net/about/programs/bmp/additional_resources

The current Agriculture Workgroup's BMP Verification Guidance is included in Appendix B of the full Framework Document. For the AgWG's guidance only, go here:

http://www.chesapeakebay.net/documents/Appendix%20B%20-Ag%20BMP%20Verification%20Guidance%20Final.pdf

6.2 Future Verification of Nutrient Management Practices

The Panel envisions that potential opportunities may exist in the future for utilizing alternative forms of BMP verification, including examples such as remote sensing from satellite, aerial, and drone imagery, aggregated fertilizer industry sales information, and aggregated manure hauler/broker data.

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Preface to Appendices

The Agriculture Workgroup approved the enclosed Panel Report (dated October 18, 2016) on October 20, 2016 with the addition of amendments that are summarized in the introductory paragraph of Appendix G. The final Panel Report as updated in response to the Agriculture Workgroup amendments is contained in Appendix G, which supersedes the original Panel Report for implementation by the CBP partnership in all aspects as approved. Appendices B-F for the Panel Report (dated October 18, 2016) were not affected by the approved amendments and are therefore not included in Appendix G with the amended report. Appendices A and Appendix H were affected by the approved amendments and updated versions of these two appendices are included with the amended report in Appendix G, and also supersede their original counterparts in all aspects as approved. The original versions of Appendix A and Appendix H are also provided here for context.

Appendix A: Technical Requirements for Reporting and Simulating Nutrient Management BMPs in the Phase 6 Watershed Model

Background: In June, 2013 the Water Quality Goal Implementation Team (WQGIT) agreed that each BMP expert panel would work with CBPO staff and the Watershed Technical Workgroup (WTWG) to develop a technical appendix for each expert report. The purpose of the technical appendix is to describe how the expert panel's recommendations will be integrated into the modeling tools including NEIEN, Scenario Builder and the Watershed Model.

Q1. What are the individual nutrient management practices a jurisdiction may report in the Phase 6 Watershed Model?

A1. The individual practices along with their definitions are provided below.

Nitrogen Core NM

Applications of nitrogen are made in accordance to ALL the following elements as applicable:

- Land-grant university recommendations for nitrogen applications at field level
- Manure analysis and volume using either test or book values to determine nitrogen content
- Calibration of spreader/applicator
- Yield estimates and cropping plan at the field level
- Cropping and manure application history at the field level

Phosphorus Core NM

Applications of phosphorus are made in accordance to ALL the following elements as applicable:

- Land-grant university recommendations for phosphorus at the field level. This may include recommendations resulting from advanced assessment (i.e. P Index, etc.) that recommend higher P application rates where the risk of P loss is low.
- Soil test for phosphorus levels at the field level. This requirement may be waived if restrictions on manure applications (rate, timing, and placement) are imposed that limit P application rates and management to the same degree as if the soil test result for phosphorus was in the "high" category.
- Manure analysis and volume using either test or book values to determine phosphorus content
- Calibration of spreader/applicator
- Yield estimates and cropping plan at the field level
- Cropping and manure history at the field level

Nitrogen Rate Supplemental NM

Applications of nitrogen are made in accordance to all elements of the Nitrogen Core practice, and one or more of the following practices are implemented resulting in a reduction in application rate of nitrogen:

- Nitrogen application rate made at less than land-grant university recommendations
- Nitrogen applications split across the growing season resulting in lower than planned applications
- Nitrogen applications are made using variable rate goals resulting in lower than planned applications.

Nitrogen Placement Supplemental NM

Applications of nitrogen are made in accordance to all elements of the Nitrogen Core practice, and one or more of the following practices are implemented resulting in better placement and utilization of nitrogen:

- Applications of inorganic nitrogen are injected into the subsurface or incorporated into the soil
- Applications of nitrogen are made with setbacks from surface water features

Nitrogen Timing Supplemental NM

Applications of nitrogen are made in accordance to all elements of the Nitrogen Core practice, and are split across the growing season into multiple applications to increase utilization of nitrogen.

Phosphorus Rate Supplemental NM

Applications of phosphorus are made in accordance to all elements of the Phosphorus Core practice, and one or more of the following practices are implemented resulting in a reduction in application rate of phosphorus:

- Applications of manure are based upon annual crop removal of phosphorus rather than nitrogen
- Applications of phosphorus are made at less than land-grant university recommendations
- Phosphorus applications are made using variable rate goals resulting in lower than planned applications

Phosphorus Placement Supplemental NM

Applications of phosphorus are made in accordance to all elements of the Phosphorus Core practice, and one or more of the following practices are implemented resulting in better placement and utilization of nitrogen:

- Applications of inorganic phosphorus are injected into the subsurface or incorporated into the soil
- Applications of phosphorus are made with setbacks from surface water features

Phosphorus Timing Supplemental NM

Applications of phosphorus are made in accordance to all elements of the Phosphorus Core practice, and are made in seasons with a lower risk of phosphorus loss.

- Applications of phosphorus are split across the growing season resulting in lower than planned applications.

Q2. What are the nutrient reductions associated with core practices?

A2. Each acre reported under the core practices will have an application goal adjusted slightly from land-grant university recommendations. For example, an acre of corn not receiving manure (a crop in the Grain without Manure land use) under the Nitrogen Nutrient Management Core practice will have an application goal of 0.92 lbs. of nitrogen/bu./ac. The modified land-grant university applications will be increased by the multipliers provided in the tables below for each acre NOT under the Nutrient Management Core practice. For example, an acre of corn not receiving manure (a crop in the Grain without Manure land use) NOT under the Nitrogen Nutrient Management Core practice will have an application goal of 1.10 lbs. of nitrogen/bu./ac. (or 0.92 X 1.20). See *Example Calculation of County Crop Application Goal using Core Nutrient Management for Nitrogen Acres on Corn for Grain* below for additional details.

Core N Nutrient Management Application Goal Multipliers

Land Use	**Nutrient Management BMP**	
	Nitrogen Core ***Non-Nutrient Management***	**Nitrogen Core** ***Nutrient Management***
Full Season Soybeans	1.20	1.00
Grain w/ Manure	1.30	1.00
Grain w/o Manure	1.20	1.00
Legume Hay	1.20	1.00
Silage w/ Manure	1.40	1.00
Silage w/o Manure	1.20	1.00
Small Grains and Grains	1.20	1.00
Small Grains and Soybeans	1.20	1.00
Specialty Crop High	1.30	1.00
Specialty Crop Low	1.20	1.00
Other Agronomic Crops	1.10	1.00
Other Hay	1.00	1.00
Pasture	1.00	1.00

Core P Nutrient Management Application Goal Multipliers

Land Use	Nutrient Management BMP	
	Phosphorus Core ***Non-Nutrient Management***	**Phosphorus Core** ***Nutrient Management***
Full Season Soybeans	1.50	1.00
Grain w/ Manure	3.00	1.00
Grain w/o Manure	1.50	1.00
Legume Hay	1.00	1.00
Silage w/ Manure	3.00	1.00
Silage w/o Manure	1.50	1.00
Small Grains and Grains	1.50	1.00
Small Grains and Soybeans	1.50	1.00
Specialty Crop High	2.00	1.00
Specialty Crop Low	2.00	1.00
Other Agronomic Crops	1.50	1.00
Other Hay	1.00	1.00
Pasture	1.00	1.00

Example Calculation of County Crop Application Goal using Core Nutrient Management for Nitrogen Acres on Corn for Grain

County Assumptions:

Acres of Corn for Grain in County: 100,000 ac.

Average Yield for County: 100 bu. /ac.

Nutrient Management Application Goal: 0.92 lbs. of N/bu.

Non-Nutrient Management Application Goal: 1.2 lbs. of N/bu.

- Calculation: (0.92 lbs. N/bu.) X (1.3)

Number of Acres under Nutrient Management: 20,000 ac.

Number of Acres under Non-Nutrient Management: 80,000 ac.

Crop Application Calculations:

Crop Application Goal for all Nutrient Management Acres: 1,840,000 lbs. N

- Calculation: (20,000 ac.) X (100 bu. /ac.) X (0.92 lbs. N/bu.) = 1,840,000 lbs. N

Crop Application Goal for all Non-Nutrient Management Acres:

- Calculation: (80,000 ac) X (100 bu. /ac.) X (1.2 lbs. N/bu.) = 9,600,000 lbs. N

Total Crop Application Goal for all Acres: 11,440,000 lbs. N

- Calculation: (1,840,000 lbs. N) + (9,600,000 lbs. N) = 11,440,000 lbs. N

Total Crop Application Goal per Acre: 114.4 lbs. N/ac.

- Calculation: (11,440,000 lbs. N) / (100,000 ac.) = 114.4 lbs. N/ac.

In this way, the acres of core nutrient management impact the overall application goal for each crop within a county. The more acres of nutrient management, the lower the goal will be, and vice versa. However, the final nutrient application rates for the calibration period are determined by the amount of manure and commercial fertilizer available within a county. Thus, the final application rate may be higher or lower than the 114.4 lbs. N/ac. described in the example above.

Q3. What are the nutrient reductions associated with the supplemental practices?

A3. Each supplemental practice will be credited as a percent reduction to estimated runoff from the appropriate land use. These percent reductions are listed in the tables below.

Nitrogen Supplemental Percent Reductions to Land Use Runoff

Land Use	Nutrient Management BMP		
	N Rate Supplemental	N Placement Supplemental	N Timing Supplemental
Full Season Soybeans	0%	0%	0%
Grain w/ Manure	15%	5%	10%
Grain w/o Manure	5%	3%	5%
Legume Hay	0%	0%	0%
Silage w/ Manure	15%	5%	10%
Silage w/o Manure	5%	3%	5%
Small Grains and Grains	5%	3%	10%
Small Grains and Soybeans	5%	3%	10%
Specialty Crop High	15%	5%	5%
Specialty Crop Low	5%	3%	5%
Other Agronomic Crops	5%	3%	5%
Other Hay	0%	3%	5%
Pasture	0%	0%	0%

Phosphorus Supplemental Percent Reductions to Land Use Runoff

Land Use	Nutrient Management BMP		
	P Rate Supplemental	**P Placement Supplemental**	**P Timing Supplemental**
Full Season Soybeans	5%	10%	1%
Grain w/ Manure	10%	20%	20%
Grain w/o Manure	5%	10%	1%
Legume Hay	1%	10%	1%
Silage w/ Manure	10%	20%	20%
Silage w/o Manure	5%	10%	1%
Small Grains and Grains	5%	10%	1%
Small Grains and Soybeans	5%	10%	1%
Specialty Crop High	5%	10%	1%
Specialty Crop Low	5%	10%	1%
Other Agronomic Crops	5%	10%	1%
Other Hay	0%	10%	1%
Pasture	0%	0%	0%

Q4. Can a state report an acre of supplemental nutrient management on an acre that does not fulfill the definition of the core practices?

A4. No. The panel recommended that every acre of supplemental nutrient management must also fully meet the definition of the core practice as applicable.

Q5. If an acre utilizes multiple strategies listed under a single supplemental practice's definition, should it be reported twice? For example, if a producer both sets back applications of nitrogen from surface waters AND injects inorganic nitrogen below the soil surface, should a state report the acre twice as qualifying for the Nitrogen Supplemental Placement practice?

A5. No. The panel recommended that each acre can only qualify once for each of the BMPs. However, an acre can qualify for all four types of BMPs at once. For example, an acre could be reported under the core practice and all three supplemental practices for nitrogen and phosphorus if appropriate.

Q6. How will multiple, supplemental nutrient management practices credited on the same acre impact runoff estimates?

A6. A single acre of land may qualify for up to three supplemental practices reported for each nutrient. The reductions for each practice will be combined in a multiplicative manner to impact final runoff estimates. An example calculation for a single acre of Grain with Manure with three supplemental practices for nitrogen is included below.

Initial Runoff Estimate: 20 lbs. N/ac.

Supplemental Credits Available: 15% N Rate; 5% N Placement; 10% N Timing

Final Runoff Estimate: 14.54 lbs. N/ac. = 20 lbs. N/ac. X (1-0.15) X (1-0.05) X (1-0.1)

Q7. Are the supplemental practices credited in any particular order?

A7. No. There would be no difference in the runoff reductions by re-ordering the reduction efficiencies listed in the example calculation in question 6 due to the multiplicative nature of the credit calculation.

Q8. How should a state report these practices to NEIEN?

A8. States should report the following information:

- *BMP Name:* Nitrogen Core NM ; Phosphorus Core NM; Nitrogen Rate Supplemental NM; Nitrogen Timing Supplemental NM; Nitrogen Placement Supplemental NM; Phosphorus Rate Supplemental NM; Phosphorus Timing Supplemental NM; Phosphorus Placement Supplemental NM
- *Measurement Name:* Acres
- *Land Use:* Approved NEIEN agricultural land use classes; if none are reported, the default will be CROP
- *Geographic Location:* Approved NEIEN geographies: County; County (CBW Only); Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); State (CBW Only)
- *Date of Implementation:* Year plan was active.

Q9. Are all nutrient management practices annual?

A9. Yes. States should report the total number of acres qualifying under each practice type each year.

Q10. Can states take credit for practices on pasture?

A10. No. The panel specifically recommended reductions to application goals and runoff estimates on non-pasture acres only.

Appendix B: Methods to Estimate Historic Implementation

The Panel recommends that historic implementation on a state-by-state basis be based on the premise that the baseline of 1985 is set at zero, or near zero acres for Nutrient Management Core N and Core P implementation, and the highest level of implementation be represented at 2015 reported implementation acreages. Due to the differences between state Nutrient Management program initiation dates and implementation reporting for the six-state partnership, the "baseline" year is recommended to reflect these state partnership differences. Thus, the initial Nutrient Management implementation year for each state will be unique.

The increasing level of historic implementation between the state Nutrient Management program initiation year and the 2015 reported implementation acreages represent two points on a state-by-state basis. The intervening annual representation of implementation acreages may be represented as a linear progression if there is a paucity of implementation data, or inferred by state implementation data representative of the definitions of nutrient management proposed by the panel. Historic implementation estimation shall consider additional sources of nitrogen and phosphorous reduction credits commensurate with State Quality Assurance Project Plans (QAPPs) currently in place, given they are consistent with the BMPs and efficiency credits described by the Panel.

In cooperation with the Chesapeake Bay Program Office, a state-by-state representation of Nutrient Management reported implementation following the Panel's recommendations for historic implementation levels in default of additional state implementation data was presented both to the Panel and the Agriculture Workgroup as part of the preliminary Panel recommendation report and review and approval by the Agriculture Workgroup in May 19, 2016.. The state-by-state representation was developed for N Core Nutrient Management only, and with the following methodology:

- Assume straight-line interpolation between 2015 Progress acres and a starting year for each state.
- Starting year was evaluated by looking at historic NEIEN data to determine when states started reporting information.
- 2015 Progress has acres on crop, pasture and hay. Interpolation was made for each of these categories.
- Interpolation was made in each county.
- Assume all acres on crops for NY, PA, and WV only apply to crop acres eligible for receiving manure.
- Assume all acres on crops for DE, MD and VA can be distributed to crop acres with or without manure.
- All acres assumed to qualify for core N.
- No acres yet determined for core P.

Figure B-1 illustrates the relationship between state reporting of historic data through NEIEN and the methodology described above.

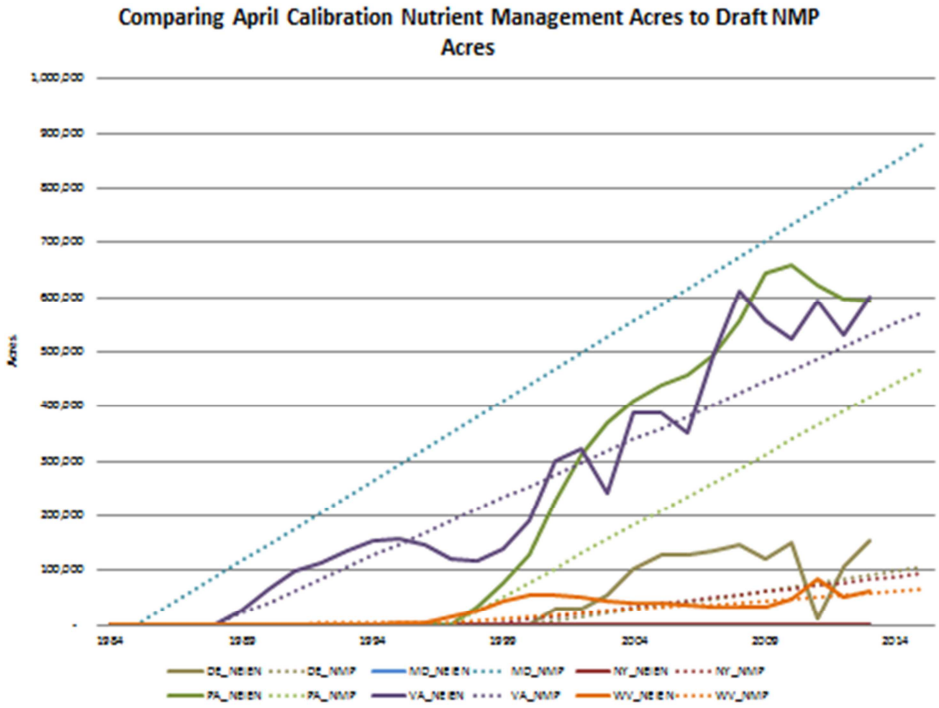

Figure B-1. Comparing April Calibration Nutrient Management Acres to Draft NMP Acres

A second independent source of representing historic Nutrient Management implementation has been requested from the USDA NRCS CEAP based on the two existing reports published on the Chesapeake Bay Watershed. Tables 2.7 and 2.8 from the 2013 CEAP report summarize nitrogen and phosphorus management practices and percent of cropped acres within each category for the Chesapeake Bay region, respectively (USDA 2013).

In utilizing the Panel's practice recommendations for tracking and reporting practice implementation, the Panel recommends that acres, or percentage of acres, be reported by Phase 6 land use, or grouping of similar land uses, by year as an annual practice. Nutrient Management Core N and P are stand-alone practices which should be tracked and reported separately. Likewise, advanced supplemental N and P practices should be tracked and reported separately, but only when the corresponding Core N or P elements have been met by the Panel's recommended practice definitions.

Table 2.7. Nitrogen management practices and percent of cropped acres within each category for the Chesapeake Bay region, 2003-06 and 2011 (USDA 2013).

Nitrogen*	2003-06	2011	2003-06 percent	2011 percent
No N applied to any crop in rotation	214,000	87,000	5	2
For acres where N is applied:			95	98
Commercial Fertilizer Only	2,457,000	2,177,000	60	51
Manure with or without Commercial Fertilizer	1,608,000	2,089,000	40	49
Rate of application:				
Acres receiving commercial fertilizer and/or manure applications:				
All crops in rotation meet the nitrogen rate criteria described in text			32	23
Some but not all crops in rotation meet the nitrogen rate criteria described in text			54	71
No crops in rotation meet the nitrogen rate criteria described in text			13	6
Acres receiving commercial fertilizer applications only:				
All crops in rotation meet the nitrogen rate criteria described in text			42	35
Some but not all crops in rotation meet the nitrogen rate criteria described in text			52	62
No crops in rotation meet the nitrogen rate criteria described in text			6	3
Acres receiving manure with or without commercial fertilizer applications:				
All crops in rotation meet the nitrogen rate criteria described in text			17	9
Some but not all crops in rotation meet the nitrogen rate criteria described in text			59	82
No crops in rotation meet the nitrogen rate criteria described in text			24	9
Time of application:				
Acres receiving commercial fertilizer and/or manure applications:				
All crops in rotation have application of nitrogen fertilizer less than 21 days before planting			50	36
Some but not all crops have application of nitrogen fertilizer within 21 days before planting			34	50
No crops in rotation have application of nitrogen fertilizer within 21 days before planting			11	11
Acres receiving commercial fertilizer applications only:				
All crops in rotation have application of nitrogen fertilizer less than 21 days before planting			69	59
Some but not all crops have application of nitrogen fertilizer within 21 days before planting			15	25
No crops in rotation have application of nitrogen fertilizer within 21 days before planting			9	13
Acres receiving manure with or without commercial fertilizer applications:				
All crops in rotation have application of manure less than 21 days before planting			18	12
Some but not all crops have application of manure within 21 days before planting			66	78
No crops in rotation have application of manure within 21 days before planting			16	10
Method of application:				
Acres receiving commercial fertilizer and/or manure applications:				
All crops in rotation have N applied with incorporation or banding/foliar/spot treatment			34	27
Some but not all crops in rotation have N applied with incorporation or banding/foliar/spot treatment			45	55
No crops in rotation have N applied with incorporation or banding/foliar/spot treatment			21	18
Acres receiving commercial fertilizer applications only:				
All crops in rotation have N applied with incorporation or banding/foliar/spot treatment			41	37
Some but not all crops in rotation have N applied with incorporation or banding/foliar/spot treatment			34	44
No crops in rotation have N applied with incorporation or banding/foliar/spot treatment			25	19
Acres receiving manure with or without commercial fertilizer applications:				
All crops in rotation have manure applied with incorporation or banding/foliar/spot treatment			22	16
Some but not all crops in rotation have manure applied with incorporation or banding/foliar/spot treatment			63	67
No crops in rotation have manure applied with incorporation or banding/foliar/spot treatment			16	17
Rate *and* timing *and* method of application (excludes acres not receiving nitrogen)				
All crops meet the nitrogen rate criteria described in text and application within 3 weeks before planting with incorporation or banding/foliar/spot treatment			13	7
Some but not all crops meet the nitrogen rate criteria described in text or application within 3 weeks before planting with incorporation or banding/foliar/spot treatment			87	93
Nitrogen *and* Phosphorus				
Crop rotation phosphorus and nitrogen rates meet criteria described in text and all applications occur within 3 weeks before planting and include incorporation or banding/foliar/spot treatment, including acres with no nitrogen or phosphorus applied			8	5

Note: Percents may not add to 100 because of rounding.

* These estimates include adjustments made to the reported data on nitrogen and phosphorus application rates from the survey because of missing data and data entry errors. In the case of phosphorus, the 3-year data period for which information was reported was too short to pick up phosphorus applications made at 4- and 5-year intervals between applications, which is a common practice for producers adhering to sound phosphorus management techniques. Since crop growth, and thus canopy development which decreases erosion, is a function of nitrogen and phosphorus, it was necessary to add additional nitrogen when the reported levels were insufficient to support reasonable crop yields throughout the 52 years in the model simulation. For additional information on adjustment of nutrient application rates, see "Adjustment of CEAP Cropland Survey Nutrient Application Rates for APEX Modeling," available at http://www.nrcs.usda.gov/technical/nri/ceap).

Table 2.8. Phosphorus management practices and percent cropped acres within each category for the Chesapeake Bay region, 2003-06 and 2011 (USDA 2013).

Phosphorus*	**2003-06 acres**	**2011 acres**	**2003-06 percent**	**2011 percent**
No P applied to any crop in rotation	43,000	<1	1	<1
For acres where P is applied:			99	100
Commercial Fertilizer Only	2,414,000	2,264,000	60	52
Manure with or without Commercial Fertilizer	1,608,000	2,089,000	40	48
Rate of application:				
Acres receiving commercial fertilizer and/or manure applications:				
Rotation meets the phosphorus rate criteria described in text			54	57
Some but not all crops in the rotation meet the phosphorus rate criteria described in text			46	43
Acres receiving commercial fertilizer applications only:				
Rotation meets the phosphorus rate criteria described in text			68	76
Some but not all crops in the rotation meet the phosphorus rate criteria described in text			32	24
Acres receiving manure with or without commercial fertilizer applications:				
All crops in rotation meet the phosphorus rate criteria described in text			32	35
Some but not all crops in the rotation meet the phosphorus rate criteria described in text			68	65
Time of application:				
Acres receiving commercial fertilizer and/or manure applications:				
All applications of phosphorus fertilizer less than 21 days before planting			53	42
Some but not all applications of phosphorus fertilizer within 21 days before planting			34	38
No applications of phosphorus fertilizer within 21 days before planting			13	19
Acres receiving commercial fertilizer applications only:				
All applications of phosphorus fertilizer less than 21 days before planting			75	69
Some but not all applications of phosphorus fertilizer within 21 days before planting			13	18
No applications of phosphorus fertilizer within 21 days before planting			12	11
Acres receiving manure with or without commercial fertilizer applications:				
All applications of phosphorus fertilizer less than 21 days before planting			16	13
Some but not all applications of phosphorus fertilizer within 21 days before planting			67	59
No applications of phosphorus fertilizer within 21 days before planting			16	28
Method of application:				
Acres receiving commercial fertilizer and/or manure applications:				
All applications of phosphorus include incorporation or banding/foliar/spot treatment			42	37
Some but not all applications of phosphorus include incorporation or banding/foliar/spot treatment			28	30
No applications of phosphorus include incorporation or banding/foliar/spot treatment			30	32
Acres receiving commercial fertilizer applications only:				
All applications of phosphorus include incorporation or banding/foliar/spot treatment			51	53
Some but not all applications of phosphorus include incorporation or banding/foliar/spot treatment			19	26
No applications of phosphorus include incorporation or banding/foliar/spot treatment			31	22
Acres receiving manure with or without commercial fertilizer applications:				
All applications of phosphorus include incorporation or banding/foliar/spot treatment			28	21
Some but not all applications of phosphorus include incorporation or banding/foliar/spot treatment			42	35
No applications of phosphorus include incorporation or banding/foliar/spot treatment			30	44
Rate *and* timing *and* method of application (excludes acres not receiving phosphorus):				
All applications meet the phosphorus rate criteria described in text and application within 3 weeks before planting with incorporation or banding/foliar/spot treatment			22	21
Some but not all applications meet the phosphorus rate criteria described in text or application within 3 weeks before planting with incorporation or banding/foliar/spot treatment			78	79
Nitrogen *and* Phosphorus				
Crop rotation phosphorus and nitrogen rates meet criteria described in text and all applications occur within 3 weeks before planting and include incorporation or banding/foliar/spot treatment, including acres with no nitrogen or phosphorus applied			8	5

Note: Percents may not add to 100 because of rounding.

* These estimates include adjustments made to the reported data on nitrogen and phosphorus application rates from the survey because of missing data and data entry errors. In the case of phosphorus, the 3-year data period for which information was reported was too short to pick up phosphorus applications made at 4- and 5-year intervals between applications, which is a common practice for producers adhering to sound phosphorus management techniques. Since crop growth, and thus canopy development which decreases erosion, is a function of nitrogen and phosphorus, it was necessary to add additional phosphorus when the reported levels were insufficient to support reasonable crop yields throughout the 52 years in the model simulation. (For additional information on adjustment of nutrient application rates, see "Adjustment of CEAP Cropland Survey Nutrient Application Rates for APEX Modeling," available at http://www.nrcs.usda.gov/technical/nri/ceap).

References

USDA. 2013. Impacts of Conservation Adoption on Cultivated Acres of Cropland in the Chesapeake Bay Region, 2003-06 to 2011. Conservation Effects Assessment Project, U.S. Department of Agriculture, Washington, DC. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/na/?cid=stelprdb1240074

Appendix C: Nutrient Management Phase 6.0 Expert Panel Charge Document

Recommendations for the Nutrient Management Phase 6.0 Expert Panel

Prepared for the Chesapeake Bay Program Partnership's Agriculture Workgroup by the Nutrient Management Phase 6.0 Expert Panel Establishment Group

March 19, 2015

Background

The current version of the Chesapeake Bay Program (CBP) partnership's Watershed Model (Phase 5.3.2 or P5.3.2) credits Crop Group Nutrient Application Management (or Tier 1), under the following definition: "Documentation exists for manure and/or fertilizer application management activities in accordance with basic land grant university (LGU) recommendations. This documentation supports farm-specific efforts to maximize growth by application of nitrogen (N) and phosphorus (P) with respect to proper nutrient source, rate, timing and placement for optimum crop growth consistent with LGU recommendations. Particular attention is paid to: (1) standard, realistic farm-wide yield goals; (2) credit for N sources (soil, sod, past manure and current-year applications); (3) P application rates consistent with LGU recommendations based on soil tests for fields without manure; and (4) N based application rates consistent with LGU recommendations for fields receiving manure."

Enhanced Nutrient Management and Decision Agriculture BMPs are currently represented in the P5.3.2 Model. However, these practices are expected to be replaced by Nutrient Application Management Tier 2 and Tier 3 practices respectively, which are being finalized by the Nutrient Management P5.3.2 Expert Panel in spring 2015.

- Proposed Tier 2

  The implementation of field-specific nutrient application management efforts to maximize growth by application of nitrogen (N) and phosphorus (P) with respect to proper nutrient source, rate, timing and placement for optimum crop growth consistent with LGU recommendations incorporating a P risk assessment tool.

- Proposed Tier 3

  The implementation of subfield-specific nutrient application management efforts to maximize growth by application of nitrogen (N) and phosphorus (P) with respect to proper nutrient source, rate, timing and placement for optimum crop growth incorporating sub-field monitoring and operational practices to further refine the LGU recommendations for the specific farm site and conditions.

The Nutrient Management Expert Panel Establishment Group (EPEG) was formed to:

- Identify priority tasks for the Phase 6.0 (P6.0) Nutrient Management Expert Panel (EP),
- Recommend areas of expertise that should be included on the Nutrient Management EP, and
- Draft the Nutrient Management EP's charge for the review process.

From February 18, 2015 through March 6, 2015 the EPEG met 3 times by conference call and worked collaboratively to complete this charge for presentation to the Agriculture Workgroup

(AgWG) on March 18-19, 2015. Final approval of the charge was obtained by online polling of all members. Members of the EPEG are listed in Table 1.

Table 1. Nutrient Management Expert Panel Establishment Group membership and affiliations.

Member	Affiliation
Beth McGee	Chesapeake Bay Foundation
Chris Brosch	Virginia Tech
Doug Goodlander	Pennsylvania Department of Environmental Protection
Frank Coale	University of Maryland
Jack Meisinger	U.S. Department of Agriculture-Agricultural Research Service
Jason Keppler	Maryland Department of Agriculture
EPEG Support Staff	
Emma Giese	Chesapeake Research Consortium
Mark Dubin	University Maryland
Steve Dressing	Tetra Tech, Inc.

Method

The Nutrient Management EPEG developed its recommendations in accordance with the process specified by the AgWG (AgWG 2014). This process is informed by the strawman proposal presented at the December 11, 2014 AgWG meeting, the Water Quality Goal Implementation Team (WQGIT) Best Management Practice (BMP) protocol, input from existing panelists and chairs, and the process recently undertaken by the AgWG to develop the charge for the Manure Treatment Technologies EP.

The collective knowledge and expertise of EPEG members formed the basis for the recommendations contained herein. A number of EPEG members have had experience on BMP expert panels, including the P5.3.2 Nutrient Management EP. Other EPEG members have knowledge and/or expertise in state and federal programs, the Chesapeake Bay model, and nutrient management practices within the Chesapeake Bay watershed.

Communication among EPEG members was by conference call and email. All decisions were consensus-based.

Recommendations for Expert Panel Member Expertise

The AgWG expert panel organization process directs that each expert panel is to include eight members, including one non-voting representative each from the Watershed Technical Workgroup (WTWG) and Chesapeake Bay Program modeling team. Panels are also expected to include three recognized topic experts and three individuals with expertise in environmental and water quality-related issues. A representative of USDA who is familiar with the USDA-Natural Resources Conservation Service (NRCS) conservation practice standards should be included as one of the six individuals who have topic- or other expertise.

In accordance with the WQGIT BMP protocol, panel members should not represent entities with potential conflicts of interest, such as entities that could receive a financial benefit from Panel recommendations or where there is a conflict between the private interests and the official responsibilities of those entities. All Panelists are required to identify any potential financial or other conflicts of interest prior to serving on the Panel. These conditions will minimize the risk that Expert Panels are biased toward particular interests or regions.

The Nutrient Management EPEG recommends that the P6.0 Nutrient Management EP should include members with the following areas of expertise:

- Nutrient management planning and agronomy.
- Expertise in farm- and field-level nutrient risk assessment tools for N and P.
- Experience with carrying out research projects relating to nutrient management.
- Expertise in fate and transport of N and/or P in agricultural systems.
- Knowledge of nutrient management practices implemented in the Bay jurisdiction(s).
- Knowledge of how BMPs are tracked and reported, and the Chesapeake Bay Program partnership's modeling tools.
- Experience with verification of nutrient management plans and other forms of nutrient management.
- Knowledge of relevant USDA-NRCS practice codes or standards.

Expert Panel Scope of Work

The general scope of work for the Nutrient Management P6.0 EP(s) will be to define and configure the Nutrient Management BMPs in the P6.0 model. Specifically, the Nutrient Management EPEG recommends the following five charges with associated tasks for the P6.0 Nutrient Management EP:

1. Review the P5.3.2 definitions and effectiveness estimates for the implementation of component practices of Nutrient Management and make adjustments or modifications as needed for Phase 6.0.
    a) Consider the current P5.3.2 Tier system used for identifying levels of nutrient management implementation activities to be credited to the model, and
    b) Recommend if the current proposed Tier process should remain or if a more component oriented process for crediting nutrient management practices is more appropriate.
2. Determine how nutrient management practices can be applied to the P6.0 land uses, taking into consideration the mass balance data and nutrient spreading routine in Scenario Builder.
3. If possible, make recommendations using multi-year vs. annual model representation of soil nutrient residuals for calculation of available nutrients to meet crop requirements on an annual basis.
4. Collaboration with the Cropland Irrigation Management EP on fertigation will be critical to ensure that recommendations are complementary as well as to avoid double-counting and ensure effective reporting of practices.

This scope of work addresses nutrient management reduction efficiencies for N and P.

Under the first charge, the Nutrient Management Phase 6.0 (P6.0) Expert Panel will review the P5.3.2 definitions and effectiveness estimates for the implementation of component practices of Nutrient Management and make adjustments or modifications as needed for Phase 6.0. This charge is necessary because the P6.0 model features a change in land use categories, a possible change in the baseline condition, and some likely changes in how BMPs are applied. While the EPEG considers the tiered approach to be an improvement over the previous P5.3.2 approach to nutrient management, there is interest in considering an alternative approach for P6.0. Both a tiered approach and practice-specific approach have pros and cons associated with reporting implementation and determining efficiency values. Items 1a and 1b specify that the P6.0 EP will consider the current Tier system used for identifying levels of nutrient management implementation activities to be credited to the model and recommend if the current proposed Tier process should remain or if a more component oriented process for selecting nutrient management practices is more appropriate. Nutrient management Tiers 1-3 are described in the *Background* section of this document.

The second charge directs the P6.0 EP to determine how nutrient management practices can be applied to the P6.0 land uses. Factors to consider when performing tasks under this charge include the baseline conditions assumed by the model (e.g., with or without nutrient management), the nutrient spreading routine and improved mass balance data for Scenario Builder, and potential variation in crediting for different land uses.

Residual nutrients are not adequately accounted for by the P5.3.2 model. Under the third charge, the P6.0 EP will consider management of residual nutrients and how they are carried over to subsequent years in the P6.0 model. This will require close coordination with the Chesapeake Bay modeling team which is ultimately responsible for developing the capability to add this important feature to the model.

Collaboration with the P6.0 Cropland Irrigation Management EP is specified under the fourth charge to ensure that recommendations from the two panels are complementary and that practice reporting and crediting are accurate. Either panel could address fertigation, but both panels should have a role in determining the final recommendations.

Timeline and Deliverables

Early summer 2015 - Panel stakeholder kickoff meeting

Summer 2015 – Based on their written EPEG charge, the panel will develop a proposed scope of work including BMP structure and type, draft BMP definition(s), and initial elements of the BMP such as associated components and conservation practices, and USDA-NRCS associated CP codes. Initially identified literature citations will be included to provide a range of potential effectiveness values that the panel will consider and supplement with further evaluation. The panel will present their provisional BMP paper to the AgWG, WTWG, and WQGIT for informational purposes, and for initial partnership comments on the proposed direction of the panel’s evaluation. The paper will not represent a full recommendation report, and the partnership will not be asked for formal approval at this time.

Prior to October 1, 2015 – In the absence of a Partnership approved panel recommendation report, the CBPO modeling team will request a decision by the Agriculture Workgroup, Watershed Technical Workgroup, and the Water Quality Goal Implementation Team of whether the BMP will be represented using the existing Phase 5.3.2 definitions, the approved recommendations of the Phase 5.3.2 Panel report if applicable, or the Phase 6.0 panel's provisional paper, in the Phase 6 Beta Scenario Builder tool to meet an early October deadline.

Spring 2016 – **Final date** for panel to release full recommendations for approval by the AgWG, WTWG, and WQGIT.

Early summer 2016 – If approved by the partnership, panel recommendations are final and will replace the interim representation of the BMP in the final version of the Phase 6 modeling tools.

Phase 6.0 BMP Verification Recommendations:

The panel will utilize the Partnership approved ***Agricultural BMP Verification Guidance***[1], as the basis for developing BMP verification guidance recommendations that are specific to the BMP(s) being evaluated. The panel's verification guidance will provide relevant supplemental details and specific examples to provide the Partnership with recommended potential options for how jurisdictions and partners can verify nutrient management practices in accordance with the Partnership's approved guidance.

References

AgWG. 2014. Agriculture Workgroup expert panel organization – DRAFT January 8, 2014. Agriculture Workgroup, Chesapeake Bay Program.

[1] http://www.chesapeakebay.net/documents/Appendix%20B%20-Ag%20BMP%20Verification%20Guidance%20Final.pdf

Attachment 1: Outline for Final Expert Panel Reports

- Identity and expertise of Panel members
- Practice name/title
- Detailed definition(s) of the practice
- Recommended nitrogen, phosphorus, and sediment loading or effectiveness estimates
  - Discussion may include alternative modeling approaches if appropriate
- Justification for the selected effectiveness estimates, including
  - List of references used (peer-reviewed, unpublished, etc.)
  - Detailed discussion of how each reference was considered, or if another source was investigated, but not considered.
- Description of how best professional judgment was used, if applicable
- Land uses to which the BMP is applied
- Load sources that the BMP will address and potential interactions with other practices
- Description of pre-BMP and post-BMP circumstances, including the baseline conditions for individual practices
- Conditions under which the BMP works:
  - Should include conditions where the BMP will not work, or will be less effective. An example is large storms that overwhelm the design.
  - Any variations in BMP effectiveness across the watershed due to climate, hydrogeomorphic region, or other measureable factors.
- Temporal performance of the BMP including lag times between establishment and full functioning (if applicable)
- Unit of measure (e.g., ft., ac)
- Locations within the Chesapeake Bay watershed where this practice is applicable
- Useful life; effectiveness of practice over time
- Cumulative or annual practice
- Description of how the BMP will be tracked, reported, and verified:
  - Include a clear indication that this BMP will be used and reported by jurisdictions
- Suggestion for a review timeline; when will additional information be available that may warrant a re-evaluation of the estimate
- Outstanding issues that need to be resolved in the future and a list of ongoing studies, if any
- Documentation of any dissenting opinion(s) if consensus cannot be reached
- Operation and Maintenance requirements and how neglect alters performance

Additional Guidelines

- Identify ancillary benefits and unintended consequences
- Include negative results
  - Where studies with negative pollution reduction data are found (i.e. the BMP acted as a source of pollutants), they should be considered the same as all other data.
- Include results where the practice relocated pollutants to a different location. Examples include where a practice eliminates a pollutant from surface transport but

moves the pollutant into groundwater, or where the practice will move manure from the farm credited for the practice to another farm more in need of nutrients.

In addition, the Expert Panel will follow the "data applicability" guidelines outlined Table 1 of the Water Quality Goal Implementation Team *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model*.

Appendix D: Approved Nutrient Management Expert Panel Meeting Minutes

7/22/2015

Frank Coale, Panel Chair, welcomed the group to the call and thanked everyone for agreeing to contribute to this Panel effort. Panel members and staff introduced themselves.

Coale: The plan for the face-to-face meeting on September 10-11 is to create draft recommendations following the meeting. Not expecting to develop much technical content today during the call, instead information will be sent out over email to Panel members between now and the in-person meeting in order to make the best use of time in September.

Travel reimbursement for the September meeting will be offered through UMD.

Mark reviewed the Panel charge, which was developed by a scoping group earlier this year and approved by the Chesapeake Bay Program's Agriculture Workgroup. The charge was sent to members in an email from Emma Giese on 7/21.

- Question: Does this Panel need to address BMP verification more in depth than the previous Panel?
- Response by Coale: We have been charged with addressing it. The depth of the response will have to be determined by our other recommendations, but we will have to lay out a plan for verification.

- Question: Will there be interaction with the Chesapeake Bay Program's BMP Verification Panel?
- Response by Dubin: Likely not, as the Panel is looking at the larger scale overview. This Panel will be working within the existing verification guidelines developed by the Agriculture Workgroup.

Chris Brosch, chair of the previous (Phase 5) Nutrient Management Panel, gave a brief overview of this Panel's work to date. Chris recommended the Panel members watch the first 40 minutes of the July 1 webinar where the Phase 5 Panel recommendations are recorded. Webinar recording is available here: http://www.chesapeakebay.net/calendar/event/22716/.

Frank noted that this Panel will be able to build off of the work already done by the Phase 5 Panel. Frank asked Matt Johnston (CBPO modeling team) to explain how the changes in the Phase 6 Chesapeake Bay Program Watershed Model will affect how this Panel develops recommendations relevant to the Phase 5 recommendations.

- Johnston: The two big changes being tested right now for Phase 6 that will impact what this group does are 1) land uses (The land uses will be more specific in Phase 6, i.e. corn, and small grains rather than "row crops") and 2) how the nutrients are applied (there will already be a better accounting for "right application rate" in Phase 6)

Coale: Emma's email included a link to the Phase 5 Panel webinar summarizing their recommendations. Once the Phase 5 Nutrient Management panel final report has been approved by the Bay Program Partnership, it will be shared with this Panel as well. There will be documents distributed from either Frank, Mark, or Emma, and email conversations over the coming weeks to begin considering different

options. Frank encouraged Panel members to read these emails as they are sent in order to make the best use of time in preparation for and during the September meeting.

Travel reimbursement forms were sent by Emma this morning (7/22). The form needs to be submitted before travel (9/7/15 at the latest) in order for approvals to be processed through the university. Contact Mark with any questions about travel reimbursement.

Participants

Frank Coale	UMD, Panel chair
Quirine Ketterings	Cornell
Jack Meisinger	USDA-ARS
Doug Beegle	PSU
Chris Brosch	VT/VADCR, Watershed Technical Workgroup representative
Deanna Osmond	NCSU
Matt Johnston	UMD, CBPO Modeling Team
Mark Dubin	UMD, Agriculture Workgroup coordinator
Emma Giese	CRC, Panel staff

9/10/2015 – 9/11/2015

Open Stakeholder Meeting:

- Tom Simpson gave a presentation, discussing the Nutrient Management Panel's Phase 5.3.2 Report, highlighting some of the issues with this report, and providing some suggestions for the new Phase 6 panel.
    - Simpson: Will substantive draft information be publicly available? What about opportunities for input/comment between open session and final draft review?
        - Mark Dubin: Frank and other panel chairs will be presenting at the September quarterly meeting next week to provide updates.
        - Frank Coale: The panel will also be corresponding with open session participants as they move forward.
- Mike Twining from Willard Agri-Service presented on the adapt-N and Eco-N tool and modeling system for modeling and mapping agronomic and soil characteristics to predict future trends.
    - Tom Fisher: Are those models or measurements in the figures?
        - Twining: They are modeled results based on published research that was fed into the model.
    - Jack Meisinger: How much data from the figures you've shown us is from the Bay watershed?
        - Twining: If you want replicated, strip-trial data, then this development work was done outside the Bay watershed. The model has been adapted to our field-specific questions.
    - Lindsay Thompson: Is there a general number of producers or acres that implemented this in the cropping cycle?
        - Twining: I won't give a specific number, but it's in the hundreds.
    - Quirine Ketterings: Are there farmers you're working with in the Chesapeake Bay area that would be open to conducting trials in the future?
        - Twining: We are coordinating with these farmers, but replication is very difficult to achieve. Our side-by-side analyses allow us to come within statistical

confidence levels that are close to a replicated trial.
    - Deanna Osmond: Do you include N recommendations from universities when you're thinking about putting these trials together?
        - Twining: All of our recommendations are university recommendations, in compliance with Nutrient Management law. When our model differs from the recommendations, then we move into more unfamiliar territory.
    - Matt Johnston: What happens when this technology is used to increase profitability and yields, what would happen to the losses? How is this technology changing applications and runoff to water?
        - Twining: As growers adopt this tech, growers will increase side-dress applications. Yields have increased year after year, but we can't promise any kind of absolute reduction in Nitrogen. But Nitrogen use efficiency is improving with this technology.
    - Meisinger: This panel will have to wrestle with verification. How would you verify Adapt-N?
        - Twining: In my opinion, the verification process should come through annual implementation reporting process. Ultimately, the obligation is on the farmer to verify what they are doing on their farm.
- Matt Miller from DuPont/Pioneer gave a presentation on Encirca services, designed to increase efficiency of nitrogen management.

Open discussion after presentations:

- Tom Fisher: Question to Matt Miller. How would nitrogen be applied during the tackling stage?
    - Miller: We've had a few different types of application (aerial, fertigation…).
- Quirine Ketterings: Can you talk a little bit about what you're doing in these trials?
    - Bill McCollum: We did whole-field trials, so there wasn't any replication. The small-scale and replicated trials are done with the agronomy sciences group in Iowa.
- Jack Meisinger: Are there any new methods for manure management?
    - Twining: We are modeling manure application on fields.
- Twining: Move in-season to in-season management. There's more year-to-year variation in Nitrogen management than there is in a field. That's what's driving us to look at in-season decision tools. There's a strong ecological and economic component to that.
- Frank: Can a blanket assessment be made on weather-based models?
    - Twining: I would say yes. In the absence of modeling tech, the risk of loss is likely greater.
- Tom Fisher: As long as we continue with n based manure application, we'll always have excess P in soils. If we go to a P based manure application rate, then we'll have a surplus of manure. So we should create an alternative product(s) for manure – composting, packing for sale, energy production, etc.

Participants:

Frank Coale	UMD
Chris Brosch	VT/VADCR
Matt Miller	DuPont/Pioneer
Bill McCollum	DuPont/Pioneer
Deanna Osmond	NCSU
Steve Dressing	Tetra Tech
John Dantinne	Willard Agri-Service
Mike Twining	Willard Agri-Service

Jack Meisinger	USDA ARS
Quirine Ketterings	Cornell University
Lindsay Thompson	MD Association of Soil Conservation Districts
Matt Johnston	CBPO
Mark Dubin	UMD
Tom Simpson	Aqua Terra Science LLC
Lindsey Gordon	CRC Staff
Frank Schneider	PA DEP
Tom Fisher	UMCES
Dawn Stolzfus	MD Clean Agriculture Coalition
Greg Levow	Agronomic Technology Corp.
Jeremy Hanson	VT
Karl Blankenship	Bay Journal
Kelly Shenk	EPA Region 3
Kristen Hughes Evans	Sustainable Chesapeake
Kristen Saacke Blunk	Headwaters LLC
Robin Pellicano	MDE
Ron Korcak	USDA ARS
Harold Van Es	Cornell University
Doug Beegle	PSU
Seung Ah Byun	Brandywine Conservancy

Closed Panel Meeting:
Actions and Decisions:
ACTION: Panel will need to deliberate and determine a negative efficiency number, as well as decide if this value will be the same for all "bad actors".
ACTION: Frank Coale to ask for candidate nominations for new BMPs that are not captured on the list that has been drafted.
Thursday September 10, 2015:

- Chris Brosch gave a presentation of the Phase 5.3.2 Nutrient Management tiered plan.
    - Deanna Osmond: Had anything really changed from Tier 1 to Tier 2 relative to practice behavior?
    - Brosch: Not really, but we weren't trying to credit anyone that wanted to apply commercial fertilizer in the fall.
    - Osmond: Was the SWAT model the latest version with better P routines? When was this done?
        - Meisinger: Using the older version.
- Frank Coale: Can someone describe how the Phase 6 land uses will look and work?
- Matt Johnston briefed everyone on the list of new Phase 6 agricultural land uses and the Phase 6 Scenario Builder.
    - Coale: Whatever recommendations come with BMP efficiencies will be applied to this group of acres.
    - Meisinger: The model world shouldn't be driving the real world. If you can collect model validation (we'll have to do this for Tier 1) then that should impact the model.
    - Dubin: One of the problems is that we're estimating. We don't always have good data, and this impacts the estimates that we come up with. It also impacts manure transport. So unless the jurisdictions report manure transport, the model will assume that all manure

that is made in the county, stays in the county.
    - Steve Dressing: Manure transport is factored in for that initial mass county balance?
        - Dubin: Not quite. The counties can get credit, but they need data to get the credit.
    - Johnston: Whenever we estimate crop need for corn, we ask the states what NM planners were doing in the past 3 decades.
- Coale: I see two approaches in moving forward: 1) Find the path that Chris described (With the tiers – here's a group of practices that count one way, and another group, etc…) or 2) We enumerate all the different practices we can think of. Some will apply to some land uses, some won't. Each one of those BMPs will have an efficiency coefficient that will apply to a practice. Then systems can be constructed to incorporate BMPs and determine final efficiencies.
    - Meisinger: I'm a proponent of non-tiering option #2. I would like to have N and P separated. I like the independent "menu" system, where you can specify what tests or BMPs you are doing. There would be a lot of flexibility, but the problem is that we'd have to get some estimate of those practices. And perhaps we could even get a paper published out of this.
    - Coale: There are 3 things we have to try to assure can be done. We can define things that can be tracked. It has to be reportable to whatever agency is collecting the numbers. And then it has to be verified. That's a tricky one, but we should keep track of that as we go ahead.
    - Meisinger: The menu system is much friendlier to verification as opposed to a Tier system.
    - Dressing: A menu approach would also be compatible with a checklist approach, which is a verification practice used in PA. It seems to me that your approach needs to be compatible with what the Agriculture practice panels are doing with regard to what the states have to verify.
    - Dubin: A new component is the verification guidance and protocols, which we're in the process of finalizing right now. If you're looking at a non-visual BMP (aka NM), then you're reduced to looking at records. Right now, none of the states have a very good tracking system for NM plans, but they'll be encouraged that they have to re-think that. NM plans are also represented in other BMPS.
- Tom Fisher: Could we go back to the way manure and fertilizer allocations were done? It seems a bit contrived and I was wondering if it corresponded with the way fertilizer sales in fact are distributed throughout the state. In other words, is this model really reflecting reality?
    - Matt and Mark replied that predicting and measuring fertilizer use is almost impossible, because data is not reliable enough at this point.
- Doug Beegle: One of the things I struggled with is how we separate active planning from the practices that are driven by planning. I think that's one of the things we missed, that the active planning is going to give some benefit.
    - Meisinger: So my thought is we would still have a fundamental NM piece. That's Tier 1, and everything else is a menu based off of that. Put some record keeping, soil test monitoring, and any basic tools you want to see available (education might be a part of this) would go in that Tier 1, NM piece. There wouldn't be any practice credit for it.
        - Coale: Maybe there should be practice credit for it.
        - Dubin: But wouldn't that be exclusionary? Because I could do a lot of the work to get the data that would influence application rates, but I don't have a formally written plan, I would be excluded from getting any of this.
            - Coale: So you may not be required to have a NM plan.
        - Meisinger: N and P would remain separate, but you could tie them to practices.
        - Johnston: Regardless, we need to make sure that each practice results in a water quality benefit everywhere.

            - Dubin: I think the key to what you were discussing earlier is not how much fertilizer you put on, but what's the nitrogen efficiency?
    - Osmond: How do you aggregate these practices and data up to a county level? And does everyone have the resources to do this?
        - Coale: Not everyone has the resources, and that's what the states might get upset about if we choose to continue with this menu plan.
- Coale: Some of the items in this menu idea wouldn't have any data at all, and some would have very shaky data. So are there any other ideas for how to structure this?
    - Ketterings: What do we have that we can verify outcomes with, or can somehow make intelligent connections to the outcomes with?
    - Brosch: We establish a starting point (1 lb. /bushel corn/acre), so if someone isn't achieving that fundamental level of NM, then they won't get credit. Start targeting states that are not nutrient/fertilizer balanced (more nutrients than can be utilized), who would accumulate negative credits if the baseline assumes balance.
        - Coale: So what I'm envisioning is this: At the bottom of these three levels, you have the "bad actors" who do not invest in the base-line NM plans would be hit with a negative efficiency/points/credits. Then you would have the core people that remain neutral. Then above this, you can have the "menu" idea, which is all positive efficiencies.
            - Beegle: But then how would you be crediting the neutral folks?
                - Johnston: We've developed the next scenario builder to be that good baseline (IE- you're following those baseline recommendations), so that's your baseline credit.
            - Ketterings: Unless you consider it a load reduction allocation, in which case you don't need credit.
            - Meisinger: So how are we going to identify these "bad actors"? We could do the P budget, but when you get to N it's a lot harder. We could do it, but it's harder.
    - Brosch: Mark had an option of going to the industry and collecting data on how management is performed. Meeting performance standards. This would mean collecting manure data effectiveness, and this would be a great option for variable rate, but no necessarily for a standard plan like we're working with.
- Group had a planning session to map out the structure of Nutrient Management recommendations, and what BMPs would be associated with each structure level.

Participants on 9/10/15:

Frank Coale	UMD
Chris Brosch	VT/VADCR
Steve Dressing	Tetra Tech
Deanna Osmond	NCSU
Jack Meisinger	ARS
Quirine Ketterings	Cornell
Matt Johnston	CBPO
Mark Dubin	UMD
Lindsey Gordon	CRC Staff
Doug Beegle	Penn State
Tom Fisher	UMCES

Friday September 11, 2015:

- Jack Meisinger: In regards to the sediment question, I think it would be slightly awkward to have 3 panels dealing with sediment.
    - Mark Dubin: I think we need to have cross-discussion between the panels to figure this out. I think we should keep sediment up on the list, but maybe sideline it for now until we talk to the other groups.
- Meisinger: As you think about the matrix of the core tier, that will change over time because practices change and some disappear, so I think we want to get clear what our baseline is at the beginning or if we're going to use a floating baseline across the time (which I don't particularly like because it's not well defined).
- The panel reviewed the 7 core nutrient management practices drafted in yesterday's meeting
    - Doug Beegle (in reference to "soil tests for P – field level"): Consider an alternative, where you would have book values for manure analysis, and you can't put more manure on than what crop removal is. This would be fairly protective, and would be good for people who don't have soil tests to be able to get through the system.
        - Dubin: Do you see many people going that route?
            - Beegle: We're a little worried some farmers and planners are going that route because it's simpler, though it's not as comprehensive as a soil test. It's not as if we are foregoing soil tests; this alternative would be pretty restrictive. It assumes high P index, and acts as a workaround if you have high soil P and shouldn't put any more P on it. But these farms are low-density farms, and likely wouldn't have those high P indexes to begin with.
    - Meisinger: Doesn't that conflict with N-based application rates, the manure analysis and volume? I think what Doug's describing belongs as a menu item above this.
        - Coale: So let's remove "N-based" from "method of determining NM application rates"
- BMPs listed in the Supplemental Menu are able to be stacked on top of the Core practices, but are not eligible to substitute for core practices.
- Dubin: Each of these menu items will be its own separate, and identifiable BMP.
- Agenda topics for next meeting:
    - Meisinger: Work on shrinking the list of Phase 6 practices
    - Review efficiency numbers for Phase 5.3.2 BMPs
    - Mark and Lindsey to coordinate with other panel chairs to schedule cross-panel (Cover Crops, Conservation Tillage, Stormwater Mgmt.) meetings on/after 2nd week of October
    - Lindsey to begin scheduling follow-up conference call meeting

Participants on 9/11/15:

Lindsey Gordon	CRC Staff
Matt Johnston	CBPO
Jack Meisinger	ARS
Quirine Ketterings	Cornell
Steve Dressing	Tetra Tech
Chris Brosch	VT/VADCR
Deanna Osmond	NCSU
Doug Beegle	Penn State
Mark Dubin	UMD
Frank Coale	UMD

11/20/2015:

Actions and Decisions:

ACTION: The panel members have 2 assignments to complete by December 20th, sent to Lindsey Gordon (Gordon.lindsey@epa.gov) and Mark Dubin (mdubin@chesapeakebay.net). They are:

- Each panel member will go through the land use matrix and continue populating all of the cells as to whether, for each specific land use, N or P applies to the BMPs listed.
  - Each panel member will additionally go through each column of land uses, and prioritize the BMPs that impact either N and/or P in that column as to which BMPs are the most important. Format should follow N1, N2, N3… or P1, P2, P3…, where N1 represents the most important BMP, following order of decreasing importance. Panel should prioritize **all** of the BMPs for each land use, where rankings are across **both** Phase 5.3.2 and Phase 6 BMPs.
- Panel members should begin compiling a list of potential conflicts in current recommendations. (Ex: allowing a plan if farmers don't agree to use a P based application of manure then they don't have to use a soil test.)

Panel Work Recap

- Frank Coale reviewed the presentation given at the September AgWG Quarterly meeting. The overall reaction was positive, though there was concern from state agency partners about how they will provide the data and reporting.
- Tom Fisher expressed concern that PSNT tests are not included in the core nutrient management practices. Frank Coale responded that this is captured in the supplemental nutrient management BMP menu.
- Mark Dubin clarified that having a negative BMP is new, but that the effect is something being implemented currently. Moving forward in the Phase 6 modeling tools, there will not be a land use set-up, and this will be applied as BMPs.
- Doug Beegle asked: In the original list, we had to have soil tests. In our supplemental menu it seems like we would be penalizing farmers for not having a soil test and then crediting them for a p-based application rate. This would not go over well with the PA farmers, at least.
  - Frank Coale explained how in order to get any of the supplemental practices, the core practices would have to be met. But this could cause big headaches, and is something that the panel will have to work through.
  - Mark Dubin suggested writing in an either/or in the core practices category that soil tests are being done, or in PA they can do a P-based application rate as an alternative. This would fall more on the reporting side, and hopefully wouldn't change the modeling at all.
- Jack Meisinger asked if the panel will separate N and P on the core practices list, because N-tests are not traditional.
  - Frank Coale explained that the P test should stay on the core menu, and the N based rates are built into the common nutrient management plans.

Preliminary Recommendations

- Panel needs to continue process of categorizing BMPs in terms of N and P, and prioritize BMPs to assign efficiencies and include in the panel report.

Partnership Feedback

- Mark Dubin gave a presentation to the panel on the current modeling of Nutrient Management in the beta Phase 6 model. The current modeling methods are temporary, and will be replaced later on with the panel recommendations.
- Jack Meisinger: The basic change of utilizing the fertilizer sales data is something we'll have to keep a close eye on. The modelers think they know the rates pretty well, but in years past we've never trusted the sales data basis so I think this is a potential area we need to monitor. Are you able to do that or do we need some other oversight?
  - Mark Dubin replied that he has been in discussions with the modeling folks, and that the Ag Modeling Subcommittee (AMS) will also need to have some discussions with them. This

recommendation came from the AMS, and it was recognized that Ag sales data have problems, but currently there isn't anything better. The panel will have to look closely at the Beta model runs in January and see whether it's working.

Partnership Outreach

- Mark Dubin explained that the panel has an open invitation to meet with state nutrient management program representatives in order to brief them on the panel recommendations and field any questions or concerns. Mark, Frank, and Lindsey will organize a meeting sometime in early 2016.
  - Chris Brosch supported this idea. He explained that program managers may be reluctant to adopt the panel recommendations, and this discussion should be started early on to improve communication.
- Frank clarified that this would only occur once the panel has something productive to present (i.e. in a few months).

State Nutrient Management Program/Panel Meeting:

- The WQGIT will be reviewing the Phase 5.3.2 Nutrient Management Task Force report during their December meeting.
- Mark Dubin explained the Task Force will be circling back to the states to ask for better documentation on their compliance programs. If this information is unavailable, the EPA will be referencing other reports to gather their information.

Partnership Webinars:

- Frank Coale will be conducting some webinars summarizing the panel and the process for future activities and recommendations. If panel members would like to participate with Frank, they should send him an email.

Phase 5.3.2 Nutrient Management Task Force Report

- Mark Dubin briefed the panel on the Phase 5.3.2 Nutrient Management Task Force report.
- Tom Fisher: I saw a report from MDA on compliance, and it looked like there were many places where there was not very good compliance. I got the impression that they were sugarcoating the results, making it look like there was significant compliance, when in reality ½-1/3 of the farms did not comply with at least one of the questions they were asking. What is your impression of this? Was that generally true?
  - Mark Dubin replied that there are many factors that can result in a noncompliance, but stated that the results may be slightly biased. Overall, it's a good report, but you will see a lot of variation among the states in their compliance rates.

Next Steps

- The panel should be completing their assignments by December 20th, sent to Lindsey Gordon (Gordon.lindsey@epa.gov) and Mark Dubin (mdubin@chesapeakebay.net).
- Assignment 1: Each panel member will go through the land use matrix and continue populating all of the cells as to whether for each specific land use, N or P applies to the BMPs listed.
  - Each panel member will additionally go through each column of land uses, and prioritize the BMPs that impact either N and/or P in that column as to which BMPs are the most important. Format should follow N1, N2, N3… or P1, P2, P3…, where N1 represents the most important BMP, following order of decreasing importance. Panel should prioritize all of the BMPs for each land use, where rankings are across both Phase 5.3.2 and Phase 6 BMPs.
  - Frank specified that if panel members think certain BMPs should be handled by other BMP panels, to leave the cell blank.
  - Frank will then summarize all of the panel members' submissions into one spreadsheet.
- Assignment 2: Panel members should begin compiling a list of conflicts in current recommendations. (Ex: allowing a plan if farmers don't agree to use a P based application of manure then they don't have to use a soil test.)
- Jack asked a question about prioritizing BMPs by region (ex: NY is the only state to use ISNT, but does that mean it does not merit importance in the panel recommendations?)

  - Frank responded that the BMPs can be prioritized regionally, but it is something that will have to be discussed further. Additionally, panel members should focus on their local regions to the best of their ability.
- Jack noted that the linkages in the BMP matrix should be communicated to other panels as soon as possible in order to clarify the role and jobs of the Nutrient Management Panel.
  - Mark Dubin explained that Frank, Mark, and Ken Staver (chair of Cover Crops Panel) met to clarify the issue of commodity crops. Frank further noted that the Cover Crops Panel will focus on cover crops as they're intended to function to conserve residual soil N levels. The Nutrient Management Panel will adopt any responsibilities that specifically relate to the charge and scope.
  - Tom Fisher asked whether the CCP panel was considering the flying of cover crops on soybeans.
    - Mark explained that aerial seeding has been included for a number of years, and they did add a longer list of available cover crops (radishes, triticale, legumes, etc.). The Phase 6 panel will be more focused on commodity cover crops, as well as summer fallow cover crops.
- Jack also noted his concern with using fertilizer sales data, and that if it will come down to a county level estimate, that in the future the panel should ask whether there are specific counties in the states that the panel feels comfortable estimating the actual rates at the field level.

Participants:

Frank Coale	UMD
Lindsey Gordon	CRC
Doug Beegle	Penn State
Tom Fisher	UMCES
Deanna Osmond	NC State
Steve Dressing	Tetra Tech
Mark Dubin	CBP
Jack Meisinger	USDA ARS
Chris Brosch	DE Dept. of Ag/VT
Quirine Ketterings	Cornell

2/2/2016

Action Items:

Action: Mark and Frank will take the ranked list of 27 BMPs, and group the BMPs into ~9 succinct categories. They will present this back to the panel at the next conference call.

Action: Frank is asking for volunteers to begin tackling a few groups to determine a starting assessment of what an efficiency % would look like.

Action: Mark, Frank, and Lindsey will begin developing a schedule of calls for the panel moving forward.

- Frank Coale reviewed the proposed modeling structure of Nutrient Management that was drafted by the panel. The panel still needs to define a non-nutrient management acre, and determine a negative efficiency value to associate with that. Frank also reviewed the prioritization matrix results of nutrient management BMPs.
- Tom Fisher: What is the assumed loss associated with a neutral acre?
  - Jack Meisinger: I worked on a panel that was estimating relative N losses for each Phase 6 land use. How that relative number gets translated to a load is still being worked on by the modeling team at the CBP.
  - Frank Coale: We're looking at this whole process as a % efficiency relative to a baseline. These core practices assume a 0-case scenario.
  - Mark Dubin: The values vary between LRSEG across the watershed, so it won't be a set number and will fluctuate based on calculated loading rates from water quality monitoring.

- Jack Meisinger: Some of these top ranked BMPs seem very similar – could we combine some of them? That would allow the panel to look at some of the other BMPs to move into the top 10 ranking.
    - Frank: Absolutely – we can combine some of them into joint management practices.
- Chris Brosch: How much did we take into account the load of effort that the 5.3.2 panel would save in this list? If we're talking about cutting things off, then it might be useful to consider that several of these BMPs were aggregated and taken care of by the 5.3.2 panel work.
    - Frank: In the top 10, 6 of them were partially defined in the 5.3.2 panel, and 4 of them are brand new.
    - Chris: Only because yield mapping and variable rate N might not get priority from our panel, but for use moving forward, some of these BMPs ought not to get cut out. If we have confidence in the 5.3.2 report recommendations, I would cut off everything below ranking 18.
- Tom Fisher: We use FSNT to show them what's left over in their field after they've grown corn or soybeans, and they actually seem to be using that information to adjust how much fertilizer they're applying next year. We're just getting some data on that now, but they recognize that if there's a high nitrate in the soil in October, that they have too much N, and will adjust their fertilizer application accordingly.
- Jack Meisinger: I think some of these tests are a bit regional – the ISNT would be high in New York, the FSNT would be high in MD and VA, so these rankings might flex across the regions somewhat. I don't know how we would deal with it, but it's good to be aware of it.
    - Frank: Agreed – and I think it's important that the list be longer rather than shorter.
- Quirine Ketterings: Can we group them into categories for enhanced soil management or something similar? That would allow states to pick which one is most relevant.
- Mark Dubin: Would there be a value to identify the rankings by state?
    - Frank: If anyone has a few that they think are highly important that came up short on prioritization, then we can revisit that.
    - Quirine suggested a category for spatial field variability management – geo-spatial mapping, etc.
    - Jack identified the important of whole farm P balances. Quirine agreed that whole farm balances sit apart from the rest of the BMPs, and suggested they should perhaps be treated separately. Frank noted that the panel will have to determine numerical values to represent losses, and that it might be difficult to come up with a specific number for the more unique BMPs.
- Mark Dubin noted that it would make sense if relative efficiency values were similar if the panel agrees to group some of the BMPs together.
- Jack suggested that Frank and other panel members complete some draft groupings of the BMPs, and then the panel would review what groupings the Phase 5.3.2 panel could give preliminary estimates on.
- Frank suggested the panel could take each of the BMPs as they are ranked, and decide which ones the panel currently wants to address. Then, within that collection, the panel would group similar BMPs together. Each grouping would have a single efficiency value, and then states would decide which BMPs are counted within that grouping. Then the panel would go back to each grouping to identify relative efficiencies.
- Tom asked if there was enough literature for the panel to do all of the BMPs, or if the panel will have to use its best professional judgement to determine values.
- Mark expressed concern about cutting off the ranking at rank 18 based on the importance of regionality for some BMPs.
- Doug Beegle suggested that instead of having many different types of N and P loss risk assessments, to group them together and have one single multiplier to all of them. Mark Dubin

and Jack Meisinger supported this suggestion.

- Matt Johnston reminded the group that the Ag Modeling Subcommittee reviewed outputs from the newest version of the model, and Frank noted that the panel is not looking at rate very much.
    - Frank: Some of these do modify rate, but the overall gross determination of rate is part of the core determination of practices.
- Jack noted that the panel should consider their timeline moving forward, making sure to be aware of the modeler's needs.
- Frank suggested that the panel should begin compiling efficiency values based on their personal expertise.
- Deanna made note that the panel should be aware that the practices listed are more plans, and may not result in any change to the farm-level nutrient management. Frank replied that the panel should specify that based on the results of the tools, that the farmer would implement any recommended changes.
- Jack Meisinger noted that Phase 6 will be requiring more stringent verification than Phase 5, and asked if the panel would have to make verification suggestions.
    - Mark replied that the panels are expected to address verification on the recommendations they are making.
- Matt Johnston: The modelers worry that the new format may run into a situation where a negative/positive efficiency would double count the nutrient loads/reductions.
    - Frank: The basic assumption when you achieve those core practices is a more appropriate rate.
    - Jack: Matt is talking about trying to make county-level estimates on fertilizers and manures, which the model will be better able to do, but it may not be able enough to supersede what a nutrient management approach would do. So I think that decision is still up in the air.
    - Matt: We're pretty far down the line with the bucket approach, but everything's still up in the air for Phase 6. But I want to note that because we're tracking changes in fertilizer use, we think the model will account for application rate. But we feel that doing anything +/- efficiency for rate would be double counting.
    - Chris Brosch: It's worth noting that while that approach was agreed upon, we know now that agriculture fertilizer sales data is as much as 40% too high, at least in DE. I think that's the impetus for us not being confident in our prior decision.
    - Jack: And remember that the 4 Rs are not independent, and there are interactions.
    - Deanna: Quite a number of these items are associated with rate, so as we go through this next exercise, could you clarify if we consider rate?
        - Frank: If you think about where we're most concerned in the real world, it's manure driven. Our most important thing in a NM plan is manure rate, and then in the model we distribute manure where there's too much, and where there's not enough we backfill with fertilizer. So if the number 1 benefit of a NM plan is to get manure management correct, if we can't adjust the rate for people that aren't at the core practice threshold, then I find that hard to swallow.
        - Matt: The impact of those NM plans on manure rate should be reflected in manure transport data or fertilizer sales. It should be different practices. The plan itself isn't the practice, it's everything the plan creates/incentivizes.
- Jack suggested inviting the modelers onto the next conference call to confirm that the panel recommendations are compatible with the modeling infrastructure.
    - Chris noted that the application rate is a moving baseline for the newest version of the model.

Participants:

Lindsey Gordon	CRC
Frank Coale	UMD
Chris Brosch	DDA
Doug Beegle	Penn State
Deanna Osmond	North Carolina State University
Jack Meisinger	USDA
Tom Fisher	UMCES
Quirine Ketterings	Cornell
Mark Dubin	UMD
Matt Johnston	UMD

2/24/2016
Actions & Decisions:

DECISION: The NMP and the AMS need to coordinate and resolve the issue of using fertilizer sales data as well as the baseline conditions. A subset of the NMP will attend the next meeting of the AMS: Frank Coale, Jack Meisinger, Mark Dubin, and Chris Brosch.

DECISION: The NMP agreed to move forward with the revised conceptual NMP structure proposed by Frank. A few panel members noted that it may require some tweaking moving forward.

Review of Proposed NM Structure

- Frank briefly reviewed the proposed NM approach previously defined by the panel, and supporting materials.
- Jack Meisinger: The field buffer that's going to the forest buffer panel – that does not include setbacks?
    - Coale: That would be a non-crop vegetated buffer.

Review of New Proposed NM Structure

- Frank introduced and reviewed a new conceptual NM structure based on previous input from the panel and discussions with individual members.
- Meisinger: You're suggesting setting aside the negative efficiency approach
    - Coale: That's right – and this is just a concept for us to discuss today. We're going to create a core group of BMPs that would have an efficiency we apply to a baseline of some sort.
    - Fisher: I can see the value, but I look at this group and there's variability associated with each of the core BMPs, and assigning one number to represent those as a group may be difficult.
- Doug Beegle: I think there is a value to doing these assessments that may not be captured in the specific practices. I would argue for a small efficiency just for going through the process of doing the assessment, because I think that farmers do a better job of managing just from going through that process, and it may be hard to capture all that he did.
    - Coale: I tend to agree with that concept. If we do decide to do this, it would have to be a pretty small efficiency value.
    - Beegle: I agree, and it might even have to be at least some kind of formalized process.
- Quirine Ketterings: Is this really 3 years for the manure analysis? For us, it's required to have them every year, so 1 year old at most with soil testing every 3 years.
    - Mark suggested revising so that manure analyses can be 1-3 years old.
- Doug made a point that a farmer could do more than one BMP within a broader category, and only get credit for that one entire category.

  - Coale: The idea is that you get credit per category, and not for each individual practice.
  - Beegle: I'm playing devil's advocate here, so I would just pick the easiest BMP out of all of them – and this might discourage some farmers from doing more beneficial practices.
- Brosch: It's often true that even though a farmer doesn't have a codified plan, they are still practicing all of the core BMPs. Is there a scenario where a farmer could get credit for the core and variable rate applications without a documented plan?
  - Coale: You're going to have to collect this data somehow, and I, as an academic, couldn't care less whether it's a plan. However a state can cover the fact that this is being done without plans, then that would be fine.
  - Brosch: I think it would go a long way for a state that doesn't have that requirement in their law, to have that option.
  - Meisinger: Wouldn't verification require checking off those core practices?
  - Coale: Absolutely, but it doesn't necessarily have to be in a state-sanctioned NM plan. It could be through a service provider, which supplies the documentation.
  - Meisinger: So maybe states could have some flexibility as to how they define a plan.
- Fisher: These hierarchical schemes make sense, but I'm wondering if we have enough empirical evidence to assign an efficiency to this large number of BMPs.
  - Coale: Some of these elements will have better data than others.
- Beegle: There's a lot of details here that give me heartburn. One that's unique to PA but is a reality is that in the core, you require P soil tests, which I totally agree with but we have an option in PA to try and get people to at least do a plan. If they don't have a soil test, we assume they're high and they have to go to a P-based manure rate, which is one of our advanced BMPs. So in place of the soil test, they adopt an advanced BMP.
  - Coale: We could include that as an asterisk – the either/or policy.
  - Dubin: We could treat it like an equivalency.

Phase 6.0 Modeling

- Frank moderated a discussion between the panel members and the CBPO modeling team representatives regarding the current and future directions for the development of the Phase 6.0 modeling tools, and their influence on the representation of NM.
- Shenk: Commented that the conceptual approach being considered by the panel included the adjustment of nutrient application rates, which is currently being represented in the SB Phase 6.0 modeling tools by recommendation and approval of the AMS and the partnership. Representing a change in rate would seem to double count for this factor, but timing could be a separate management function for consideration.
- Dubin: Noted that not all of the panel members may be aware of what "AMS" stands for and that an explanation may be helpful.
- Shenk: Agreed, and provided a brief description of the Agricultural Modeling Subcommittee (AMS) as a subgroup under the Agriculture Workgroup (AgWG) for providing modeling recommendations pertinent to agricultural land uses and functions.
- Meisinger: The fertilizer sales data are still under consideration. They aren't approved quite yet. You're right in saying that we've got a point of potential double counting, but the die is not cast for using the sales data.
  - Shenk: I think we're in agreement. It's double counting; the die is cast but there's some discussion of it being un-cast.
- Beegle: The manure rate is determined by the amount of manure that's produced, and then spread evenly?
  - Shenk: The total amount of manure in a county = total amount produced – losses for storage and handling. It's spread according to an algorithm that the AMS developed. You would spread first to the most important crops, and then it goes to the less important crops. If you

have too much, it would go on pasture. For fertilizer, there's a total amount of fertilizer available in a county, and then it's spread through a similar process relative to how much remaining crop need there is after the manure is placed.
    - Johnston: There's 3 big things in the manure and fertilizer spread. 1) There's a number for each county – total pounds of N and P. 2) You're prioritizing application to the highest commodity crops. 3) The actual rates you're trying to hit with the buckets actually do change through time.
    - Meisinger: So you're saying that the sliding NM plan, there's no baseline and so I don't know how to come up with a reduction efficiency if there's no baseline.
    - Shenk: The rate is already taken into account, so there wouldn't be a reduction efficiency for rate unless that was changed. But you could still do timing.
    - Beegle: We're saying a farmer is working out the appropriate rate on a given field, as opposed to blanket rates based on crop type. That itself may not be captured in the model, but it should be an efficiency over this generic distribution. Like a rate adjustment.
    - Johnston: Would that adjustment result in a water quality change on 2 fields combined?
    - Beegle: It would. Even though the same total amount is being spread, this is where the advanced management BMP on rate would come into play.
    - Shenk: I think we're saying that rate counts, it's just already counted in the way that the AMS has set up the inputs.
    - Johnston: I agree with Doug, and saw that as above and beyond the core practices. I think all of the enhanced practices are legitimate in that type of a model.
    - Coale: So we could modify or adjust the credit we're giving for rate through an efficiency that's tied to a measurable practice on the field level.
    - Johnston: I think so, if we stick with the way it's currently built.
    - Shenk: When we're talking about planning, and moving forward, then NM into the future would still be a reduction because we're talking about adjusting the amount of fertilizer from what we have at this moment. That would still count, and when states are developing WIPs, you would still need a reduction associated with NM into the future. But once the fertilizer sales data come in, then we have our facts on the ground for what actually happened relative to what was planned.
    - Meisinger: But our reduction efficiencies would be based on a moving baseline, and working with actually estimating reduction efficiencies using the old No BMP 1980's baseline, took the 5.3.2 panel a long time to get those worked out. If we have to do those for a moving baseline, I don't know if we could do it – it's just a lot of work.
    - Fisher: What if we used N-use efficiency? All you would need is N content, and then you'd be able to estimate the N-use efficiency. The only other thing you need besides application is the soil mineralization rate.
    - Johnston: Those mechanisms are in the current version of the model.
    - Brosch: The use efficiency is a separate concept from a NM plan, because it's completely dependent on weather. And the NM plan is setting goals that are based on reasonable expectations of good weather.
    - Fisher: But that might help the model explain differences year to year.
- Coale: There's some consternation about using fertilizer sales data at all. I know there's a lot of concern about its usability, and the scientist in me is just not comfortable with using that as the determining factor for what our application base rate is.
    - Shenk: That's something not necessarily aimed at us. The history of fertilizer sales at the CBP is always in motion, and for every model development, we've always used something other than fertilizer sales. It's something that should be taken up by the AMS. Matt and I are not making this decision, but we just need a partnership approved process.
    - Meisinger: The AMS has only approved considering fertilizer sales data, and not the use of them quite yet. One problem is that NM is field-scale, and we're trying to take county-scale

rates and adjust them down.
- Brosch: We have much more recent data suggesting that, at least in DE, the numbers are 40% off. And Gary's point about not being able to capture changing P-inputs, I think, is a factor of not having a P-based nutrient application schedule.

NM Panel Technical Assistance
- Mark and Steve discussed the increased level of technical assistance that is being made available to the panel and related supporting materials.
- Steve presented a draft of the literature review spreadsheet to the panel. The panel agreed to defer their review of the spreadsheet until the panel representatives and the AMS have resolved issues relating to fertilizer sales data and baseline conditions.

Participants:

Frank Coale	UMD
Lindsey Gordon	CRC
Mark Dubin	UMD
Quirine Ketterings	Cornell
Steve Dressing	Tetra Tech
Tom Fisher	UMCES
Doug Beegle	Penn State
Gary Shenk	USGS
Matt Johnston	UMD
Jack Meisinger	USDA
Chris Brosch	DDA

3/31/2016

Actions & Decisions:
DECISION: The panel came to unanimous consensus on following the approach to representing nutrient management laid out in the Straw Man #3, where P and N credit will each contain core BMP practices that can supplemented with BMPs that would affect the rate, timing, and placement of BMPs. The next step of the panel is to determine the efficiency values that would apply to each of the practice categories.
DECISION: The panel agreed to move forward with the four-step process outline by Frank on determining total N application (spread).
DECISION: The panel agreed to move forward with exploring how the CEAP 1 Report for the Bay Watershed calculated a fertilizer sales cap, and whether it aligns with what the panel has outlined in option 4 (of Straw Man #3) for determining total N application. Panel will discuss using a combination of nutrient management implementation and fertilizer sales data that parallels the CEAP methodology during their next meeting.

ACTION: Mark will work with Lee Norfleet from USDA to gather information on the methodology for using fertilizer sales used by CEAP and will present it to the panel during their next call.

ACTION: Panel should review the white paper that has been drafted, and provide comments and feedback in advance of the AgWG's monthly meeting on April 21st.
Review of New Proposed NM Structure
- Frank introduced and reviewed a new conceptual NM structure (Straw Man #3) based on previous input from the panel and discussions with individual members.
- Meisinger: Do you want to assign all of those P-placement tools to one of those slots? Is that the work

to be done?
    - Coale: The tools I envision as a non-limited list that we could add assessment tools to over time, as long as we those tools to drive change in implementation. The key is that what tools did I do, and what did it result in? Like, what would happen if I did a P-index assessment? Potentially nothing would change. But if the assessment changed the rate, then you could get the rate credit, etc.
- Frank asked the panel to come to consensus on the logic of organizing N and P into core practices with supplemental efficiencies on rate, placement, and timing.
- Frank discussed options for incorporating and representing N application/spread in the Phase 6 model.
    - Fisher: For manure, is the assumption that if manure is generated in a county that it's assumed to stay within a county?
        - Coale: We're not getting into that part, but it's based on records of whether it's transported across county lines. But that's beyond what we've been charged with at this point.
    - Beegle: Is there one plant available N for the whole county? How does that work?
        - Johnston: After you've counted the animals, each animal type produces a different amount of N and P in their manure. You apply some BMPs, and in the end you get a county bucket of total pounds of N and P manure. You apply some mineralization factors, take off volatilized ammonia, and you're result is a big pile of plant available N and P in each county. That's distributed to the crops based on the application goals. But just because you have an application goal doesn't mean you always meet it if there's not always enough manure in a county.
    - Beegle: You said you subtract off the ammonia and add in mineralization. Is that somehow one average for the whole county, or is there a breakdown?
        - Johnston: Everything's broken down to individual nutrient species at the animal type level.
    - Beegle: All dairy cows in the county have one assumed volatilization loss then, right?
        - Johnston: The baseline assumption is everything is the same until we get BMP data that tells us otherwise.
    - Brosch: The plant available N to P ratio for a county is locked in based on the mix of animal types, right? They're not really separate piles at the manure stage.
        - Johnston: Correct.
- Frank reviewed the steps to and 4 different options for calculating fertilizer N application goal limit per county.
    - Meisinger: Fertilizer sales separates N and P, and I see you've also done that here.
        - Johnston: True. In option 2, there are actually 2 factors that go into redistributing those fertilizer sales. One is basically option 1 – the fraction of fertilizer goal for the county. The second factor is Ag census dollars spent on fertilizer and soil amendments. And so that's a hybrid approach – option 2 is already a hybrid, where you're already considering N and P application goals, but you're also bringing in dollars spent which are not specific to N and P.
    - Coale: How are those 2 subsets balanced?
        - Johnston: They're multiplied by 50%.
    - Fisher: I'm not sure how you would translate 1 lb. N/bushel into an N-use efficiency. I'm wondering if our lb. N/bushel should be more of a rate.
        - Coale: Application rates that are below the recommended rate would be given a credit in our N supplemental credits. So we'll capture it there.
        - Johnston: It's also currently captured when you cap things at the fertilizer sales level, you don't hit 1.0 lb. N/bushel/acre on every acre of corn across the watershed.
    - Meisinger: Are lime sales included?

        - Johnston: Pounds are not included, but dollars spent includes those spent on lime.
- Coale: Option 1 sets fertilizer sales limit to be parallel to what we determine for NM application + non-NM application.
    - Beegle: But isn't that limiting you to step 3? The fertilizer N application goal in Option 1 – is that not the answer we got in step 3?
        - Coale: It is, but it'd be the ratio of that county to the whole watershed.
        - Beegle: But the limit for that county is the goal, i.e. – step 3.
    - Brosch: Is it fair to consider goal limit as fertilizer N applied?
        - Coale: Yes – they are synonymous.
    - Johnston: It's really fertilizer N supplied that WILL get applied in the model in the county.
    - Beegle: So if we use Option 1 – that's what the model would apply to that county?
        - Johnston: Correct. The AMS had looked at Phase 5, and it's built on option 1, and they found there was 30-50% more N the model thought should be going down when compared to fertilizer sales data. That's what led us into option 2.
    - Johnston: Option 3 could be rewritten as fert N application goal / dollars spent.
    - Beegle: If you have confidence in the N sales value, why don't you use that number? That plus N fixation could be N delivery.
        - Coale: It's a very noisy data pool, especially when you break it down to the county level.
    - Fisher: It would be helpful to see how big of an impact that would have based on CEAP.
    - Dubin: CEAP is using the national resource inventory points across the watershed. They're doing surveys on those points, and they do an interview with the owner/operator on the mgmt. activities that happened on the past 3 years. They look at application, timing, placement, tillage, cropping systems, everything. It's done with NASS survey personnel. They have their own database looking at the exact nutrient applications on the exact crops, etc. That survey data's used in a comparison against ERS reports, and they look at fertilizers sales. They compare the three points, and they want the NRI report to be somewhere in the middle of the fertilizer sales and the NRI report.
        - Johnston: At what level does CEAP look at fertilizer sales as a cap? In option 4, we're looking at a county level, which is pretty fine-scale. What does CEAP do?
        - Dubin: They're working on a HUC4 scale, because that's what they use for NRI and ARM, and fertilizer. They're distributing fert sales within a basin level, and using that distribution information to do the comparison to the NRI points.
        - Johnston: The AMS looked at comparing option 1 with fert sales at a basin level, and the comparison was pretty poor. And it's poor now because we don't have access to all that data.
    - Osmond: We struggle with this same issue, because we know fert sales data by county isn't indicative of much. I don't know how you think through these strategies, but sometimes we have kept strategies that other people have used, like option 4, because at least there's a basis for using that strategy there.
    - Beegle: If the NRI data fits in with this, then that would give me a lot more confidence.
    - Osmond: Could we ask Lee Norfleet to come and talk about the CEAP reports at another meeting?
    - Dubin: Most definitely. Lee said he would welcome the opportunity.
    - Coale: So CEAP has published a concept that is very similar to what we're representing in option 4?
        - Dubin: It's in the CEAP 1 Report for the Ches. Bay Watershed.
        - Johnston: The Modeling Team can definitely provide results for option 4. But because of everything we've looked at in the past, I think it'll show similar results and show us that we need to improve our estimates of LGU recommendations that are going into the model. But it may not result in much difference. So don't expect

option 4 to look much different from what's currently in there. You'll get very different answers between options 1 and 2. But option 4 says if crop need is higher than fert sales, take fert sales. But in almost all cases, crop need is higher than fert sales, so you end up using fert sales everywhere almost.

- Meisinger: Step #3: The N application goal per county. Why do we go to the whole watershed basis? It's a combination of NM with a LGU recommendation basis.
  - Coale: We're just taking the land uses and taking them to create a combined weighted average per county. It was done because all of the other decisions are about county level based.
  - Johnston: Phase 6 recommendations for every crop are based on states looking at LGU recommendations for every crop. It's just missing the NM and non-NM acres this group is suggesting the AMS tie-in.
  - Coale: After this, we need to determine NM implementation rates going back to 1985. From here forward, it's going to be incumbent upon the states to report their verified implementation rates.
  - Meisinger: But I don't see why we wouldn't use LGU recommendations as the size of the bucket.
  - Johnston: We do use those. If you were back-filling step 1, you only need to know the county crop need that's not met with manure. But if you're trying to redistribute a watershed-wide bucket of fertilizer, you need to know the fraction of need. So it's needed in some places, and not others.

NM Panel White Paper

- Mark Dubin provided an overview of the request for all AgWG panels to develop and draft a brief white paper that outlines the structure of the BMP, applicable land uses, and BMP definition in order to begin incorporating elements of the BMP into Scenario Builder and facilitate state historic reporting.
- The AgWG will be reviewing the white papers during their April 2016 meeting, and the panel will be asked to review the draft and provide edits.

Panel's Next Steps

- Panel will review and present white paper to AgWG.
- Panel will begin considering efficiency values.

Participants:

Frank Coale	UMD
Lindsey Gordon	CRC
Mark Dubin	UMD
Quirine Ketterings	Cornell
Steve Dressing	Tetra Tech
Tom Fisher	UMCES
Doug Beegle	Penn State
Matt Johnston	UMD
Jack Meisinger	USDA
Chris Brosch	DDA
Deanna Osmond	NC State University

4/14/2016

Actions & Decisions:

DECISION: Panel came to consensus on moving forward with the methodology laid out in Option 4 of Straw Man #3, where fertilizer sales data will be used as a cap to the calculated nutrient loads.

ACTION: The panel is asked to review the drafted version of their preliminary report that will be presented to the Agriculture Workgroup during their April face-to-face meeting on Thursday, 4/21. Please provide fatal flaw comments back to Mark Dubin and Lindsey Gordon by no later than COB Tuesday April 19th.

DECISION: The NMP agreed to set a 1985 baseline in their recommendations, to be included in their preliminary report.

ACTION: Mark and Lindsey will incorporate panel's suggested edits to the preliminary report, and redistribute for final review before it is presented to the Agriculture Workgroup during their April meeting.

ACTION: Frank will correspond with panel members in the coming weeks to begin assigning leads on developing efficiency values for the NM BMPs. Panel members should consider their expertise in helping to determine these efficiencies.

Discussion of CEAP nutrient spread methodology

- Frank provided a brief overview of the Straw Man #3 proposal that the NMP is considering to use for their BMP representation.
- Lee Norfleet, USDA, discussed the methodology used by the USDA NRCS CEAP reports to calculate and represent nutrient spread. This facilitated discussion between the Agricultural Modeling Subcommittee (AMS) and the panel on representing nutrient spread in the Phase 6 model. Potential approaches will be presented to the Agriculture Workgroup during their April face-to-face meeting, with a follow-up presentation during the May meeting.
- Lee discussed overall methodology for gathering data and conducting CEAP reports. Results are reported at the HUC4 level.
- Coale: Your comment about fertilizer sales data – you use that as a maximum value?
    - Norfleet: Right. And we know we shouldn't go above that amount because some of that fertilizer is going on other land uses besides cultivated crop land.
- Dubin: You just released a report for Lake Eerie, which uses a more advanced process. Did that report include pasture and hayland as well?
    - Norfleet: It doesn't. The California Bay Delta survey tried to use that method, but we've run into a few issues with defining pasture land.
- Norfleet: We use a process model to generate our yields and effects.
- Johnston: It sounds like you look at the survey results for estimated rates of application of N and P, and then you extrapolate that out to all the acres of cultivated crop land in a HUC4, and then you compare that number of N lbs. going down on cultivated crop land to total fertilizer sales for farm use in that watershed. So most of the time, you're under that value because you aren't capturing pasture and hay in that equation.
    - Norfleet: Right. And I should reinforce that it's a rough check and we just use it to ensure that we're below the sales number. And we expand our results – one survey result gets expanded to represent 5,000 acres.
- Dubin: Will you be looking at this for the CEAP III, including the surveys for pasture and permanent hay land? If they're included in your values, how close do you think you would come to the fertilizer sales data set?
    - Norfleet: I'm not sure at this moment.

- Johnston: I've looked at it, and you do come very close to the fertilizer sales data when you sum up everything. But what years are represented in this chart? IE – what dates of fertilizer sales should I compare this to?
    - Norfleet: The table may have both survey periods, but the 2011 survey goes back 3 years. So an average for 2009-2011. For the CEAP 1 survey, you would compare it against the average for 2001-2006.
- Meisinger: The table roughly lists that if the cultivated cropland = 1, then the sum of pasture and hayland also = 1. So, roughly, the tonnage of fertilizer is getting split almost evenly between cropland, and hayland/pasture.
- Dubin: In order to use fertilizer sales reported at a county scale, you have to break those out where counties split between watersheds. What's the process you use to create a fertilizer sales value for a watershed like the Potomac?
    - Norfleet: We don't go with the county level at all. We have some estimates from the 90's, and others from the surveys. But all of our work is at the watershed scale. We do the same thing with our yields, and uptake is derived from those yields.
- Johnston: A quick look at fertilizer sales data across the watershed that we have, shows that we are <1% off from what's reported in the CEAP table.
    - Norfleet: But that's the gross amount, and each acre will behave differently with yield and loss potentials.
- Beegle: Question on the size of the areas this is applied to – it's at a HUC4, which is an entire watershed. So it's distributed uniformly, regardless of where it is in the watershed?
    - Norfleet: That's the scale that we report at, but we model at the in-stream at the HUC8.
- Osmond: When you look at N losses, you used the word runoff. Are those runoff and leaching, or just runoff?
    - Norfleet: I have run-off potential, and then the runoff treatment level. The total that you see is the two combined.
- Norfleet: I've learned most that you have to take into account the differences in the soils and the crops being produced. At some point, the marriage between our soils layer and the NASS crop data layer will improve your estimates greatly, because it'll shift a lot.
- Meisinger: Knowing the Bay model has no soils data, how would we capture that? Right now, the panel is capturing it through the LGU recommendations. What are your thoughts on that approach?
    - Norfleet: At some level, you need to account for different soil types, so if you use LGU recommendations, they're often parsed by soil type.
- Johnston: Soils are not explicitly in any of the calculations, but the LGU recommendations are yield-based, and we use NASS yearly yields for the major crops, which differ dramatically across the watershed. Any comments on that as a proxy?
    - Norfleet: You have the crop yield, but you don't have how those different soils may have different loss characteristics.
    - Johnston: Inputs are based on yields, and we have a soil characteristic parameter when calculating runoff, and that comes from SPARROW analysis from USGS.
- Dubin: Other than starting to incorporate NRI survey data, is there anything else that you foresee you wanting to do differently if you could start from scratch?
    - Norfleet: If we started over, we would address complexities at the field scale, and tailor our management to that scale.

Panel Discussion of nutrient spread

- The Nutrient Management Panel discussed and deliberated on an approach to represent nutrient spread in the Phase 6 modeling tools.
- Coale: So CEAP uses the NRI survey data to determine their rate, and they check it against fertilizer sales data for the region just to make sure their calculated application rate doesn't exceed the fertilizer

sales data. That's very similar to what we proposed in option 4 of Straw Man #3, where we use our NM versus our non-NM acres and the assumed application rate for each land use, add those total rates up for NM and non-NM acres, and if that's less than the fertilizer sales total for that county, then we move forward. If it was more, then we would use the fertilizer sales as a cap for that county.
    - Panel agreed with Frank's thoughts on CEAP methodology versus proposed panel methodology.
- Frank noted that this decision will be presented to the Agriculture Workgroup during their monthly meeting on April 21st. The panel next needs to consider determining efficiency values for Nitrogen and Phosphorous practices.

Request to review NMP Preliminary Report
- Mark reviewed the drafted preliminary report that will be presented to the Agriculture Workgroup during their monthly meeting on Thursday, April 21st.
- Meisinger: When we start to do reduction efficiencies, it's important we have a baseline stated. Without that, we can't get efficiencies or reductions. So we need to state that we're using a 1985 baseline somewhere in the report, if the panel is agreeable to that proposal.
- Fisher: Is the assumption here that the 1985 data represents what would happen now if there were no conservation practices?
    - Dubin: Pre-1985 is considered as a no-BMP scenario, so that's our baseline. Anything that happens after that is considered as an addition to implementation and reductions.
    - Fisher: But most farmers would argue that their fertilizer rates and yields have increased in the last few years.
    - Coale: That's built into why we have a baseline that's so far back in time. We want to assume that's when things were at their minimum as far as BMP implementation is concerned.
    - Fisher: In the model, if you had farmland with no conservation practices, then it would look like 1985 N losses, is that correct?
    - Dubin: Yes – there's pre-BMP implementation, and we would represent that with 1985 county level production numbers for cropping systems as well. We start off using the 1982 Ag census as our starting point, and that would move forward and yields would increase through time.
    - Ketterings: Does that include 1985 fertilizer use with the same approach?
    - Dubin: I believe so.
    - Meisinger: That's the baseline that other panels use too.
    - Fisher: So if you had a no-BMP scenario today, would the losses and nutrient inputs scale up based on the recommendations and data from today?
    - Dubin: Yes, essentially.
- Brosch: The implementation between 1985-2015 – what is the source? And is this referring to specifically the baseline, or all the elements in our proposal, including our supplemental menu?
    - Dubin: What we're looking to do here is provide some guidance, and we would recommend the WTWG to have some more discussions about that with the Modeling Team. I got a similar question for one of the other panels.
    - Brosch: So we'll determine the implementation rates in an on-going process, then?
    - Dubin: Yes. And I think we're suggesting that we'll have a default where a state partner doesn't have historical information.
    - Brosch: I'd be concerned with using the NEIEN information as the true implementation for baseline nutrient management in 2015, at least in DE. I think this paragraph needs to reflect the difference between implementation and verified implementation as well. How do you intend to work in verification, as in – we're not worried about it, or the number representing implementation should account for verification acres?
    - Dubin: We'll have to work on that, perhaps making reference back to the Task Force report.

- Meisinger: Isn't there a verification panel?
    - Dubin: The panel has been sunsetted, but we do have the BMP verification guidance, but isn't required for full implementation across all BMPs until 2018.
    - Meisinger: We could draft our verification statements, and potentially run that by someone else to make sure we've captured what we think we have.
    - Dubin: Well I would suggest the AgWG.
- Fisher: If you have a high verification rate, does that mean you'd reduce the efficiency by a certain percentage?
    - Dubin: It would translate in a reduction of acres reported for implementation.
- Beegle: Should something related to state flexibility with soil tests be included in this report?

Panel's Next Steps

- Meisinger: Will these efficiencies be for each different land use?
    - Coale: For N, we should be able to lean heavily on the existing 5.3.2 dataset, but P will present some new challenges.

Participants:

Lindsey Gordon	CRC
Mark Dubin	UMD
Frank Coale	UMD
Matt Johnston	UMD
Deanna Osmond	North Carolina State University
Doug Beegle	Penn State
Jack Meisinger	USDA
Steve Dressing	Tetra Tech
Chris Brosch	DDA
Tom Fisher	UMCES
Ken Staver	UMD
Quirine Ketterings	Cornell
Alisha Mulkey	MDA
Lee Norfleet	USDA

5/6/2016

Actions & Decisions:

ACTION: The panel agreed to have Jack follow-up with Dr. Lee Norfleet in order to get data of percent BMP implementation for nutrient management at the HUC4 level.

ACTION: Deanna will review the Smith 1999 paper in order to pull out additional information on Phosphorous for 1995.

ACTION: Matt Johnston will work on breaking out the proposed NM acres to % acres implemented at the HUC4 scale, with additional data broken out by manured versus fertilized acres. This will be used to compare against the HUC4 data to be provided by Dr. Lee Norfleet from the CEAP report.

DECISION: Matt Johnston will use the drafted implementation acres based on 2015 NEIEN data in a test run of the model to compare different nutrient management approaches, and will present this to the AgWG during their May meeting.

ACTION: Jack and Deanna will take the lead on developing efficiency recommendations for Nitrogen across all land uses. Quirine, Frank, and Doug will work on developing efficiency recommendations for Phosphorous across all land uses.

ACTION: By mid-day Tuesday May 10, the panel will provide Matt with better estimates of efficiency values for the 13 land uses to be used in preliminary model runs.

Recap of AgWG Discussion

- Frank gave the panel an overview of the presentation and update that was given to the AgWG during their April 21st meeting.
- There was feedback from the AgWG that the proposed representation would be difficult to implement from the state agency's perspective.
- The AgWG charged the panel to continue developing their scheme for representing the BMP, and to present it back to the AgWG during their May meeting.
- Jack Meisinger asked if the proposed structure of the BMP could be revised, or it if was set in stone. Frank cautioned against making any major changes before it's presented back to the AgWG.

Historical BMP Implementation Schemes

- Jack presented an approach for estimating implementation of nutrient management practices over time. The focus of this proposal will be using rate data to track implementation.
- Fisher: What about type?
    - Meisinger: It's basically either fertilizer or manure, and that's assumed here.
    - Fisher: I was thinking urea vs. ammonium nitrate vs. manure vs. sludge… there's a lot of options out there.
    - Meisinger: Good points. We've never dealt with sludge; I think that's being covered under another ad hoc group right now. We're not going to separate urea and ammonium nitrate because data is so limited.
- Ketterings: So this crop removal from the CEAP report is what we're considering using in our recommendations?
    - Coale: Not quantitatively, but this basis is what we could use to determine an appropriate rate to use for crediting nutrient management.
    - Deanna Osmond agreed that these values generally agree with what the NRCS values are.
- Ketterings: Our P fertilizer use is very small up in NY, so I'm not sure how to interpret these numbers you've pulled out. We have a sizeable acreage that receives manure across the board. For fields that do receive fertilizer, where the application rates are way below 1.2, the value here should probably be higher. For acres receiving manure, I would think that it would have to be a higher % than 32.
    - Coale: For the manured acres – the 32% and 35% is probably a little bit low?
    - Ketterings: I would think our acres that receive manure - a larger % of those acres falls under the 1.2
    - Johnston: From other data (industry reports, USGS, USDA) are showing plummeting use of P in organic fertilizer across our region since 1985. Some suggest that N is pretty steady, but P is cut almost in half.
- Jack asked the panel if they would like to use % implementation values to be provided by Lee Norfleet at the

HUC4 level.
    - Johnston: The Bay Program has asked for this information at a finer scale before, but the CEAP statistical analysis is only confident at the HUC4 scale.
- Dubin: I think having this information would be great to reference later on when developing their final report.
- Coale: For our purposes here of doing some historical back-casting, I think this information would be very helpful.
- Jack asked if Deanna would be willing to review the Smith 1999 report for her to review the Phosphorous material and information that is contained.
- Mark presented on an alternative approach to estimating historical BMP implementation.
- Coale: How would we take this analysis and compare it to the CEAP analysis? Could you regenerate this in % of acres by state?
    - Johnston: Wouldn't be difficult to do the conversion to %. And we did the comparison for 2015 progress, and what you'll see is that in MD and DE, we're higher than the CEAP values, but the opposite is true for WVa and PA. So it just varies.
- Meisinger: Are these acres that have a plan? Or are they acres that have an implemented plan that meets some criteria?
    - Dubin: These are self-reported, implemented acres.
    - Meisinger: CEAP data are NRI summaries, which is also self-reported, but has a different level of scrutiny.
- Meisinger: Do you think you could parse this out into HUC4s at some level of reasonableness?
    - Johnston: I think so – we would just have to break up VA and MD. And I also wanted to say that since this is a BMP in a management model, it'll always be up to the states to track and report this data, and this information is what we expect states to report in the future. CEAP gives us a good idea of what farmers are doing regardless of regulation, but the states have to report actual tracked data. 2016 and 2017 progress, and future implementation data, will not be assumed, and will look like the end of these dotted lines. So it behooves us to use something akin to those dotted lines in our calibration.
- Coale: So if we can get that HUC4 data from Lee Norfleet, and if Matt can get this analysis done at the HUC4 level, then we would have 2 datasets to compare and we could develop a solid recommendation moving forward.
- Johnston: That's a good idea, but the CBP was asked to provide side-by-side model results by May 19th, and I would like to get this in front of the AMS and this panel before then. So the second we can agree to testing acres, then we can press go and get the results distributed.
- Meisinger: We saw manured acres behave different than fertilized acres, so is it possible to break that out of the % HUC4 data?
    - Johnston: So we said the data coming in for 2015 progress was coming in on crop, hay, and pasture, but we've broken it out into lines for each land use. So yes it would be possible to break out that information as well.
- Coale: So I'm thinking that what Matt's presented could be used to demonstrate to the AgWG, and we would need to follow-up with the panel to look at the NRI points and do an independent verification of whether it makes sense. So I'd like to ask the group if they're comfortable with moving forward with this approach laid out by Matt solely to do a test run of the model that can be presented to the AgWG.
    - Meisinger: We also have to remember this is all for N at this stage; we can't forget about P.
    - Fisher: I'm wondering if we're not going to cause the model problems, because the real world isn't a straight line. If they're trying to match model predictions to empirical measurements, I'm wondering if it wouldn't be better to report the actual vetted values with the variations in them.
        - Johnston: Great point there – and I actually expect that WVa and VA will submit to the Bay Program something that looks like their solid lines. This is just a proof of concept. I suspect PA and DE will have to go back to the drawing board. But in the end it's up to the states to define what the acres are, and all we can give them is justification and aid in doing so.
    - Meisinger: One word of caution – as I looked at some of these surveys, it became apparent that there's a big farm size difference in BMP implementation, with larger farms having more implemented BMPs than smaller farms, so we have to be careful with both the NRI and the reported data if they're weighted towards CAFOs and large operations.

Nutrient Management BMP Efficiency Approximations

- Frank reviewed the efficiency matrix that he distributed to panel members, and asked panel members to volunteer taking the lead on developing first draft efficiency values.
    - Jack offered to take on some of the N efficiency estimates. He noted that the pasture and other hay land uses may be the most problematic. Non-NM acres could be fertilized less than the NM acres in those instances.
        - Deanna Osmond offered to help Jack with this effort.
    - Johnston: MD told the modelers to make their crop application rate for pasture to equal 15 lbs. assuming NM, so in this case we would use that 15 lbs. in MD and multiply it by 1.2 for every acre of pasture not reported NM. That's how I read the chart.
    - Coale: So the reported goal that the states set can be modified to be different from LGU recommendations.
    - Johnston: And the states have already done that.
    - Meisinger: So we need to know what those are, because some states will use 80-100 lbs. on pasture, and other states will be 15.
- Johnston: So we looked through all the LGU recommendations, gave it to the states, and asked them for their best estimate. A lot of work has gone into base application goal in the model, and I would suggest we multiply those goals by 1.2 for N.
- Coale: So we're going to move forward with assuming our basis is the LGU recommendation, and we'll figure out the relative deviations between NM and non-NM.
- Meisinger: Matt, it would be helpful if you could send it out by land uses – what the LGU recommendation is, and what you're using now as far as an adjusted application rate.
    - Johnston: We don't have that by land uses because the model works by crops.
    - Meisinger: But you convert your crops to land uses somewhere along the line?
- Coale: So Matt, how does the way we're perceiving everything across the land uses get integrated?
    - Johnston: Applications of manure/fertilizer are done on individual crop goals, and at the end of the process those crops are aggregated up to land uses.
- Quirine Ketterings, Frank Coale, and Doug Beegle will work on drafting Phosphorous efficiencies.
- Johnston: So we owe the results of this preliminary run by the 18th, so I would ask the group – since it's a proof of concept, can I use 1.2 for N and 1.5 for P with a huge caveat that this is a proof of concept and more work is being done?
    - Meisinger: I would say no.
    - Coale: I agree with Jack's hesitation. If we want to give you a really quick dirty update of this table, when do you need it?
    - Johnston: Honestly, ASAP. Because the nutrient spread is the biggest decision being made on May 19th, and I'd like to get the results in front of this group, the AMS, and the AgWG long before May 19. We're good to go with the acres, and we were going to assume 1.2 and 1.4 for non-NM acres, but otherwise – ASAP. Today would be preferable.

Closing Thoughts

- Meisinger: The way we've set up this BMP, we'll be using fertilizer sales or LGU recommendations, depending which one gives the lower value. I would propose that we consider using those two, not as one or the other, but to compare with each other with the goal of saying that they should compare within 20% of each other or something. And in the end, the fertilizer sales data only be used during that comparison, and only use the LGU value if we can figure out which value gives the proper estimate. So if the 2 agree – use the LGU value. If they don't agree, then convene and figure out which value is questionable.
- Johnston cautioned against this because the AMS had a specific charge from the AgWG to develop these data, and making significant changes to the BMP approach does not provide enough time to get everything done.

Participants:

Deanna Osmond	NC State University

Lindsey Gordon	CRC
Frank Coale	UMD
Tom Fisher	UMCES
Matt Johnston	UMD
Jack Meisinger	USDA
Mark Dubin	UMD
Steve Dressing	Tetra Tech
Quirine Ketterings	Cornell

6/28/2016

- Frank Coale reviewed the work of the panel thus far, as well as the proposed structure and efficiencies to represent nutrient management.
- Tom Fisher: Is the extra 20% on the efficiency for non-NM plans based on any empirical evidence, or just the idea that if you aren't doing NM then you probably don't follow the LGU recommendations very well?
    - Coale: Some states have a historical precedent before NM was utilized. A lot is also based on best professional judgement of how far above NM application rates a common application rate would be if someone's not adhering to a plan.
    - Fisher: So there's no real empirical evidence for that. Regardless, the number seems reasonable to me.
    - Coale: In most cases, there isn't empirical evidence.
- Question on the timing of when supplemental practices have to be implemented relative to core practices in order to receive credit.
    - Dubin: This is an annual BMP, so if a farmer is implementing the core practices, and adds a supplemental practice on top then they will be receiving credit for that.
- Frank noted that the panel needs to evaluate the accuracy of the efficiency values for the nutrient management elements for each of the 13 land uses.
- Question on the difference between edge of field and edge of stream.
    - Fisher: In the real world, the same field may have one or more of these crops on it, and when you get actual delivery to a stream, it will probably reflect the last 5-10 years of cropping practices. I'm just trying to think about how this seems almost overly detailed if you're trying to match what's delivered to a stream in the real world.
- Panel agreed to move forward with finalizing the matrix of BMP efficiencies for each of the 13 land uses.
- Frank Coale reviewed the drafted excel spreadsheet of crop application rates, and noted that these numbers will be used in lieu of LGU recommendations in the NM BMP flowchart.
    - Panel discussed efficiency and application rate values for pasture and hay.
    - The panel agreed that pasture and other hay will not be eligible for nutrient management and will receive an efficiency value of 1.00.
- Panel needs to find literature citations supporting the proposed efficiency values.
- Steve Dressing and Mark Dubin reviewed the current work on the literature review and citation spreadsheets.
    - Mark noted that the panel and partnership is open to published and non-published, grey literature sources, and if any panel member would like to include a literature source but does not have access to the source, they should get in touch with either Mark or Frank.
- Frank asked for volunteers to take small portions of the BMP efficiency table and review the values based on available data and literature:
    - Tom Fisher will look into soybeans.
    - Frank will review specialty crops high and low, other agronomic crops, and hay and pasture for N and P.
    - Jack will review his work on the Phase 5.3.2 panel, and will work with Deanna and Tom on reviewing N values for full season soybeans, grains with and without manure, legume hay, silage with and without manure, small grains and grains, and small grains and soybeans.
    - Doug, Frank and Quirine will work on reviewing the P values for full season soybeans, grains with and without manure, legume hay, silage with and without manure, small grains and grains, and small grains and soybeans.

- Panel members should have completed their work by July 14.

- Mark reviewed the timeline for the panel completing their work. The panel should plan to release their draft report for partnership comments in late July. The AgWG will begin reviewing during August, and the report will go to the AgWG, WTWG, and WQGIT for final approval in September.

Participants:

Lindsey Gordon	CRC
Mark Dubin	UMD
Gary Shenk	USGS
Chris Brosch	DDA
Deanna Osmond	North Carolina State University
Frank Coale	UMD
Doug Beegle	Penn State University
Jack Meisinger	USDA
Steve Dressing	Tetra Tech
Tom Fisher	UMCES

7/19/2016

Actions and Decisions:

DECISION: The panel agreed to move forward with recommending the approaches to nutrient management laid out in the motion put forth by Jack Meisinger ('First draft motion for Nutrient Management Panel.docx'.

ACTION: Frank Coale will revise the PowerPoint presentation with the panel's guiding principles based on feedback from the panel members in advance of the July AgWG meeting.

LGU recommendations versus fertilizer sales approach for setting application goal: N and P.

- Jack presented a first draft motion for the panel to consider specific recommendations on representing nutrient spread and using fertilizer sales data in the Phase 6 model. These recommendations include using the State Partners Fertilizer Application Rate Table as a check against the AAPFCO Fertilizer Sales data for Nitrogen, and using the State Partner Fertilizer Application Rate Table to distribute the AAPFCO Fertilizer Sales data for P applications.
  - Mark Dubin explained the Phase 6 Model Beta 3a and 3b approaches to nutrient spread, as well as a proposed hybrid approach that uses the fertilizer sales data in combination with the LGU recommendations/agronomic need as a weighting factor to distribute the fertilizer back down to the counties.
  - Jack noted that the description in 3a (of the first draft motion document) is a straight use of the LGU recommendations as an approach, and only using fertilizer sales as a check-point; in line with the CEAP methodology. This methodology is not identical to the hybrid approach laid out by Mark. Jack also noted concern with using fertilizer sales data because it is not as effective a selling-point for farmers as LGU recommendations.
- Tom Fisher: Is PSNT represented in this methodology?
  - Dubin: The PSNT is a more advanced tool that we would use to re-adjust the application. This is included as a separate crediting function within the current recommendations of the panel.
- Coale: So what Jack is proposing is the final application of fertilizer is determined the LGU recommendations of what each crop was determined to need.
  - Meisinger: Yes. And it turns out that the difference between the Phase 6 Beta 3a and 3b is about 100,000,000 pounds of N, which to me, is very small and suggests there is no difference between those two approaches. One big factor is the number of acres of pasture in the watershed, which is our biggest and most uncertain land use. If that number is incorrect, it can have a significant impact. The other biggest land use is other hay, so if that's combined with pasture, they account for 5.5 million acres out of the 12 million total acres. A small difference in their estimation can have huge impacts in applications. So I don't trust the fertilizer sales data before 2007, and my approach would use AAPFCO Fertilizer Sales data only after 2007.

  - Tom Fisher: I think it more closely represents the actual practices in the DelMarVa.
  - Meisinger: Actually, since pasture and other hay aren't prominent in the DelMarVa, there isn't as much a difference in the Phase 6 Beta 3a and 3b approaches.
- Question from Tom Fisher is the fertilizer sales data includes fertilizer used in winter de-icing.
  - Mark Dubin replied that the AAPFCO data separates out urban and agricultural fertilizer sales, and that this piece of the model will only look at agricultural fertilizer sales data.
- Deanna Osmond: I agree with Jack – the fertilizer sales data is always tricky, especially with the pasture land uses. I support Jack's comment.
- Tom Fisher: Which is the larger of the two estimates for P when you compare them?
  - Meisinger: I think the LGU approach was about 200-300% higher than fertilizer sales.
  - Dubin: The discrepancy varies by state, but yes there is a large difference. A lot of factors are influencing this variation
- Meisinger: So we would basically use fertilizer sales in two different ways for N and P, and the panel has already separated N and P months ago, so I don't see any problems with that.
- Dubin: And I would like to remind everyone that whichever decision comes down from the partnership, this is a main structural element of the modeling tools and so it will be in place until we get another model tool. There won't be an opportunity to change it until we get to the next phase of the model.
- Frank Coale: Given the panel agrees on items 1 and 2, I would summarize item 3 that we think application rates for N and P should follow the same decision making procedures that states use to determine nutrient application rates. For P, this involves knowledge of soil-test P levels, and until the Bay Program collects and utilizes soil test P data, then a surrogate for that would be using fertilizer sales data as a proxy for P-distribution until soil-P data can be included in the modeling tools.
  - Meisinger: Correct. We would prefer a unified approach, but it's not required for N and P and there's a good reason that we can't reach that point right now.
- Dubin: Jack, did you want to make sure that N-residuals from legumes, etc., are included in the fertilizer sales information, as part of 3a?
  - Meisinger: When you say N-residuals from legumes, they are already included in the LGU recommendations in the core element. So they're already wrapped in.
  - Dubin: Right. I just want to make sure they're recognized in the N-applications.
  - Meisinger: Yeah – and Mark is referring to corn acreage right now. When you look at our core requirements, legume credits are included in them, because they've always been included in LGU recommendations. So the actual amount of N applied to corn following soybeans would be less than the standard 1 lb. /bushel. So those legume credits are already in the core element for NM, and they don't need to be in the AMS, because that would be double-counting.
- Tom Fisher: Is there an adjustment for cover crops in those recommendations?
  - Meisinger: This is where the LGU recommendations really help, because if they credit cover crops, then it's folded into the NM.
- Tom Fisher asked if there needed to be a check in place for P, similar to the sales data as a check for N.
  - Frank responded that there was nothing really to check the P-data against.
- Dubin: One thing we saw with the comparison between the Phase 6 Beta 3a and 3b runs was there with N, there is a fairly good relationship between the two over time. There was a separation with pounds of fertilizer for the states, but the relationship was steady. So maybe that's the check – the relationship.
- Jack noted a preference for the LGU recommendations being based upon the field scale, as opposed to the fertilizer sales data, which is at the county scale, citing the fact that NM occurs at the field scale in the real world.
- Jack and Frank noted that the panel can consider whether to allow for crediting of supplemental nutrient management practices above the 1-practice per category (rate, placement, timing).
  - Tom Fisher: In our experimental watersheds, we've been encouraging farmers to use PSNT and FSNT soil tests. So I would think it's a great idea to credit both of those.
  - Coale: Our original premise was that any type of those tests/assessments have to demonstrate a change in rate/timing/placement as a result of doing that assessment. So I'm thinking we should phrase this as if you do PSNT and changed your rate, you should get that credit, and if you do a separate practice and make an additional change in rate, you can get that credit again. As long as it's not trying to take multiple credits

for the same change in implementation.
  - Meisinger: That makes sense, but I'm not sure how the reporting would work with that.
  - Dubin: We're going to ask the states to track these elements anyway, but I think it will definitely add to the reporting through NEIEN, because we're tracking multiple potential changes on different acres, etc., so that would make it more difficult, yes. But we also need to consider that this is an annual practice, and these changes may occur through different years.
  - Meisinger: Maybe this time we can stick with 1 practice, and then future panels can consider expanding the crediting to 2 or more supplemental practices if they feel it's necessary.
  - Steve Dressing: I wonder if you'd need to account for additive practices by using a discounted efficiency when these practices are combined.
  - Panel agreed to remain with crediting 1 practice per supplemental category, and will describe their thoughts on the potentiality of crediting multiple supplemental practices in the Future Research Needs section of their final report.

CBP modeler survey of NM questions

- Frank and Matt reviewed the survey of NM questions that was developed by Matt Johnston in order for the CBP Modeling Team to develop multipliers for every acre that is not under nutrient management.
- Coale: We developed the efficiency factor table for the core and supplemental BMPs for N and P. Those numbers range a lot. How will this information be used together with the information we're presenting in our final report, with those efficiency values?
  - Johnston: The supplemental stuff can be set aside because that's an efficiency. We're looking at written plans of NM on acres. The states will tell us their acres of written plans. Using the multiplier table, every acre with a written plan receives an LGU rate, and every acre without a plan receives something above that. But we don't have P-values for acres with plans. This data would supersede the values from the efficiency table, but also gets at the question of whether the plan equals an LGU recommended rate for P. Right now, the answer to that is no.
  - Meisinger: I am going to boycott this poll, primarily because the panel is not charged with doing the implementation, and these are implementation questions. We do reduction efficiencies, and we suggest possible implementation approaches only.
  - Johnston: And the group can certainly go that way, and recommend the previously developed efficiency table. But we still are going to be receiving acres under plans from states, and we only have values for N, and not P.
  - Coale: I would guess that most acres from states come close to satisfying the core requirements for N, and a majority probably don't come close to satisfying the P core requirements.
- Jack Meisinger made a comment about the need to include P-based management in the model.
  - Johnston: The code is in the model, and I was talking to MD about getting the acres that we need to use in that part of the model. MD said they can give it their best effort, but they don't have the information available to say the # of acres in each county where manure was applied to meet P. MD probably knows the most about what their farmers are doing, so if MD can't get it, we probably can't get it elsewhere. If we do eventually get that data, we can absolutely run P-based management in the model.
  - Meisinger suggested doing a test to make sure the code works.
  - In order to include P-based management, Frank suggested picking the 0-point for state data in time, and take the most recent data from the states for P-based management, which at this time would be 0.
- Tom Fisher: I work with 40 farmers in DelMarVa, and my impression is that they treat their soils as having a P bank account. They monitor how much P is there, and every once in a while add some manure or something, and the account fluctuates but they're constantly tracking it. Unlike N, P stays in place, so they can monitor what's going on and make sure they keep it in a specific range. So that's the kind of P-management I see being done in the field in our group of farmers.
  - Coale: I agree with your observations and Jack's point, and I think the panel needs to recommend that soil P levels is ultimately included in the model somehow. It should be collected, and utilized eventually, since it's the baseline determining factor for P management. So we should make that point very clear in our report as a future research need.

Review of AgWG presentation

- Frank reviewed the NMP's guiding principles that will be included in their final recommendations.
- Mark suggested including a qualifier on the efficiency table noting that they are still draft, and are subject to change based on feedback from the partnership and the determinations of the panel.

Discussion of Panel Timeline for Completing Recommendations

- Mark Dubin: Our timeline for having a fully partnership approved panel recommendation set is September 30. If you work back from that, then we will need a 30-day review period of the report and time built in for the approval process by the CBP workgroups and GITs. So we have been working on developing a draft report in order to begin a 30-day review process beginning in August. Steve, Frank, and I have been working on building out this draft report, and we anticipate getting a draft report in the hands of the panel very soon.
- Coale: Exactly. We'll be sending this draft report to panel members, and will be asking for a very quick turn-around. Given this tight turn-around, if you are only able to review the sub-topics that are particularly relevant to you, that's great. We'll have time to do more polishing and tweaking during the comment received and response period that will occur after/during the partnership review. The goal is to have a draft version to the panel within the next 10-14 days.
- Panel agreed that the proposed timeline for completing the panel's work is agreeable.

Participants:

Lindsey Gordon	CRC
Frank Coale	UMD
Matt Johnston	UMD
Mark Dubin	UMD
Deanna Osmond	NC State
Steve Dressing	Tetra Tech
Chris Brosch	DDA
Jack Meisinger	USDA ARS
Tom Fisher	UMCES

Appendix E: Consolidated Response to Comments on: Definitions and Recommended Nutrient Reduction Efficiencies of Nutrient Management for Use in Phase 6.0 of the Chesapeake Bay Program Watershed Model (August 1, 2016 Version)

Commenter identification is highlighted in **bold underline**. Specific comments/questions are highlighted in ***bold italics***. Relevant text from the draft report (8/1/16) is contained within quotation marks. Responses are in *italics*.

Section 2: Practice Definitions

West Virginia

"It is essential that an initial baseline for NM implementation is established that allows estimation of progress over time." ***What year will be used for this baseline?***

Response: *The Phase 6.0 Nutrient Management Expert Panel (the Panel) recommendations are established on a baseline of 1985 to mirror the Chesapeake Bay Program partnership's modeling tools baseline for BMP implementation and model calibration. The individual partner jurisdictions are separately responsible for reporting their historical BMP implementation to the Chesapeake Bay Program Office through the National Environmental Information Exchange Network (NEIEN) for the Phase 6 model calibration period (1985-2013) based on the CBP partnership-approved BMP structure and definitions. However, the Panel report includes an alternative method, co-developed with the CBP Modeling Team, which provides a simplistic state-by-state template for representing historic BMP implementation based on the 1985 no-BMP baseline and a 2015 progress implementation level.*

"Spreader/applicator calibration: The equipment being used to perform the nutrient applications by the farm operator needs to be documented and verified that the machine(s) have been calibrated either according to manufacturer specifications or by standard calibration practices within one year of the application." ***Need flexibility on this point in both verification methodology and length of time between calibration. Would recommend removing "within one year of the application" language.***

Response: *The Panel's description of "spreader/applicator calibration" has been modified in the report to insert "preferably within one year of the application." Operator documentation of previous spreader/applicator calibrations can and should be utilized as part of verification, thus not requiring the verifier to personally conduct or oversee the equipment calibration within one year of the application.*

"Verified documentation of manure mineralization N credits are included as part of the nutrient balance to account for at least the three prior years." ***This seems like overkill and while it may not be so much of an issue with small farms, it would be a sizeable issue for large farms. It would be very time consuming for plan writers to sit down with farmers to retrieve all the data needed for this exercise.***

Response: *The Panel recognized that organic N sources mineralize over multiple years and convert to a form available for plant uptake. A three-year record of soil organic N mineralization is standard LGU practice in determining plant N availability. The documentation and verification of manure mineralization N credits to develop a nutrient balance was not developed by the Panel but is instead based on the CBP partnership-approved BMP Verification Guidance, which relies on soil analysis and farm management records reviewed by an independent trained and/or certified party. The CBP partnership-approved "BMP Protocol" requires all BMP Panel recommendation reports to incorporate the "BMP Verification Guidance" into the Panel's recommendations. Farm management records can be complex GPS application maps, electronic datasets, or as simple as hand-written notes compiled by the operator during the mineralization period.*

"Rather, independent documentation and verification that all of the required elements of the N Core NM BMP were implemented is required." ***We were surprised that the Panel did not require plans to be written by a certified plan writer. This represents significant flexibility while other portions of the document did not.***

Response: *The Panel recommendations describe the management elements required to meet the Core N and P BMPs, which when coupled with the CBP partnership-approved BMP Verification Guidance, would require written and/or electronic documentation to sufficiently enable a trained and/or certified independent third-party to record, track, and verify the BMP(s). The required nutrient management documentation could be in the form of a formal federal-, state-, or county-reviewed and certified nutrient management program plan, a non-certified formal nutrient management plan developed by a federal- or state-certified plan writer, or detailed documentation and an informal management plan compiled by an operator or private consultant that met the Panel's BMP recommendations.*

New York Upper Susquehanna Coalition

Recommending that farms receive credit for setbacks under the condition that they follow state guidelines for setback widths is problematic in that some states may have narrower setbacks than others, therefore causing a disparity between the states. While every farm should be following their state's requirements for setbacks, we feel that the credit in the Bay Model should be given to all states at the same setback distance. We recommend setting a standardized setback distance in which all states can receive credit for "Placement Adjustment" in the Bay Model, regardless of their state's minimum setback requirements.

> **Chesapeake Bay Commission:** ***Is there a minimum setback in order to receive credit?***
> **Comment reiterated by Maryland Department of Agriculture.**

Response: *The Panel considered the question of recommending a standard application setback distance and crediting value as part of the BMP evaluation process. Given the great diversity among the physiogeographic zones of the watershed, including soils, slopes, pathways for nutrient environmental losses, etc., the Panel chose not to be prescriptive in recommending a standard application setback for the entire region. Instead, the Panel elected to rely upon the existing conservation standards established by the locally responsible federal and state agricultural and conservation agencies. Similar to representing a diversity of LGU recommendations across the six-state watershed, the Panel recommended an approach of crediting operators who are following local conservation standards, and managing their nutrient applications in compliance with those standards. Furthermore, the Panel was not able to identify sufficient scientific evidence which would support a significant difference in "crediting" based solely on the width of an application setback given the multitude of influencing factors. The Panel's report has been modified to include the following language: "Setbacks must meet the minimum standards required under applicable local, state, or federal programs and laws."*

Environmental Integrity Project

The report is not clear about how split applications will be treated. Split P applications appear in only one category on pages 11 and 25, but appear in both rate and timing categories on page 17. The report should be revised to make it internally consistent on this point. Overall, it would help to have a more complete explanation of how split N or P applications should be reported.

Response: *Split N application is both a N Rate Supplemental NM BMP and a N Timing Supplemental NM BMP, whereas split P application is only a P Rate Supplemental NM BMP. For both N and P, a split application can result in more efficient use of nutrients because crop progress can be tracked and anticipated yields reassessed between the initial and final nutrient application. This allows the operator to avoid a single nutrient application in anticipation of maximum average yield, resulting in a reduced total application rate better matched to crop needs. For N there is also a timing benefit because - depending on soil type, climate, agronomic practices, and other factors - N fertilizer can be vulnerable to environmental losses. Denitrification, leaching, and volatilization can all result in losses of N and decreased nutrient application efficiency. For this reason, there is also a timing benefit to split N application. The risk of P loss, however, is much lower so there is no timing credit for split P applications. Therefore, loss reduction multiplier credits can be earned for both N Rate and N Timing if split N application is implemented, whereas only a single loss reduction multiplier credit for P Rate can be earned with split P application.*

Chesapeake Bay Commission

"One single NM Supplemental BMP efficiency may be credited for each of the N Rate, N Timing, and N Placement categories." - ***So, this means that there is a single credit per category, correct? Not that only one practice per category can be credited? These questions also apply to P.***

Response: *The Panel recommendations provide one opportunity for crediting per each Supplemental NM BMP category for N and P. There are three such categories each for N and P Supplemental BMPs: rate, timing, and placement. Application of a loss-reduction multiplier for the N NM Supplemental BMP elements can only occur after satisfactory implementation of the N Core NM BMP. The N Supplemental NM BMP loss reduction credit for each of these three categories (rate, timing, and placement) can be obtained if implementation of at least one effective practice from each category is verified. Similarly, application of a loss-reduction multiplier for the P Supplemental NM BMP elements can only occur after satisfactory implementation of the P Core NM BMP. The P Supplemental NM BMP loss reduction credit for each of these three categories (rate, timing, and placement) can be obtained if implementation of at least one effective practice from each category is verified. Supplemental N NM BMP loss reduction credits for N rate, N timing, and N placement are stackable, e.g. multiplicative with diminishing returns for reducing environmental loss, as are Supplemental P NM BMP loss reduction credits for P rate, P timing, and P placement.*

Regarding Table 7: PSNT is listed in Table 4 as an Assessment Tool. Assessment tools are described on p. 8 as not representing an efficiency credit in and of themselves. Therefore, why is PSNT given credit here?

Response: *The Panel recommendations recognize the value of utilizing N and P assessment tools to better inform operator decisions in managing nutrients. However, the use of assessment tools alone without a corresponding informed adjustment to nutrient management for rate, timing, and/or placement does not represent a credit according to the Panel. Instead, the Panel chose to provide credit based on the implementation of the management information provided by the N and/or P assessment tool.*

Page 16: "Cropping/manure history at field management unit level, and Federal and/or state certified Nutrient Management Plan not required" – ***These two practices are listed under P, but the descriptive language discusses how they relate to N. Perhaps a cut and past error.***

Response: *The Panel recommendations have been modified to reflect the intended descriptive language.*

Page 16 N Rate Adjustment Practices: "By implementing one or more of the practices listed, an additional N credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment." - ***This limit (one credit per category) is only listed in the Rate section, so I assume it does not apply to the Placement or Timing categories. Is that correct?*** "Split applications over time per crop. Total amount of N application may or may not change, but the application is divided into multiple, lower-rate applications throughout the year." - ***What if the total of the split applications is greater than the Core NM rate?***

Response: *The Panel recommendations provide no more than one opportunity for crediting per each NM Supplemental BMP for N and P (e.g., rate, timing, and placement), but instead provide a framework of multiple management options for achieving each Supplemental BMP credit for N and P. The Panel recommendations have been modified to include the same language for each of the N and P Supplemental BMPs. The Panel decision to limit one credit for each NM Supplemental BMP was based on the recognition that multiple management actions applied to the same nutrient management process (e.g., rate, timing, and placement) provide a diminishing return. Split applications may or may not result in a change of the total application rate, in addition to timing. Split applications can reduce environmental loss and thereby potentially reduce the total nutrient application need if alternatively applied in only one application. However, the Core NM BMP practices must be adhered to first before additional credits can be achieved through Supplemental NM BMPs. In neither case can the total application rate exceed the Core NM BMP rate and be credited as a Supplemental NM BMP.*

Page 17: "By implementing one or more of the practices listed, an additional P credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment." - ***This limit (one credit per category) is only listed in the Rate section, so I assume it does not apply to the Placement or Timing categories. Is that correct?*** "Split applications over time per crop. Total amount of P application may or may not change, but the application is divided into multiple, lower-rate applications throughout the year." - ***What if the total of the split applications is greater than the Core NM rate?***

Response: *The Panel recommendations provide no more than one opportunity for crediting per each NM Supplemental BMP for N and P (e.g., rate, timing, and placement), but instead provide a framework of multiple management options for achieving each Supplemental BMP credit for N and P. The Panel recommendations have been modified to include the same language for each of the N and P Supplemental BMPs. The Panel decision to limit one credit for each NM Supplemental BMP was based on the recognition that multiple management actions applied to the same nutrient management process (e.g., rate, timing, and placement) provide a diminishing return.*
Split N application is both a N Rate Supplemental NM BMP and a N Timing Supplemental NM BMP, whereas split P application is only a P Rate Supplemental NM BMP. Split N applications may or may not result in a change of the total application rate, in addition to timing. Split applications can reduce environmental loss and thereby potentially reduce the total nutrient application need if alternatively applied in only one application. However, the Core NM BMP practices must be adhered to first before additional credits can be achieved through Supplemental NM BMPs. In neither case can the total application rate exceed the Core NM BMP rate and be credited as a Supplemental NM BMP.

Page 17
Section 2.5: "Subsurface injection or incorporation of applied inorganic N." - ***P instead of N?***

Response: *The Panel recommendations have been modified to correct this error (i.e., P instead of N).*

Page 19, Section 3.1.3: "These efficiencies apply multiplicative modifiers to edge-of-stream delivery of N, on the output side of the CBP modeling scheme, and can only be applied if the requirements for N Core NM BMP are met." - ***Is there an order in which the efficiencies are applied? In other words, apply the Rate efficiency, and then the Placement and then the Timing? Does it matter? Given the differences in efficiencies, it seems like there would be different outcomes depending on the order in which efficiencies were applied. This question also applies to P.***

Response: *The Appendix A of the Panel recommendation report provides additional clarification and examples of how the Core and Supplemental NM BMPs will be represented and applied in the Phase 6 modeling tools. Supplemental N NM BMP loss reduction credits for N rate, N timing, and N placement are stackable, e.g. multiplicative with diminishing returns for reducing environmental loss, as are Supplemental P NM BMP loss reduction credits for P rate, P timing, and P placement.*

Pennsylvania DEP
Concerns and questions regarding language on pages 7-8 on specific definitions of "field management unit", the meaning of the term "volume", and the specific requirements of manure spreader calibration. ***For example, Pennsylvania would like to see the language regarding manure spreader calibration read "Spreader calibration and/or application rate documentation", as we have concerns about our ability to document calibration for prior developed manure management plans, but we can document manure application rates relating to plan implementation.***

Response: *The Panel's description of "spreader/applicator calibration" has been modified in the report to insert "preferably within one year of the application". Operator documentation of previous spreader/applicator calibrations can and should be utilized as part of verification, thus not requiring the verifier to personally conduct or oversee the equipment calibration within one year of the application. The Panel description also includes recognition of "standard calibration practices" for addressing equipment calibration, which could include multiple recognized forms, e.g. small area calibration, field scale calibration, etc. Large scale calibration would require documentation of full capacities of the application equipment, e.g. tons or gallons, a consistent application method, and the number of spreader/tanker applications applied onto a known acreage.*

Table 2 (and Table 3 where appropriate): We have a number of comments regarding this table: What does "and Verified" mean? Each state has their own verification plan document and QAPP, so this reference seems redundant if that is the reference. Is this referencing some other verification? We need a clearer definition of "field management unit". We would like to see this read; "N rate according to LGU recommendations at crop or field management unit". Maybe the definition buried on pg 14 could be brought forward? We have concern about the term volume and would like to see "and volume" stricken or alternatively to read "Manure analysis and applied volume". For spreader calibration we would like to see this read "Spreader/applicator calibration and/or application documentation". We have concerns about our ability to document calibration but we can document mass applied over area. The yield estimate line would be more correct if it read "Planned crop and yield estimate at the field management unit" Cropping plan implies a multi-year plan for an annual practice.

Response: *The incorporation of verification requirements within the Panel report was not developed by the Panel but is instead based on the CBP partnership-approved BMP Verification Guidance, which relies on farm management records reviewed by a trained and/or certified independent third party. The CBP partnership-approved "BMP Protocol" requires all BMP Panel recommendation reports to incorporate the "BMP Verification Guidance" into the Panel's recommendations. The specifics of what those verification requirements are based on the BMP Verification Guidance, but will vary from state to state based on their BMP verification plan and QAPP requirements.*

The Panel's description of a "field management unit" as the basis for developing and implementing nutrient application recommendations was utilized to apply to a range of management conditions and scales across the six-state region. According to the Panel recommendations, "The field management unit can represent any field, collection of multiple fields, or sub-portions of a single field that are managed the same way, with similar history and cropping practices." This statement can accommodate LGU recommendations provided at a crop scale if the other descriptive parameters are satisfied, e.g. "managed the same way with similar history and cropping practices".
The Panel's description including the use of nutrient concentrations and volumes is a standard basis of measurement utilized to determine the appropriate nutrient application rate based on crop need.

The Panel description for "spreader/applicator calibration" also includes recognition of "standard calibration practices" for addressing equipment calibration, which could include multiple recognized forms, e.g. small area calibration, field scale calibration, etc. Large scale calibration would require documentation of full capacities of the application equipment, e.g. tons or gallons, a consistent application method, and the number of spreader/tank applications applied onto a known acreage.

The Panel's use of the term "cropping plan" implies that more than one crop may be managed on a given field management unit in a given year. Double and multiple cropping systems are commonly implemented across the six-state region every year, and the management of nutrients on a field management unit should reflect the nutrient needs and application management of one or more crops being implemented in any given year.

Table 5: Need clarification: Is split application for a total reduced rate below LGU rate?

Response: *Split applications may or may not result in a change of the total application rate as well as timing. Split applications can reduce environmental loss and thereby potentially reduce the total nutrient application need if alternatively applied in only one application. However, the Core NM BMP practices must be adhered to first before additional credits can be achieved through Supplemental NM BMPs. In neither case can the total application rate exceed the Core NM BMP rate and be credited as a Supplemental NM BMP.*

Table 6: We take this to mean the state-required setback.

Response: *The Panel recommendation report has been modified to include the following language regarding application setbacks: "Setbacks must meet the minimum standards required under applicable local, state, or federal programs and laws."*

Table 11: We are not sure that we would ever be able to provide this detail. This is actually done during the development of the plan and is effectively "baked into the cake".

Response: *The Panel recommendations for the P Supplemental NM BMP for application timing recognized that management opportunities for implementation are more limited than with N application timing due to their inherent characteristics in the soil environment. The structure of the Panel's recommendations provide an opportunity for the partnership to track, verify and report according to their abilities for multiple levels of nutrient management. If a partner is not in a position now to track, verify and report P application timing, it will not exclude them from doing so with other related nutrient management BMPs.*

Page 14, 'Spreader/Applicator Calibration': We are unaware of manufactures' actually developing these specifications and suggest modifying the last part of the sentence to: "according to recommended LGU practice or by jurisdictional regulation requirements within one year of the application."

Response: *The Panels description for "Spreader/Applicator Calibration" described that the machine(s) have been calibrated either according to manufacturer specifications or by standard calibration practices, preferably within one year of the application." The Panel is aware that equipment manufactures may not provide calibration tables or charts, however, they do recommend the use of calibration procedures consistent with the application capacities and methods of their equipment. The report also includes the recognition of "standard calibration practices" for addressing equipment calibration, which could include multiple recognized forms, e.g. small area calibration, field scale calibration, etc., including jurisdictional regulatory requirements.*

Section 3: Effectiveness Estimates

Kelly Shenk

A significant shortcoming of the Panel's report is that it does not provide sufficient documentation on how the Panel arrived at the nutrient reduction efficiencies. Citing a collective 150 years of experience, the use of Best Professional Judgement, and listing references evaluated is insufficient detail in justifying the final efficiencies. Developing nutrient management efficiencies is the crux of the Panel's charge and having sufficient documentation to justify the efficiencies derived is critical. I recognize the extensive nutrient management expertise of the Panel members and trust that the Panel can write a section in the report that provides explains how they arrived at the efficiencies. Recommendation: Provide further description of how the Panel arrived at the nutrient reduction efficiencies that covers: what data were evaluated for what geographic regions, the range of efficiencies evaluated, how the Panel distilled all the data into one number for N and P for the entire watershed, justification for why the efficiencies are representative of the watershed, the level of confidence in the efficiencies and any caveats that need to be highlighted, indication of the level of conservatism the efficiencies represent, and any comparative analysis if appropriate that sets the efficiencies in the context of any similar efforts throughout the country.

> **Reiterated by Delaware:** ***First, this report draws from unprecedented levels of best professional judgement. The conclusions are drawn from numerous primary source, peer-reviewed, documents without a transparent connection. While Nutrient Management is a worthwhile enterprise for reaching TMDL goals and the benefits of this activity as parameterized by this report service that goal, a higher standard of rigor should be brought to the Agriculture Workgroup.***
>
> **Reiterated by Jeff Sweeney:** ***The report is thorough regarding 1) BMP definitions, 2) recommended verification procedures, and 3) descriptions of how to apply information in the models. However, the report does not adequately describe the basis of the recommended efficiencies and, therefore, does not follow the BMP Protocol. Section 3.2 "Justification for Effectiveness Estimates" should be the most detailed section in this report – and among all CBP Expert Panel reports. The BMPs are, in part, designed to minimize excess nutrients from manure and chemical fertilizers, the greatest source of pollution to the Chesapeake Bay and many other waterbodies in agronomic regions throughout the world. Clear justifications of why the***

efficiencies are what they are is essential. What's needed are changes similar to revisions to the initial draft Phase 5 Nutrient Management report. Following the protocol, there should be a matrix of relevant specific studies and data that yielded quantifications of the recommended load reductions for each element of Nutrient Management. There should be documentation of greater weight being given to study findings that are more relevant, local, recent, etc. It needs to go considerably beyond BPJ and a reference section for BMPs designed to maximize production and profitability and minimize consequences to the environment.

Reiterated by Chesapeake Bay Foundation: ***We are very concerned, however, with the lack of scientific support for the pollution removal efficiencies associated with the supplemental BMPs. The scientific justification can be summarized by this statement from page 20: "The entire body of research represented by the citations presented in the References section provided the foundation for the Panel's professional assessment of the effectiveness of the proposed NM BMPs." With all due respect to the very capable and qualified members of the Panel, there needs to be more specific documentation regarding how these efficiencies were derived. As noted in the Appendix (p 56 and 57) and is specified in guidance for BMP expert panels, the expert panel reports should include: "Justification for the selected effectiveness estimates... including a detailed discussion of how each reference was considered, or if another source was investigated, but not considered." This level of analysis and transparency is not included in this report. As noted in the introduction, NM BMPs apply to literally millions of acres, so ensuring the science is sound and decision-making is transparent, is critical – for the integrity of the scientific underpinnings, but also for the credibility of the Chesapeake Bay Program. So, we respectfully request that the Panel more closely follow the expert panel guidelines and provide the rationale and scientific foundation for decisions regarding pollution removal efficiencies as well as the land uses/crop types to which the supplemental BMP should be applied (e.g., do we expect that variable rate nitrogen on wheat would have the same benefits on corn? explicitly consider geographic variation e.g., were data representative of the different soils, ecotones we have in the Bay region? As well as note what range of efficiencies were noted in the reviewed data? e.g., are estimates conservative or do they represent the "mean"? and on a related note, what level of confidence do you have in the numbers? Was there lots of information for some practices, but little for others? From the information that was presented in the draft report, we have no idea of the answers to these questions.***

Reiterated by Environmental Integrity Project: ***The Phase 6 panel is presenting much higher efficiencies than the Phase 5.3.2 panel, with no explanation of how these efficiencies were derived. The report does not explain how the efficiency recommendations relate to the scientific literature.***

Reiterated by Pennsylvania DEP: ***While it is recognized that best professional judgement of the Expert Panel was necessary to determine the BMP efficiencies on pages 18-20, it is difficult to determine the basis for the development of the non-NM efficiencies. Some explanation of this would be useful, particularly if it is possible to address in simple terms.***

Response: *The Panel has modified section 3.2 to include a thorough discussion of the literature used in conjunction with best professional judgment to determine the recommended values for the application rate multipliers for the Core Nutrient Management BMPs and the loss reduction multipliers for the Supplemental Nutrient Management BMP.*

Jim Cropper

I hesitate though using the term Non-Nutrient Management BMP Efficiency in tables 12, 13, and 16 and in figures 3 and 4 captions and Contents, titles for figures 3 and 4. I would drop BMP out of the term as non-nutrient management is no best management practice. It is a farming practice but certainly not a best one. My greatest fear with this exercise is that we completely discredit the use of nutrient management to reduce the availability of nutrients. An efficiency value of 1 for both non-nutrient management and nutrient management does that. An average is not very meaningful because it does not indicate the range that created that average. Today if someone was to do a nutrient management plan on pasture and implement it, they appear to get no credit for doing it even though they may have been putting down a lot of extra N and P inadvertently. It makes it look like the practice has no practical value. If that is the case, then the practice name is a misnomer. It does depend on the purpose by which nutrient

management is applied - improve water quality or improve yields. They can work counter to each other if they used apart from each other.

Response: *The Panel recommendations include the use of N and P application rate multipliers for nutrient management and non-nutrient management acres. The application rate multipliers by land use are based on a 1985 baseline condition, and are coupled with the Agricultural Modeling Subcommittee -derived application rate table to represent baseline application rate targets versus prescriptive annual nutrient applications. The Agricultural Modeling Subcommittee-derived application rate table, which was approved by the Agriculture Workgroup, significantly modified the LGU nutrient application recommendations across the six states for non-legume hay and pasture land uses. The approved application rates for pasture are now reflective of an average application rate condition, which represents a range of annual nutrient applications from zero to above the recommended application rates from the LGU. Consequently, the Panel recommendations were modified to address this new baseline of application rates from the Agricultural Modeling Subcommittee by creating a neutral multiplier for non-legume hay and pasture land uses. By doing so, the Panel recommendations are avoiding the "double crediting" of nutrient management on these land uses as the "model credit" as already been represented in the base model condition established by the AMS application rate table. One potential option for the partnership to consider would be the representation of several management levels for pasture land uses in the future. Currently, only one pasture land use is available in Phase 6.*

Gene Yagow

I think the terminology used in Appendix A is much more straight-forward in referring to the Core Application Goal modifiers as "multipliers", rather than as "efficiencies", as used in the body of the report. I think it is very confusing and a mis-use of the term "efficiency".

Response: *The Panel has modified the report to use the phrases "rate multipliers" for the Core Nutrient Management BMPs and "loss reduction multipliers" for Supplemental Nutrient Management BMPs in lieu of "efficiency."*

Delaware

The combination of disparate application rate goals between nutrient management and non-nutrient management acres under the CORE lacks equity amongst the states while the final distribution of fertilizer sales is the true measure of application rates. The synthesis of CORE NM coverage and distributed fertilizer sales will result in states with higher adoption and compliance rates. This will force neighboring states to absorb additional fertilizer, in effect double-counting the detrimental effect non-NM acres. A more equitable solution to apply the benefit of NM or detriment of non-NM acres, could be to summarize current levels of CORE NM across the watershed and simulate disparate application goals in scoping runs that yield a resulting efficiency credit for acres of CORE NM which could be applied universally. This credit could be calculated by an average or other arithmetic method following the scoping runs, to be reviewed by the AMS and Agriculture Workgroup. Attempting to apply 30% more P to non-NM corn for grain acres and instead forcibly applying upwards of 40% more to counties with lagging implementation, will cause fluctuating benefits through time and across jurisdictions as implementation creeps towards 2025 goals. Documented levels of effort can be run in the models, resulting in an average benefit that can be substituted for this variable rate that works much the same as Phase 5's land use change method for credit. This would have the benefit of increasing equity of BMPs and consistency through simulations and progress runs that better communicate exceedances and shortfalls in nutrient reduction goals. Recent surveys and lab data have found that regionally, over 80% of farmers have current manure and/or soils analysis and 75% are maintaining appropriate levels of soil fertility. Such evidence is supportive of the conservativeness of recent state implementation rates and the consistency of implementation across vast areas of agriculture.

Response: *The Panel recommendations include the use of N and P application rate multipliers for nutrient management and non-nutrient management acres. The application rate multipliers by land use are based on a 1985 baseline condition, and when coupled with the Agricultural Modeling Subcommittee derived application rate table, represent baseline application rate targets rather than prescriptive annual nutrient applications across the six Bay states and three decades of time. The Panel application rate targets are in effect modified by the annual availability of nutrients for application, which will vary by state and year depending on transported organic nutrients, livestock generated organic nutrients, inorganic nutrient sales, etc. The representation of nutrient management and non-nutrient management acres*

within counties or states over time is reflective of the implementation, tracking, and reporting of nutrient management acres by the partnership on an annual basis, which can vary over time due to many factors.

Jeff Sweeney

In order for "efficiencies (that) apply multiplicative modifiers to edge-of-stream delivery of N," the recommended benefits needed to be grounded in studies that looked at monitored in-stream changes in loads or concentrations, e.g. paired watershed studies. Is this the case – or did most studies used in the Panel's evaluations look at, for example, edge of field changes?

Response: *The Panel has modified section 3.2 to include a thorough discussion of the literature used in conjunction with best professional judgment to determine the recommended values for the application rate multipliers for the Core Nutrient Management BMPs and the loss reduction multipliers for the Supplemental Nutrient Management BMP. The Panel has modified the report to use the phrases "rate multipliers" for the Core Nutrient Management BMPs and "loss reduction multipliers" for Supplemental Nutrient Management BMPs in lieu of "efficiency."*

Gene Yagow

On page 21, the supplemental BMP efficiencies are referred to as being "additive", whereas Table 16 and the examples show that they are instead "multiplicative". For further clarification, an example should be given that shows how the math works out when more than one supplemental credit is applied. Currently, all the examples just show one supplemental BMP being credited at a time.

> **Reiterated by Chesapeake Bay Commission:** ***What is the process by which C, D and E are "additive"? How is the final calculation made when multiple adjustments (rate, placement and timing) are present? This question applies to the P calculation below as well.***

Response: *The Panel has modified the report to use the phrases "rate multipliers" for the Core Nutrient Management BMPs and "loss reduction multipliers" for Supplemental Nutrient Management BMPs in lieu of "efficiency". In addition, the report language has been modified to replace "additive" with "stackable' and "multiplicative". Appendix A of the Panel recommendation report provides additional clarification and examples of how the Supplemental NM BMPs will be represented and applied in the Phase 6 modeling tools. Supplemental N NM BMP loss reduction credits for N rate, N timing, and N placement are stackable, e.g. multiplicative with diminishing returns for reducing environmental loss, as are Supplemental P NM BMP loss reduction credits for P rate, P timing, and P placement.*

Pennsylvania DEP

It would be valuable to understand the impact of non-NM efficiencies within the Phase 6 modeling structure.

Response: The *Panel has modified the report to use the phrases "rate multipliers" for the Core Nutrient Management BMPs and "loss reduction multipliers" for Supplemental Nutrient Management BMPs in lieu of "efficiency". The application rate multipliers by land use are based on a 1985 baseline condition, and when coupled with the Agricultural Modeling Subcommittee derived application rate table, represent baseline application rate targets rather than prescriptive annual nutrient applications across the six Bay states and three decades of time. The Panel application rate targets are in effect modified by the annual availability of nutrients for application, which will vary by state and year depending on transported organic nutrients, livestock generated organic nutrients, inorganic nutrient sales, etc. The representation of nutrient management and non-nutrient management acres within counties or states over time is reflective of the implementation, tracking, and reporting of nutrient management acres by the partnership on an annual basis, which can vary over time due to many factors.*

Virginia

Core Nutrient Management:

1. ***We recognize core is meant to be the base or lowest level of recognized implementation. However and more importantly, core is the foundation on which any nutrient management credit, including the enhancements, will rest upon. Shouldn't that base be built upon such fundamental, agronomically sound building blocks for***

nutrient management as actual soil and manure test values not book values? The only time manure book values should be acceptable for core nutrient management is at start up for new operations that have yet to produce manure. Only local or mid-Atlantic based book values should be considered reasonable even then. This allowance should only be valid for initial planning purposes and a manure analysis should be attained and utilized to adjust recommendations when manure is first available for land application and from that point forward. There should be no exception to using soil test at the field level less than 3 years old as the basis for phosphorus core nutrient management. Even on fields testing too high for a land grant university phosphorus recommendation, the soil test value is generally a component of a phosphorus loss assessment tool to determine if phosphorus may be applied. Using an assumed soil test value based on a waiver with such tools may allow greater phosphorus application on fields than an actual soil test value used with the tool would indicate for that field. We recognize some jurisdictions currently utilize such waivers to achieve nutrient management or manure management planning. These jurisdictions will need a ramp up or grace period to begin implementation of core nutrient management without such waivers. Three years seems to be recognized as a typical plan life cycle and could be considered as a timeframe for such a ramp up.

New York Upper Susquehanna Coalition supported this comment.
Maryland Department of Agriculture reiterated this comment.

Response: *The Panel agrees that the use of actual and current soil and manure test values are preferable over the use of applicable book values for sound nutrient management decisions by the operator. The Panel recognized the present diversity of nutrient management planning efforts across the six Bay states with the utilization of applicable book values in place of actual and current soil and/or manure analysis. However, totally eliminating the appropriate use of book values could be detrimental to federal and state nutrient management programs to varying degrees. For example, nutrient management planning efforts typically rely on applicable book values when developing plans for new or expanding livestock operations when a representative manure analysis is not possible or available. Some nutrient management programs currently permit by program guidance or regulation the use of applicable book values for soil and/or manure nutrients as part of their planning efforts. Modifications to these regulatory and permit programs may require legislative action to effectively limit the use of book values for planning efforts. Consequently, the Panel report has provided modified language within the report which places greater limits on the use of book values in place of manure and soil analysis. In a separate action, US EPA is developing a supporting document for partnership support which provides a process whereby the jurisdictions can modify their existing programs over time to address programmatic and legislative actions. The Panel, however, fully supports the preferential use of current soil and manure analysis data to guide nutrient management implementation.*

Virginia

2. The report states "Federal and/or state certified Nutrient Management Plan not required. The NM Panel did not define the N (or P) Core NM BMP to require a comprehensive and/or certified Nutrient Management Plan (NMP) in order to receive the BMP credit". ***Upon initial review these statements did not seem overtly alarming or concerning. However, following more in depth thought and discussions with colleagues they do present some troublesome undertones. Nutrient management or manure management plans (aka: plan(s)) have been the core of nutrient management programming efforts in essentially every jurisdiction within the Chesapeake Bay Watershed since inception of these state run programs. Eliminating the requirement for plans to serve as the mechanism to deliver and report the core elements of nutrient management may very well serve to erode the validity of these plans and the programs we have worked so diligently to develop. Currently, plans are required for a multitude of purposes such as permitting and cost share of various practices. How can we return to our respective states and still assert that a plan is required for any purpose if we have agreed it is not necessary to achieve credit for core nutrient management? Not only that, but nowhere in the proposal does implementing a plan garner credit. Producers and organizations that have fought the development of plans for years could very easily demand such plans be eliminated based on our agreement they are not an essential part of core nutrient management. As stated above, plans serve as the current mechanism for reporting. Many of our activities and efforts revolve around attaining, maintaining and especially reporting plans. Without this framework called a plan what mechanism will be utilized to capture core nutrient management acres? How much time, effort and***

money would be needed to facilitate use of a new or additional reporting process? How would we attain the needed data on these core practices without a plan? The point being, the plan has been a valuable tool that has been adapted and utilized over nearly three decades. To discard or even minimize it now without careful deliberation may well prove to be an error in judgement.

Response: *The Panel defined the N and P Core NM BMPs to require full implementation of a defined set of fundamental elements in order to receive the recommended practice credits. The elements that constitute the N and P Core NM BMPs may or may not be components of a formal Nutrient Management Plan. The required nutrient management documentation could be in the form of a formal federal, state, or county-reviewed and certified nutrient management program plan, a non-certified formal nutrient management plan developed by a federal- or state-certified plan writer, or detailed documentation and an informal management plan compiled by an operator or private consultant that met the Panel's BMP recommendations.*

The incorporation of verification requirements within the Panel report, based on the CBP partnership-approved BMP Verification Guidance, will rely on farm management records reviewed by a trained and/or certified independent third party. Federal and state regulatory nutriment management plans currently offer one accepted method to track, verify and report NM BMP implementation. However, the Panel also identified other existing examples of implementation documentation coupled with privately developed management plans which could potentially meet and exceed the management of nutrients associated with regulatory programs. The Panel considered excluding the recognition of these non-regulatory nutrient management efforts, but elected to be inclusive of planning systems which achieved full implementation of the required elements.

Virginia

Advanced Nutrient Management

1. ***Manure analysis < 3 years old is listed as an "Advanced N Assessment" and an "Advanced P Assessment" in the report. Soil test < 3 years old and P index Assessment are also shown as "Advanced P Assessment" items in the report. Each of these are also enumerated in the required elements for core nutrient management. Soil and manure testing are specifically detailed in the core table while the p loss assessment is included as an option under Land Grant University recommendations used to determine p application goals at the field level. Depicting these items as both core and advanced elements may be confusing and, possibly, suggestive of an attempt to garner undo double crediting for these items.***

Response: *The Panel report language has been modified to represent manure analysis less than one year old in the Advanced N and P Assessment tables. In addition, the report has been modified to represent soil tests as a Core NM element only, and P index as an Advanced P Assessment tool.*

2. ***Elements required to attain core nutrient management credit for n or p or both cannot be considered as advanced nutrient management. Also, elements that may be used to attain core nutrient management credit for n or p or both, such as p loss assessment, cannot be considered as advanced nutrient management.***

Response: *The Panel defined Core NM BMP elements as the basis for implementing enhanced management represented by the Supplemental NM BMPs. The crediting for Core and Supplemental NM BMPs are separate and apply different multipliers to application rates and environmental losses respectively. The Panel report has been modified to more fully separate the required NM practices for Core and Supplemental NM BMPs.*

3. ***Soil testing at lesser intervals than 3 years (for instance, soil test < 1 year old) should not be considered for "advanced p assessment". Inclusion of such a practice will only entice some groups to seek cost share funding for these practices based solely on their inclusion on a list of advanced n or p assessment in the model. Funding for such additional practices that may garner little benefit is not feasible or prudent.***

Response: *The Panel's recommendations have been modified to represent soil testing at less than three-years old as a required element for Core NM, not for a Supplemental NM BMP.*

Similar Comments from Chesapeake Bay Foundation: ***Table 6 and 10: It is unclear why "credit" would be given for setbacks from water. Doesn't the application of "core NMPs" require there to be some setbacks from water? Table 8: Having a soil test for P that is less than 3 years old is a parameter for the core NMP BMP credit, so why is it also listed for supplemental timing credit? Similarly manure nutrient analysis and use of a Phosphorus index are also listed as a core requirements, but also listed as an examples of advanced nutrient management. This should be clarified.***

Response: *Application setbacks are not universally implemented or required in all cases, nor were they historically represented going back to the base calibration year of 1985. Thus, the Panel chose to represent application setbacks as a potential Supplemental NM BMP for nutrient placement. The Panel's recommendations have been modified to represent soil testing at less than three-years old as a required element for Core NM, not for a Supplemental NM BMP. The report has also been modified to represent manure nutrient analysis as a required Core NM element, however, the use of P index tool is represented as an Advanced P Assessment Tool which has to be coupled with documented implementation adjusting nutrient applications in order to obtain credit.*

VA DEQ

PSNT is listed in Advanced Assessment Tool and N Timing Adjustment. So is it that a PSNT is recommended in the plan or actually done? And if done does it get credit for timing and advanced assessment or just timing? It is possible once a PSNT is done that additional N fertilizer is not needed. Would that also not be a rate adjustment since additional N fertilizer is not used?

Response: *The Panel's recommendations represent the use of PSNT as both an Advanced N Assessment Tool and as a Supplemental N Timing BMP. Assessment tools do not obtain an environmental loss reduction credit unto themselves. The credit for reducing environmental loss is only obtained by the informed implementation of the recommendations stemming from the use of the Assessment Tool, in this case the implementation of split applications of N affecting timing of nutrient applications.*

New York Upper Susquehanna Coalition

The supplemental P efficiencies on page 20 of the report for Legume Hay should also be used for Other Hay. We ask the Panel to develop non-zero supplemental N management practice efficiencies for Other Hay, perhaps at similar percentages to those used for P.

Response: *The Panel recommendations include the use of N and P application rate multipliers for nutrient management and non-nutrient management acres. The application rate multipliers by land use are based on a 1985 baseline condition, and are coupled with the Agricultural Modeling Subcommittee -derived application rate table to represent baseline application rate targets versus prescriptive annual nutrient applications. The Agricultural Modeling Subcommittee-derived application rate table, which was approved by the Agriculture Workgroup, significantly modified the LGU nutrient application recommendations across the six states for non-legume hay. The approved application rates for non-legume hay are now reflective of an average application rate condition, which represents a range of annual nutrient applications from zero to above the recommended application rates from the LGU. Consequently, the Panel recommendations were modified to address this new baseline of application rates from the Agricultural Modeling Subcommittee by creating a neutral multiplier for non-legume hay land uses. By doing so, the Panel recommendations are avoiding the "double crediting" of nutrient management on these land uses as the "model credit" as already been represented in the base model condition established by the AMS application rate table.*

Pennsylvania DEP

Table 12: Legume hay has a "penalty" applied but there is no NM BPB that can be applied against it. This seems unfair to LH-rich jurisdictions and suggest that this value be 1.00 without supporting information as to why it should be 1.20.

Response: *The Panel recommendations include an application rate multiplier for Core N NM of 1.00 and a non-NM*

Core N multiplier of 1.20.

Table 13: 3x LGU rate seems high. Is there scientific literature to establish this? Otherwise, it needs further explanation like the prior table. Would 2.5 be a better number? And what is the overall effect (sensitivity) of changing this multiplier?

Response: *The Panel recommendations are established on a baseline of 1985 to mirror the Chesapeake Bay Program partnership's modeling tools baseline for BMP implementation and model calibration. The Panel has modified section 3.2 to include a thorough discussion of the literature used in conjunction with best professional judgment to determine the recommended values for the application rate multipliers for non-NM and Core Nutrient Management BMPs.*

Section 4: Review of Literature and Data Gaps

Jeff Sweeney

What's the status of the "second independent source of data representing historic Nutrient Management implementation [that] has been requested from the USDA NRCS CEAP – based on the two existing reports published on the Chesapeake Bay Watershed"? Is this statement about HUC-4 scale information still relevant and, if so, are there results that can be used in the Nutrient Management report?

Response: *The Panel did review implementation data from USDA-NRCS CEAP based on the existing two reports published on the Chesapeake Bay Watershed. The information was utilized by the Panel as an independent reference during the Panel's considerations for historic NM implementation at a HUC 4 scale.*

Section 5: Application of Practice Estimates

Kelly Shenk

Significant Improvements from Phase 5 Approach: The following are significant improvements to the Phase 5 approach that will help increase transparency in verifying, reporting, and crediting nutrient management activities that are resulting in verified actions that will reduce nutrient losses. Improvements include: Moving away from crediting "plans" to crediting specific suites of verified practices that are implemented to manage nutrients related to source rate, timing, and placement. Crediting the supplemental practices only after the core nutrient management BMP is implemented to ensure a baseline level of nutrient management on which to build the more advanced approaches. Crediting supplemental practices only when implementation of adjustments in nutrient rates, placement or timing is verified so that we are crediting the nutrient reductions that are happening due to these advanced practices.

Response: *The Panel's recommendations were built upon the scientific expertise of the panel members in an academic approach to the BMP evaluation, and the initial ground work established by the Phase 5.3.2 Panel.*

Jeff Sweeney

In section 5.8 Practice Limitations, "These practices may be applied to all agricultural land use categories in the CBW" – ***yet it appears there's no recommendation for benefits of pasture and nursery nutrient management for practices similar to those in the report. In other words, if pasture nutrient management is anything beyond, for example, prescribed or rotational grazing, alternative watering and fencing, please clearly describe in this report – and for nursery as well. There's been uncertainty about what, exactly, should be reported for pasture nutrient management so this is the time to resolve the issue.***

Response: *The Panel recommendations include the use of N and P application rate multipliers for nutrient management and non-nutrient management acres. The application rate multipliers by land use are based on a 1985 baseline*

condition, and are coupled with the Agricultural Modeling Subcommittee -derived application rate table to represent baseline application rate targets versus prescriptive annual nutrient applications. The Agricultural Modeling Subcommittee-derived application rate table, which was approved by the Agriculture Workgroup, significantly modified the LGU nutrient application recommendations across the six states for pasture land uses. The approved application rates for pasture are now reflective of an average application rate condition, which represents a range of annual nutrient applications from zero to above the recommended application rates from the LGU. Consequently, the Panel recommendations were modified to address this new baseline of application rates from the Agricultural Modeling Subcommittee by creating a neutral multiplier for pasture land uses. By doing so, the Panel recommendations are avoiding the "double crediting" of nutrient management on these land uses as the "model credit" as already been represented in the base model condition established by the AMS application rate table. Other pasture related BMPs such as prescribed grazing and alternative watering will continue to be applicable and represent separate and independent crediting opportunities
Nursery is represented in the Phase 6 modeling tools as "Specialty Crop" Low and High. The Panel's recommendations include separate multiplier values for both non-NM and NM for N and P which represent a credit value for NM application rates.

Jim Cropper
More consideration should be given to pasture and the nutrient inputs it receives, either from manure, poultry litter, or commercial fertilizer. N application rates on pastures based on forage production removal rates, as if they were hayfields with no grazing livestock on them, is not a valid method of determining N requirements for pastures. This has the same effect (or larger) as saying that it takes 1.2 pounds of N to produce a bushel of corn. On average 85 percent of the N ingested by the grazing animal is returned to the pasture, therefore there is no need to import large amounts of N to a pasture any more than to import coal to Newcastle. I am hopeful this is not a problem with LGU's within the Chesapeake Bay. I know it is a procedure used elsewhere as I have been to their websites and have seen it mentioned in popular agricultural press. To do otherwise, is to thoroughly discount any of the N returned to the pasture by the grazing animal as being available for plant uptake. N applied either with commercial fertilizer or manures must be reduced to account for N being returned by the wastes excreted on the pasture by the grazing animal, imported feeds N contributions, and also N contributed by legumes growing in the pasture if they compose greater than 10 percent of the forage mass produced. In other words, a mass balance of N needs to be done before making any additional N fertilizer recommendations on pasture. We really do need to get a handle on how many acres of pasture do receive manure. It also appears that we need to know where exported manure goes and its rate of application that is spread off the farm producing it. I know this is a touchy subject, but it would appear if the manure is going off the farm that every place it goes to must be a part of the whole nutrient management plan for the producing farm, not just cover the producing farm acreage. The data should be available in each state doing nutrient management planning, but it may be incomplete if exported manure is not tracked.

Response: *The Panel recommendations include the use of N and P application rate multipliers for nutrient management and non-nutrient management acres. The application rate multipliers by land use are based on a 1985 baseline condition, and are coupled with the Agricultural Modeling Subcommittee -derived application rate table to represent baseline application rate targets versus prescriptive annual nutrient applications. For pasture land uses, the panel chose to recommend a neutral multiplier for application rates. However, the Phase 6 modeling tools will distribute nutrients to applicable land uses within each county based on factors such as manure nutrient generation, manure nutrient transport, and non-organic nutrients. The Agricultural Modeling Subcommittee's recommendations on nutrient application curves and distribution, approved by the AgWG, will affect the final representation of nutrients being applied within pasture land uses with a county on an average condition.*

Jim Cropper
The zero baseline has to be when P-based requirements were initiated by each State as it relates to pastures that receive poultry litter. Unfertilized pastures may as well have the baseline be 1985. For pastures where supplemental feeding of hay or TMR occurred, the zero baseline would be when nutrient mass balances were initiated that began to limit additional P into the feeding system as operators began following the protocols.

Response: *The Panel recommendations are based on a 1985 baseline condition which compliments the BMP implementation baseline conditions long established by the Chesapeake Bay Program partnership and its associated modeling tools. BMP tracking and reporting by the CBP partnership begins with the 1985 baseline for representing BMP implementation from that year forward, including nutrient management. BMPs that may have been implemented prior to 1985 are represented by their influence on water quality data collected on and after the baseline year versus as a direct BMP implementation reportable input into the CBP modeling tools.*

VA DEQ

We are very concerned that this panel is indicating no benefit to NM on "other hay" and pasture. Other hay would include Bermuda grass hay where hog or other animal wastes are applied. In these situations permitted operations must have a NMP. Yet this panel would seem to indicate no benefit to such a plan or permit requirement??? How can this be considering the prospect of disposal rates verses LGU recommendations? Basically looking at land use as provided by CBP Virginia's agriculture is roughly 50% pasture, 25% hay, and 25% cropland. Without knowing the use of legumes within planned acres of hay there is a concern that CBP will default to all NM reported by VA on hay as applied to other hay? This would seem to relegate 75% of Virginia's agriculture to not needing a NMP or no benefit to reporting them. This does not seem congruent with the educational aspects a NMP has for a farm or with VA being able to meet our Bay TMDLs reduction goals or situations where animal wastes or biosolids are utilized on pastures, pastures that are also hayed and dedicated hay production fields. A preponderance of the reported NM acres on pasture in VA are associated with biosolids permits and applications. Is this panel actually saying there is no benefit to NM planning on these sites? It seems that the Panel is only focused on fertilizer applications to pasture and hay and is ignoring organic sources. Suggest the Panel reconsider NM planning benefits to pasture and other hay especially in situations where they are tied to manure and biosolids applications.

Response: *The Panel recommendations include the use of N and P application rate multipliers for nutrient management and non-nutrient management acres. The application rate multipliers by land use are based on a 1985 baseline condition, and are coupled with the Agricultural Modeling Subcommittee -derived application rate table to represent baseline application rate targets versus prescriptive annual nutrient applications. The Agricultural Modeling Subcommittee-derived application rate table, which was approved by the Agriculture Workgroup, significantly modified the LGU nutrient application recommendations across the six states for pasture land uses. The approved application rates for pasture are now reflective of an average application rate condition, which represents a range of annual nutrient applications from zero to above the recommended application rates from the LGU. Consequently, the Panel recommendations were modified to address this new baseline of application rates from the Agricultural Modeling Subcommittee by creating a neutral multiplier for pasture land uses. By doing so, the Panel recommendations are avoiding the "double crediting" of nutrient management on these land uses as the "model credit" as already been represented in the base model condition established by the AMS application rate table. However, the Phase 6 modeling tools will distribute nutrients to applicable land uses within each county based on factors such as manure nutrient generation, manure nutrient transport, and non-organic nutrients. The Agricultural Modeling Subcommittee's recommendations on nutrient application curves and distribution, approved by the AgWG, will affect the final representation of nutrients being applied within pasture land uses with a county on an average condition.*

Section 6: Practice Monitoring and Reporting

Jeff Sweeney

The Panel recommends that the highest level of Nutrient Management implementation be represented in the models at reported 2015 acres. However, most states did not have a strong quantitative basis for their reported acres that would satisfy the guidelines for verification – that the Panel recommends is needed. There was a compliance "cross-walk" of acres in various state nutrient management programs; however, there were often weak connections between that information and what was reported for the 2015 model assessment. How do we rectify this situation?

Response: *The incorporation of verification requirements within the Panel report was not developed by the Panel but is instead based on the CBP partnership-approved BMP Verification Guidance, which relies on farm management records reviewed by a trained and/or certified independent third party. The CBP partnership-approved "BMP Protocol" requires*

all BMP Panel recommendation reports to incorporate the "BMP Verification Guidance" into the Panel's recommendations. The specifics of what those verification requirements are based on the BMP Verification Guidance, but will vary from state to state based on their BMP verification plan and QAPP requirements. Full implementation of BMP verification was established between the partners for 2018, at which time all reported BMPs are required to satisfy the guidelines for verification.

Delaware

Second, states' tracking protocols should use a simple approach to tracking and reporting. This is best accomplished by using a menu or check list of advanced NM tools enumerated in the report beyond CORE. While the science behind elements of advanced NM techniques, like PSNT, variable rate nutrient application and banding of nutrients are documented, a common interpretation of an index, tool or test is to in-fact implement no change. Please continue to make this point to non-state stakeholders to prevent any confusion.

Response: *The Panel's recommendations have been modified to provide additional clarity on the application of Advanced Assessment Tools and their role in informing nutrient management practices for Supplemental NM BMP tracking, verification , and reporting.*

VA DEQ

Suggest a single statement on the needs for NM practices to be developed consistent with each states verification program. As is the current report use of the terms related to verification (verified, implemented and verified) is redundant and unnecessary. It is not needed in multiple tables, figures, and repeatedly within the same paragraph (page 11). Current use in this report is overkill when a single statement or paragraph could suffice.

Response: *The incorporation of verification requirements within the Panel report was not developed by the Panel but is instead based on the CBP partnership-approved BMP Verification Guidance, which relies on farm management records reviewed by a trained and/or certified independent third party. The CBP partnership-approved "BMP Protocol" requires all BMP Panel recommendation reports to incorporate the "BMP Verification Guidance" into the Panel's recommendations. The specifics of what those verification requirements are based on the BMP Verification Guidance, but will vary from state to state based on their BMP verification plan and QAPP requirements.*

Environmental Integrity Project

The report is not clear about the mechanics of verification reporting, or the consequences for failure to fully document verification results. We assume that the Panel intends to give credit for all nutrient management acres, not just the acres with a verification inspection and paper trail. As we understand the mechanics of BMP verification to work, each state will verify a subset of BMP acres and use the results of that sub-sampling to discount total reported BMP acres. That process raises a few questions for the NM BMP, which is in practice not a single BMP, but a suite of BMPs:

- ***Should each state estimate the rate of overall noncompliance with nutrient management BMPs and use that noncompliance rate to discount total nutrient management acres?***
- ***If so, what constitutes noncompliance? For example, if a farmer intends to implement three supplemental practices to be eligible for all three categories of supplemental N credit, but only implements two, with the result that the farmer is only eligible for two categories of credit, would that be compliance, noncompliance, or something in between?***
- ***Perhaps, instead, the Panel would like to see each state sampling, and reporting with sampling-based discounts, each category. For example, Maryland might sample all "N Rate Adjustment Practices" and discount the total reported "N Rate Adjustment Practices" by the noncompliance rate found in sampling.***
- ***Or perhaps the Panel would like to see each state sampling and reporting at the practice level (e.g., split N applications).***

The expert panel should clearly state how verification results should be used to discount BMP reporting. For example, the Panel could say something like the following: "Nutrient management acres fail verification inspections if the farmer has not implemented all of the "core elements." Nutrient management acres additionally fail verification inspections for each category of supplemental BMP if the farmer has failed to adequately implement at least one

practice within that category. For example, if a farmer claims credit for a P Timing BMP, but has not limited P application to the "lower P-loss risk season," then that farm will have failed the verification inspection. Regardless of whether a BMP undergoes subsequent corrective action, the results of the initial inspection shall be used as representative of the success or failure of that BMP. Each state should calculate a cumulative failure rate for all nutrient management BMPs and apply that rate to discount the reporting of each nutrient management BMP."

Response: *The jurisdictions will be expected to determine if the current verification protocols and procedures in their QAPP for NM BMPs are sufficient for the recommended Core and Supplemental NM BMPs after this expert panel recommendation report is approved by the CBP partnership. This will be done before the jurisdictions are able to start submitting these BMPs in the Phase 6 modeling tools for annual progress implementation. Nutrient management practices incorporate both non-visual (e.g., nutrient application rate) and visual components (e.g., manure injection and incorporation), both of which can reasonably be verified using elements of both the Non-Visual Assessment and Visual Assessment (Annual) categories described in the AgWG verification guidance. The Panel is not proposing any new or unique aspects of BMP verification for purposes of the BMPs described in this report. Section 6 of this report simply explains how the recommended BMPs correspond to the existing BMP verification guidance.*

Each jurisdiction will determine the most appropriate methods for verifying NM BMP implementation given their specific priorities, programs, needs, and capacity. The states can follow the AgWG's guidance for Non-Visual Assessment BMPs to verify the N and P Core NM BMPs for reduction credits in the Phase 6 CBWM. The N and P reductions for Core NM BMPs are to be based on the verified required elements of the N and P Core NM BMPs which should be documented in the records available to the applicable state agency. If the state finds that this basic information for N and P Core NM BMPs cannot be verified through spot-checks or other annual BMP verification procedures described in its BMP Verification Plan and QAPP, then the BMP cannot be reported for credit. For N and P Supplemental NM BMPs, records available to the state must document the implementation of additional nutrient application changes for rate, timing, and/or placement described by the Panel for these supplemental BMPs in order to receive credit; note that credit for N and/or P Supplemental NM BMPs cannot be obtained unless satisfactory implementation of the respective Core NM BMP (N or P) is documented. Absent documentation of Supplemental NM BMP implementation, credit may still be obtained for Core NM BMPs for which implementation is documented.

Chesapeake Bay Commission

Page 30 - **"**The Panel recommends that NM BMP implementation tracking, verification, and reporting on a county-by-county or state-by-state basis be based on the premise that they represent annual Non-Visual Assessment BMPs." - ***Given the discussion below of how visual and non-visual assessments can be applied, this blanket statement is not appropriate here.***

Response: *The Panel's report has been modified to address changes in the language regarding BMP verification.*

Pennsylvania DEP

Pg. 30, "Since it is an annually reported BMP, the most important criteria (i.e. NM Core N and Core P elements) should be documented somewhere in the records available to the applicable state agency." ***Comment: Understand that plans are written for a three-year period of time.***

Response: *The Panel is aware that many, but not all, nutrient management plans are developed for a three-year period of implementation. Documentation of the implementation of those plans during the period of implementation is a fundamental element of BMP verification according to the partnership's BMP Verification Guidance.*
Appendix A: Technical Requirements for Reporting and Simulating Nutrient Management BMPs in the Phase 6 Watershed Model

Gene Yagow

Appendix A also defines the supplemental BMPs as percent reductions, while the main body of the report talks about efficiencies (1 - percent reductions). Percent reductions are additive, while efficiencies are multiplicative, though not

exactly so. Take the following example with 100 lbs. of P applied to Grain w/o Manure with rate, placement, and timing percent reductions of 5%, 10%, and 1%, respectively.

Percent Reduction Basis: 100 * (1 - (0.05 + 0.10 + 0.01)) = 84.0

Efficiency Basis: 100 * 0.95 * 0.90 * 0.99 = 84.645

These are not fully equivalent, so whichever basis is used, it should be used consistently both in the document and in the reporting requirements as in Appendix A.

> **Similar comments reiterated by <u>Environmental Integrity Project</u>: *Cumulative nutrient reductions can be much higher in Phase 6 than they were in Phase 5, and supplemental BMP efficiency values should not be additive.***

Response: *The Panel has modified the report to use the phrases "rate multipliers" for the Core Nutrient Management BMPs and "loss reduction multipliers" for Supplemental Nutrient Management BMPs in lieu of "efficiency". In addition, the report language has been modified to replace "additive" with "stackable' and "multiplicative". Appendix A of the Panel recommendation report provides additional clarification and examples of how the Supplemental NM BMPs will be represented and applied in the Phase 6 modeling tools. Supplemental N NM BMP loss reduction credits for N rate, N timing, and N placement are stackable, e.g. multiplicative with diminishing returns for reducing environmental loss, as are Supplemental P NM BMP loss reduction credits for P rate, P timing, and P placement.*

<u>VA DEQ</u>

Not all farms have manure so when it says all elements must be implemented and verified suggest you preface manure sampling with the words if applicable. Not sure how a NM plan writer can verify the spreader/applicator equipment of a custom applicator (fertilizer dealer) is calibrated. Likewise not sure how to verify a farmer actually implements the plan recommendations without tracking fertilizer sales receipts by farm and field. Similar for cropping history in that a planner might document such a history in the plan but not sure how one actually verifies a farmer did what he said he did in terms of which crops were planted in which field in any given year. Again suggest instead of saying implemented and verified so often have one blanket statement somewhere in the report indicating consistency with state verification guidelines.

Response: *The Panel recommendations for Core NM BMPs required elements include the need for the calibration of application equipment, regardless that be in the form of an application of organic or inorganic nutrients. Operators who hire custom applicators are recommended to maintain documentation of the applications, and the custom applicator's contact information, so that documentation of calibration can be obtained. The Panel description also includes recognition of "standard calibration practices" for addressing equipment calibration, which could include multiple recognized forms, e.g. small area calibration, field scale calibration, etc. Large scale calibration would require documentation of full capacities of the application equipment, e.g. tons or gallons, a consistent application method, and the number of spreader/tanker applications applied onto a known acreage.*

<u>Environmental Integrity Project</u>

It is not clear how this BMP will interact with the Bay Model. Our understanding of BMP efficiencies is that they will be used to modify Bay Model edge-of-stream load estimates. Yet the expert panel is also suggesting changes to the "input side". If the expert panel recommendations are in fact changing the "input side" of all agricultural acres, it will be a substantial change in the mechanics of the Phase 6 model that deserves broader discussion. Adding to the confusion are discussions of a comparison between "the modified LGU recommendations for application of supplemental inorganic N fertilizer" and an "alternative approach based on county-level redistribution of AAPFCO N fertilizer sales." This is confusing because it is not clear how this comparison affects the expert panel's recommendations, the "alternative approach" appears to be the Phase 6 Model approach, and these discussions only address supplemental inorganic fertilizer, and not manure.

Response: *The application of a N Core NM BMP application rate multiplier modifies the crop- and land-use-specific N application rate goal, which is based on Land-Grant University (LGU) crop fertilization recommendations, as modified by the CBP partnership. In an effort to determine the most practicable methodology for allocating fertilizer N to satisfy crop- and land-use-specific N application rate goals, the Agriculture Workgroup compared the modified LGU recommendations for application of supplemental inorganic N fertilizer to an alternative approach based on county-level redistribution of Association of American Plant Food Control Officials (AAPFCO) N fertilizer sales data. Because there were relatively small differences between the two methods for estimating supplemental N fertilizer applications, the Agriculture Workgroup approved use of the redistributed AAPFCO fertilizer sales methodology in the Phase 6 Model.*

Application of a P Core NM BMP application rate multiplier modifies the crop- and land-use-specific P application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. A significant modification imposed by the CBP partnership was the assumption that all agricultural acres in the CBW had a soil-test P concentration that corresponded with the "medium" soil test interpretive category. The Panel recognized that, in the absence of soil-test P concentration data, assumed soil-test P concentrations were necessary to create artificial P application rate goals to facilitate CBP model processes. Additionally, in the absence of soil-test P data, county-level redistribution of CBW AAPFCO P fertilizer sales data may serve as a useful surrogate for determining P application rate goals. The Panel also concluded that the inherent uncertainty in P application rate resulting from the adoption of the universal "medium" soil-test P concentration assumption is expected to be similar to or greater than the magnitude of the P application rate modifications resulting from implementation of P Core NM BMP application rate multipliers.
The Panel's proposed application rate multipliers for both N and P Core NM BMPs are based on state LGU recommendations, as modified by the CBP partnership, and apply to the nutrient application rate goal, or input side, of nutrient management modeling scheme for both NM and non-NM acres. Each value represents a multiplicative modifier of the crop- and land-use-specific N or P application rate goal utilized in the CBP models.

The Panel's proposed loss reduction multipliers for N and P Supplemental NM BMPs for each applicable agricultural land use category are multiplicative modifiers that apply to edge-of-stream delivery of N, on the output side of the CBP modeling scheme, and can only be applied if the requirements for N or P Core NM BMPs are met.

The overall BMP efficiencies for N and P nutrient management are derived from a combination of application rate multipliers for the Core Nutrient Management BMPs (N or P) with their corresponding Supplemental Nutrient Management BMP (N or P) loss reduction multipliers. These multipliers are stackable. The N Core NM BMP and P Core NM BMP address the rate of nutrient application while the N Supplemental NM BMPs and P Supplemental NM BMPs address the transport of applied nutrients. The overall effectiveness values (one for N and one for P) are calculated as the combined effect of changes in nutrient application rate and nutrient transport caused by the implementation of Core and Supplemental NM BMPs. Additional details are provided in Section 3.3 of the report.

Pennsylvania DEP

Q1/A1 (pg. 41): These sections should reflect the final report text. Consider "Calibration of spreader/applicator and/or application documentation". We have concerns on our ability to report calibration data but are more confident on mass/area reporting.

Response: *The Panel's description of "spreader/applicator calibration" has been modified in the report to insert "preferably within one year of the application". Operator documentation of previous spreader/applicator calibrations can and should be utilized as part of verification, thus not requiring the verifier to personally conduct or oversee the equipment calibration within one year of the application. The Panel description also includes recognition of "standard calibration practices" for addressing equipment calibration, which could include multiple recognized forms, e.g. small area calibration, field scale calibration, etc. Large scale calibration would require documentation of full capacities of the application equipment, e.g. tons or gallons, a consistent application method, and the number of spreader/tanker applications applied onto a known acreage.*

Q6/A6 (pg. 45) regarding land use reporting to NEIEN: We may have difficulty reporting to this level of detail for most data sources.

Response: *The Panel's recommendations for tracking, verification and reporting through NEIEN are based on the approved Phase 6 land uses. The jurisdictions have the opportunity to report BMP acreage directly to specific land uses, or in a general land use description such as "Row Crops" depending on their ability to track and report the implementation information.*

Appendix B: Methods to Estimate Historic Implementation
General Comments

Jeff Sweeney
Most lines and sections in the report are repeated several times throughout. It gives the impression of a lot of filler to make it look long. I suggest not repeating lines and sections as in a solid professional report.

Response: *The Panel report has been modified based on partner comments where appropriate.*

Delaware
Finally, as states' programs evolve to this report and more importantly, to science, some consideration for the legislative and administrative procedural pace needs to be given. For that reason, I suggest one outcome of the report should be a dialog with states about timelines to modify their NM programs in order to adaptively manage necessary updates.

Similar comment from West Virginia
Most notably, because Nutrient Management Programs vary drastically throughout the jurisdictions, flexibility needs to be incorporated as to how each state achieves the core elements and how these core elements are verified. This will obviously be addressed specifically in the states' verification programs. With this being said, it seems redundant how much verification language is included throughout the document, to the point that it detracts from the Nutrient Management focus.
Also, due to new definitions and requirements West Virginia would request that a three-year ramp up period be implemented to allow all states to make the necessary changes or adjustments to their programs to ensure that they can still receive full credit for Nutrient Management Plans.

Similar comment from VA DEQ
Many aspects of the proposed changes in this report have not been tracked or reported in the past. Actual rates, placement, timing, PSNT, CSNT, P-index use amongst other things are currently not tracked. This is a significant change that will require time to implement assuming nothing changes based on comment and subsequent workgroup and WQGIT meetings/approval. A ramp up period will be needed.

Similar comment from PA DEP
The Phase 6 Nutrient Management approach is considerably different from the past and it would be very useful to have a functional "phase-in period" to ensure that jurisdictions receive full credit for nutrient management plans similar to the "Tier 2" crediting, until additional tracking mechanisms can be established to document implementation of individual Core and Supplemental BMPs. The existing PA Chapter 83 NM Program could include some elements of the NM Supplemental BMPs, however not all operations with a Chapter 83 NM Plan utilize all of the Supplemental BMPs and PA's program does not have any collection mechanism for each of these Supplemental NM BMPs.

Maryland Dept. of Agriculture
The new Supplemental Adjustment BMPs have not been tracked or evaluated to the same degree as the Core Nutrient Management practices. Modification in the Nutrient Management Program reporting requirements will be necessary to quantify the extent of implementation in Maryland. The Department therefore requests flexibility in reporting until new program reporting requirements can be established. Further, jurisdictions should be given the opportunity to estimate historical Supplemental BMP implementation as it would be extremely difficult to glean actual supporting data.

Response: *The Panel recommendations have been modified to reflect a transitional period which may be required for some partner programs. In addition, US EPA is developing a supporting document for partnership support which provides a process whereby the jurisdictions can modify their existing programs over time to address programmatic and legislative actions.*

VA DEQ

It is not clear how this panel's recommendations square with the p5 AgNM panel recommendations that produce various tiers of NM planning and benefit. Under the tier system NM on pasture and other hay did produce a reduction. Did the phase 5 NM panel consider science the phase 6 panel did not? Or has there been new science since the p5 NM panel report was finalized? A cross walk from the phase 5 tier system to the proposed phase 6 panel recommendations is needed to fully understand the potential impacts to the historical representation of AgNM in phase 6 as earlier versions of phase 6 utilized the tier system for the historical reporting.

Response: *The Panel's recommendations were built upon the scientific expertise of the panel members in an academic approach to the BMP evaluation, and the initial ground work established by the Phase 5.3.2 Panel. Some but not all of the Phase 6 NM panel members also served on the Phase 5.3.2 NM Panel. The present Panel elected to address nutrient management practices in a different approach than the Phase 5.3.2 panel, many times utilizing the same scientific information evaluated by the previous panel. The Panel report does address historical NM implementation for the model calibration period.*

Appendix D: Approved Nutrient Management Expert Panel Meeting Minutes

Chesapeake Bay Foundation

Appendix D, the minutes from the Panel meetings was not included. We find this information extremely useful as it provides insights to the discussions and deliberations of the Panel members and can highlight areas where there was consensus and areas where there was more debate. We encourage the CBP to include this information in draft reports of other expert panels.

Response: *The Final Report of the Panel includes the full meeting minutes of the NM Panel as per the requirements of the partnership's BMP Protocol.*

Comments Submitted by:

U.S. EPA – Kelly Shenk and Jeff Sweeney
Jim Cropper, Northeast Pasture Consortium
Gene Yagow, Virginia Tech
Delaware Department of Agriculture (Delaware)
Virginia Department of Conservation & Recreation (Virginia)
Virginia Department of Environmental Quality (VA DEQ)
West Virginia Department of Agriculture (West Virginia)
Pennsylvania Department of Environmental Protection (PA DEP)
Maryland Department of Agriculture
New York – Upper Susquehanna Coalition
Chesapeake Bay Commission
Chesapeake Bay Foundation
Environmental Integrity Project, Potomac Riverkeeper Network, Midshore Riverkeeper Conservancy, Assateague Coastkeeper

Appendix F: Consolidated Response to Comments on: Definitions and Recommended Nutrient Reduction Efficiencies of Nutrient Management for Use in Phase 6.0 of the Chesapeake Bay Program Watershed Model (September 22, 2016 Version)

Environmental Integrity Project ***The report is not clear about how split applications will be treated. Split P applications appear in only one category on pages 11 and 25, but appear in both rate and timing categories on page 17. The report should be revised to make it internally consistent on this point. Overall, it would help to have a more complete explanation of how split N or P applications should be reported.***

Response: *The NM Panel's recommendations have been modified to consistently represent split P applications as a P Timing Adjustment Practice, not as a P Rate Adjustment Practice as previously represented in the Panel's draft and draft Final Report. Split P applications may reduce the environmental risk of P runoff and leaching due to soil water saturation conditions and precipitation events following application.*

New York Department of Agriculture and Markets, DEC, and Upper Susquehanna Coalition
Thank you for your and the Panel's work on the Phase 6 NM Report. Please find comments from NY on the supplemental N and P coefficients for legume hay and other hay, attached. The comments are captured in bubbles adjacent to the highlighted text starting on PDF page 111, with specific recommendations for the supplemental coefficients in Tables 14 and 15 on PDF page 22 of the report. If you have trouble viewing the comments, let me know and I'll get them over to you in another format.

The recommended changes in the comments improve consistency among crops and supplemental management types in Tables 14 and 15 and better reflect manure applications to hay land on dairy farms operating under nutrient management. My sense from prior panel reports to the Ag Workgroup, the Panel's meeting notes, as well as the revised justification for the supplemental coefficients in Tables 14 and 15 is that the focus was on row crops, with hay land as more of an afterthought. Manure is managed differently on hay fields when farms implement nutrient management, justifying credit in the supplemental placement and timing categories for N and P.
Please first see our response to the Panel's comments on PDF page 111 within this draft. The recommended updates to the N supplemental and P supplemental multipliers are then highlighted in Tables 14 and 15, immediately below [for Legume Hay and Other Hay land uses for N Supplemental BMPs, and Other Hay for P Supplemental BMPs.]

- **Please change [N Placement] to 0.97 to value the reality of manure application setbacks from watercourses and from concentrated flows within fields. Fertilizer N is not applied in the setback zones.**

- **Please change [N Timing] to 0.95 to value shifts in manure application timing away from higher risk times of the year (and/or forecasted conditions) as well as breaking up annual applications as splits between hay cuttings.**

- **Please change [P Placement] to 0.90 to value the reality of manure application setbacks from watercourses and from concentrated flows within fields. Fertilizer P is not applied in the setback zones.**

- **Please change [P Timing] to 0.99 to value shifts in manure application timing away from higher risk times of the year (and/or forecasted conditions) as well as breaking up annual applications as splits between hay cuttings.**

Response: *The Panel recommendations have been modified to recognize the value of utilizing nutrient application setbacks for N and P applications on predominantly grass hays represented under the "Other Hay" land use as N and P*

Placement Supplemental NM BMPs. Nutrient injection applications are also currently technically possible, and may become more prevalent in the future.

Response: *The Panel recommendations have been modified to recognize the value of split nutrient applications and lower environmental risk annual timing for N and P applications on predominantly grass hays represented under the "Other Hay land use as N and P Timing Supplemental NM BMPs.*

Response: *The Panel recommendations have not been modified for N applications on predominantly legume hays due to the N fixation capability of legumes, and the regional LGU recommendations for avoiding N applications on legumes.*

Pennsylvania DEP (see Attachment)
Pennsylvania (PA) would like to recognize the Nutrient Management BMP Expert Panel and applaud their efforts to draft Nutrient Management BMP report. The original report dated August 1, 2016, was an approach to nutrient management that could span across the seven jurisdictions. PA could live with the recommendations within that document and we were ready to reach consensus and move forward with the report.

However, the revisions that were made between August 1 and September 21 –the date that the final revised Nutrient Management BMP expert panel report was released — are very concerning as those revisions preclude PA from gaining credit for the substantial number of farms that are regulated under Chapter 91 and PA's Clean Streams Law. The final report removes one of PA's key means of showing progress by including a restriction that was not in the original Expert Panel report and has no real environmental benefit.

Response: *The Panel received significant partnership comments on the Panel's draft recommendation report dated August 1, 2016. Multiple partner comments were received requesting the Panel reconsider its draft recommendations regarding the equal acceptance of "published book values" in place of manure analysis beyond "new, expanded or modified livestock and poultry operations."*

The Chesapeake Bay Program Partnership's approved "BMP Protocol" procedures required that the NM Panel directly respond to these partnership comments as part of the finalization of the Panel's report. The Panel followed the "BMP Protocol" requirements and considered these comments in developing the draft Final Report, choosing to follow standard land-grant university (LGU) recommendations which prioritize the use of soil and manure sampling and laboratory analysis versus "published book values" with the exceptions noted in the report. Penn State University's (PSU) Nutrient Management extension publication, as well as the other Bay regional LGU's, fully support the Panel's recommendations to give precedence to sampling and laboratory analysis results for planning purposes versus "published book values". The PSU extension publications refer to manure analysis testing results as "essential" and "forming the basis for determining appropriate manure applications rates to meet crop nutrient needs." The publications recognize the "very wide" variance of manure nutrient concentrations when compared to "published book values", and recommend the use of book values consistent with the operational exemptions as cited by the NM Panel report, e.g.
http://extension.psu.edu/plants/nutrient-management/educational/manure-storage-and-handling/manure-sampling-for-nutrient-management-planning

The removal of book values for manure analysis in the N and P Core tables, and the introduction of the following language that is found on pages 14 and 16, not only concerns PA, but prevents us from approving the final revised report. We respectfully request that the following language be removed from the document, as well as allowing for manure nutrient book values to be used in lieu of analysis – as was stated in the previous draft document.

> ***"If laboratory analysis of manure is not available, as in the case of new, expanded or modified livestock and poultry operations, or is not required under state-specific regulations, published book values (as described above) may be used for a maximum of three years, after which time laboratory analysis data must be utilized to satisfy N Core (or P Core) NM BMP requirements."***

Response: *The Panel responded to numerous Chesapeake Bay Program partnership comments regarding the Panel's initial draft report. In response to those comments, and in concert with the Phase 6 NM addendum policy statement developed by EPA Region 3 which was unanimously approved by the Agriculture Workgroup on September 22, 2016, the Panel placed a consistent programmatic phase-in period of three-years for the phasing out of equal definitional acceptance of "published book values" in lieu of sampling and laboratory analysis recommendations with the exception of "new, expanded or modified livestock and poultry operations." The language cited above in the draft Final Report has been modified to replace the word "must" with the phrase "is strongly recommended" for not equating published book values in lieu of operational manure analysis values following the programmatic phase-in period.*

The current USDA Natural Resources Conservation Service (NRCS) Conservation Practice Standard for Nutrient Management (CP 590) also supports the Panel's recommendations by incorporating the requirement for the "collection and analysis of manure, organic by-products, and biosolids at least annually, or more frequently if needed to account for operational changes". Consistent with the Panel's report, the NRCS CP 590 Standard likewise recognizes that "when planning for a new or modified livestock operations, acceptable "book values" recognized by the NRCS and the land-grant university, or analysis from similar operations in the geographical area, may be used if they accurately estimate nutrient output from the proposed operation." The NRCS practice standard further requires and defines "current soil tests as those which are no older than three-years, but may be taken on an interval recommended by the land-grant university, e.g. ***http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046177.pdf***

The revisions to the report suggest that PA's regulatory requirements are considered to be less than the partnership's voluntary recommendations. PA's Manure Management regulations apply to all farms in PA that produce or apply manure, regardless of size and number of livestock. This includes farms that have a few laying hens or a couple of goats or horses; small dairy operations with limited storage capacity; and many other types of low-intensity operations. While all large farms (CAOs and CAFOs) are required to take soil and manure tests, and most of the medium sized farms do testing, the implementation of Chapter 91.36 allows for the use of book values to encourage compliance with the regulations. It is not only unreasonable but also unrealistic to require a manure analysis for every one of these small farms in order to develop a manure management plan and receive credit in the Bay Model via implementation of that plan. A manure sample will not be representative of the nutrient content applied throughout the year; therefore, PA allows for the use of standard book values developed by PA's Land Grant University. The book values have been built into the calculation of the prescribed application rates for each animal type and crop group. This leads to standardization, consistency, and accuracy across the estimated 30,000 farms regulated by Chapter 91 in PA's portion of the Chesapeake Bay Watershed.

Response: The Panel's draft Final Report represents the recommendations of an agricultural science panel membership represented of the Bay region. Pennsylvania's land-grant university is directly represented on the Panel by the Commonwealth's leading academic expert on Nutrient Management. Specific language was incorporated into the Panel's initial Draft Report and its draft Final Report to address specific Pennsylvania programmatic characteristics, including the Commonwealth's Manure Management regulations.

However, the NM Panel report is also intended to be applied to all agricultural lands within the Chesapeake Bay watershed based on applicable and established land-grant university standards across the six-state region. Identified differences between the separate land-grant university recommendations were incorporated, but they were convincingly consistent on the recognition that manure sample collection and analysis is strongly recommended over "published book values" as a basis for Nutrient Management recommendations.

The Panel's recommendations regarding the preference for soil analysis testing, retains and further clarifies the recognition that a "requirement for having a P soil test may be waived if restrictions on manure application (rates, timing, placement), are imposed that limit P application rates and management to the same degree as if the site's soil was in the high soil-test interpretive category." The clarification is that the replacement of a P soil analysis for a given site is with a high soil-test interpretive value.

Other comments and concerns regarding the revised document are as follows:

- **Page 7, Table 2 and Page 8, Table 3 – Tables should reflect and summarize what is written in the narrative of the document. The removal of the descriptive detail that was contained in the original draft final now creates a difference between what is written in the text and what is provided in the tables.**
- **Page 7, Table 2 and Page 8, Table 3 – Instead of "Manure analysis and volume," we recommend stating "Must account for manure nutrient content." This will allow for the use of book values or individual analysis.**
- **Page 8, Table 3 – Instead of "P soil tests at field management unit level," we recommend stating "Must account for P residual in soil." This will allow for restrictions based on crop P removal and not on soil tests.**
- **Page 9, Table 4 and Page 10, Table 8 – Instead of "Manure analysis < 1 year old," we recommend stating, "Manure analysis less than or equal to 1 year old"**
- **Page 12, Figure 1 and Page 13, Figure 2; Page 13 and Page 15 – While this is not a change from the previous version, the statement of "All elements are required" to obtain Core N or Core P is confusing. We recommend inserting "as applicable," since there are operations that strictly use commercial fertilizer. As written, it can be inferred that those non-manure operations could not obtain Core (or Supplemental) credit.**

Response: *The Panel draft Final Report utilized the N and P Core NM BMP descriptive Tables as a way of broadly presenting the elements of these BMPs in a simple format. The Panel placed detailed descriptions of the N and P Core NM BMPs in the report's narrative sections starting with Section 2.2 through Section 2.3. This format enables additional descriptive information to be presented which would otherwise be difficult in a table format. The descriptive sections represent the Panel's full recommended description of the BMPs for tracking, verification and reporting purposes.*

Response: *The Panel draft Final Report utilized the N and P Core NM BMP descriptive Tables as a way of broadly presenting the elements of these BMPs in a simple format. The Panel placed detailed descriptions of the N and P Core NM BMPs in the report's narrative sections starting with Section 2.2 through Section 2.3. This format enables additional descriptive information to be presented which would otherwise be difficult in a table format. The descriptive sections represent the Panel's full recommended description of the BMPs for tracking, verification and reporting purposes.*

Response: *The Panel's element description in the P Core NM BMP descriptive table of "P soil tests at field management unit level" represents the Panel's preference for P soil tests for determining the P soil residual value. The Panel did recognize that the "requirement for having a P soil test may be waived if restrictions on manure application (rates, timing, placement), are imposed that limit P application rates and management to the same degree as if the site's soil was in the high soil-test interpretive category."*

Response: *The Panel's recommendations for Advanced N and P Assessment Tools have been modified to represent a "Manure analysis less than or equal to 1 year old" as suggested.*

Response: *The Panel's recommendations for N and P Core NM BMPs have been modified to include the descriptive term "as applicable" throughout the report to more appropriately represent those operations which may utilize only non-organic nutrient sources that already have a known and regulated nutrient analysis.*

Attachment

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

October 14, 2016

Mr. Mark P. Dubin
Agricultural Technical Coordinator
University of Maryland Extension
U. S. EPA Chesapeake Bay Program Office
410 Severn Avenue, Suite 112
Annapolis, MD 21403

Dear Mr. Dubin:

Pennsylvania (PA) would like to recognize the Nutrient Management BMP Expert Panel and applaud their efforts to draft a Nutrient Management BMP report. The original report dated August 1, 2016, was an approach to nutrient management that could span across the seven jurisdictions. PA could live with the recommendations within that document and we were ready to reach consensus and move forward with the report.

However, the revisions that were made between August 1 and September 21 - the date that the final revised Nutrient Management BMP Expert Panel report was released - are very concerning as those revisions preclude PA from gaining credit for the substantial number of farms that are regulated under Chapter 91 and PA's Clean Streams Law. The final report removes one of PA's key means of showing progress by including a restriction that was not in the original Expert Panel report and has no real environmental benefit.

The removal of book values for manure analysis in the N and P Core tables, and the introduction of the following language that is found on Pages 14 and 16, not only concerns PA, but prevents us from approving the final revised report. We respectfully request that the following language be removed from the document, as well as allowing for manure nutrient book values to be used in lieu of analysis - as was stated in the previous draft document.

> *"If laboratory analysis of manure is not available, as in the case of new, expanded, or modified livestock and poultry operations, or is not required under state-specific regulations, published book values (as described above) may be used for a maximum of three years, after which time laboratory analysis data must be utilized to satisfy N Core (or P Core) NM BMP requirements."*

The revisions to the report suggest that PA's regulatory requirements are considered to be less than the partnership's voluntary recommendations. PA's Manure Management regulations apply to all farms in PA that produce or apply manure, regardless of size and number of livestock. This includes farms that have a few laying hens or a couple of goats or horses; small dairy operations with limited storage capacity; and many other types of low-intensity operations. While all large farms (CAOs and CAFOs) are required to take soil and manure tests, and most of the medium sized farms do testing, the implementation of Chapter 91.36 allows for the use of book values to encourage compliance with the regulations. It is not only unreasonable but also unrealistic to require a manure analysis for every one of these small farms in order to develop a manure management plan and receive credit in the Bay Model via implementation of that plan. A manure sample will not be representative of the nutrient content applied throughout the year; therefore, PA allows for the use of standard book values developed by PA's Land Grant University. The book values have been built into the calculation of the prescribed application rates for each animal type and crop group. This leads to standardization, consistency, and

Chesapeake Bay Office
Rachel Carson State Office Building | P.O. Box 8555 | Harrisburg, PA 17105-8555 | 717.772.4053 | www.dep.pa.gov

accuracy across the estimated 30,000 farms regulated by Chapter 91 in PA's portion of the Chesapeake Bay Watershed.

Most importantly, this specific revision undermines PA's implementation of our existing regulatory program for manure management. This undermining of the regulatory program for manure management occurs at a time when PA is beginning a targeted inspection program of farms and a new funding cost-share effort for plans. The regulations regarding manure management have been in place since the 1980s, but it was only within the last few years that PA focused on full compliance with these regulations by revising the manure management manual and holding hundreds of training sessions to aid farmers in completing these plans. It is only in the last few weeks that PA began a targeted effort to inspect farm operations for compliance with these regulatory requirements. Requiring manure analyses in order to show progress and receive credit in the model is detrimental not only to PA, but also to the Partnership. This undermines our regulatory structure at an extremely critical time. PA recognizes that accurate soil and manure samples and tests are preferred to book values, and PA will take necessary steps to improve the implementation of our regulatory program to utilize these, but regulations require common sense and practical implementation. As was reiterated in the most recent ***PA in the Balance*** conference, we need to move forward in the most positive, thoughtful, and practical manner in order to improve water quality. As noted in our new Chesapeake Bay restoration strategy, one of the six components of this "reboot" is to identify and implement legislative, programmatic, or regulatory changes to provide additional tools to meet federal pollution reduction goals by 2025. The implementation of our regulations for manure may need to be adjusted; however, to do so now, to change the rules when we've just recently begun requiring compliance, will significantly undermine our Chesapeake Bay restoration effort.

Other comments and concerns regarding the revised document are as follows:

- Page 7, Table 2 and Page 8, Table 3 – Tables should reflect and summarize what is written in the narrative of the document. The removal of the descriptive detail that was contained in the original draft final now creates a difference between what is written in the text and what is provided in the tables.
- Page 7, Table 2 and Page 8, Table 3 – Instead of "Manure analysis and volume," we recommend stating "Must account for manure nutrient content." This will allow for the use of book values or individual analysis.
- Page 8, Table 3 – Instead of "P soil tests at field management unit level," we recommend stating "Must account for P residual in soil." This will allow for restrictions based on crop P removal and not on soil tests.
- Page 9, Table 4 and Page 10, Table 8 – Instead of "Manure analysis < 1 year old," we recommend stating, "Manure analysis less than or equal to 1 year old"
- Page 12, Figure 1 and Page 13, Figure 2; Page 13 and Page 15 – While this is not a change from the previous version, the statement of "All elements are required" to obtain Core N or Core P is confusing. We recommend inserting "as applicable," since there are operations that strictly use commercial fertilizer. As written, it can be inferred that those non-manure operations could not obtain Core (or Supplemental) credit.

We welcome open discussion on our request. Thank you for the opportunity to comment.

Sincerely,

Ted Tesla For

Veronica Kasi
Manager

Appendix G: Amended Report October 20, 2016

The Phase 6 Nutrient Management Expert Panel presented its final report on nutrient management practices for use in Phase 6.0 of the Chesapeake Bay Program Watershed Model to the Agriculture Workgroup for approval on October 20, 2016. The Agriculture Workgroup approved the report with amendments added by the workgroup. These Agriculture Workgroup implemented amendments to the Panel's report divided both the Nitrogen Core Nutrient Management and Phosphorus Core Nutrient Management BMPs into two components reflecting whether on-site specific manure analysis for nitrogen, and both soil and manure analysis for phosphorus; or estimated (a.k.a. book value) manure analysis for nitrogen, and both soil and manure estimated analysis for phosphorous is used to determine nitrogen or phosphorus application rates respectively. These Agriculture Workgroup modifications resulted in the need to make multiple changes in the Panel's final report.

All substantive changes resulting from the Agriculture Workgroup's modifications are highlighted with gray shading in the following amended report. In addition to the main body of the report, Appendices A and H were also amended to reflect the changes made by the Agriculture Workgroup.

Final BMP Panel Report

Definitions and Recommended Nutrient Reduction Efficiencies of

Nutrient Management Practices

For Use in Phase 6.0 of the
Chesapeake Bay Program Watershed Model

Recommendations for Approval by the Water Quality Goal Implementation Team's
Watershed Technical and Agricultural Workgroups

Submitted by the Phase 6.0 Nutrient Management BMP Expert Panel

Submitted to:
Agriculture Workgroup
Chesapeake Bay Program

August 1, 2016
Revised September 22, 2016
Final October 18, 2016
Approved as Amended by Agriculture Workgroup October 20, 2016

Contents

Preface

The Phase 6 Nutrient Management Expert Panel presented its final report on nutrient management practices for use in Phase 6.0 of the Chesapeake Bay Program Watershed Model to the Agriculture Workgroup for approval on October 20, 2016. The Agriculture Workgroup approved the report with amendments added by the workgroup. These Agriculture Workgroup implemented amendments to the Panel's report divided both the Nitrogen Core Nutrient Management and Phosphorus Core Nutrient Management BMPs into two components reflecting whether on-site specific manure analysis for nitrogen, and both soil and manure analysis for phosphorus; or estimated (a.k.a. book value) manure analysis for nitrogen, and both soil and manure estimated analysis for phosphorous is used to determine nitrogen or phosphorus application rates respectively. These Agriculture Workgroup modifications resulted in the need to make multiple changes in the Panel's final report. All substantive changes resulting from the Agriculture Workgroup's modifications are highlighted with light-gray shading.

Acronyms and Abbreviations

AAPFCO	Association of American Plant Food Control Officials
ac.	Acre
AgWG	Agriculture Workgroup
ARS	USDA Agricultural Research Service
BMP	Best Management Practice
bu.	Bushel
bu./ac.	Bushels per Acre
CBP	Chesapeake Bay Program
CBPO	Chesapeake Bay Program Office
CBPWM	Chesapeake Bay Program Watershed Model
CBW	Chesapeake Bay Watershed
CEAP	Conservation Effects Assessment Project
CRC	Chesapeake Research Consortium
CSNT	Corn Stalk Nitrate Test
DE	Delaware
DRP	Dissolved Reactive Phosphorus
EOF	Edge of Field
EONR	Economic Optimum N Rate
FSNT	Fall Soil Nitrate Test
ft.	Feet
ha	Hectare
HUC	Hydrologic Unit Code
ISNT	Illinois Soil Nitrogen Test
kg	Kilogram
lbs.	Pounds
LGU	Land-Grant University
MD	Maryland
N	Nitrogen

N Core NM EMA BMP	Nitrogen Core Nutrient Management Estimated Manure Analysis Best Management Practice
N Core NM OMA BMP	Nitrogen Core Nutrient Management On-Site Manure Analysis Best Management Practice
N Supplemental NM BMP	Nitrogen Supplemental nutrient management Best Management Practice
NEIEN	National Environmental Information Exchange Network
NM	Nutrient Management
NMP	Nutrient Management Plan
NO_3-N	Nitrate N
NRCS	USDA Natural Resources Conservation Service
NRI	National Resources Inventory
NY	New York
P	Phosphorus
P Core NM ESMA BMP	Phosphorus Core Nutrient Management Estimated Soil & Manure Analysis Best Management Practice
P Core NM OSMA BMP	Phosphorus Core Nutrient Management On-Site Soil & Manure Analysis Best Management Practice
P Supplemental NM BMP	Phosphorus Supplemental nutrient management Best Management Practice
PA	Pennsylvania
PAN	Plant Available N
Panel	Nutrient Management Expert Panel
PET	Phosphorus Environmental Threshold
PSNT	Pre-sidedress Nitrate Test
QAPP	Quality Assurance Project Plan
TN	Total Nitrogen
TP	Total Phosphorus
USDA	U.S. Department of Agriculture
VA	Virginia
VTCA	Virginia Tech Corn Algorithm
WTWG	Watershed Technical Workgroup
WQGIT	Water Quality Goal Implementation Team
WV	West Virginia

Summary of Recommendations

8 Introduction

Nutrient management practices are implemented on millions of acres of agricultural lands across the Chesapeake Bay Watershed (CBW). It is one of the oldest best management practices (BMPs) in agriculture and is the cornerstone of stewardship efforts by conservation groups, producers and jurisdictions. This document summarizes the recommendations of the Phase 6 Nutrient Management Expert Panel (the Panel) for revised definitions and credits for nutrient management practices. The Panel, whose members are identified in Table 1, proposes that the Chesapeake Bay Program's (CBP) existing definitions and credits associated with implementation of Nutrient Management Plans (NMPs) be replaced by independent sets of practice elements for nitrogen (N) and phosphorus (P) management due to the marked difference in the use, fate, and transport of these nutrients in agricultural systems. The structures for both N and P nutrient management are similar, however, with supplemental management elements stacked onto a required core set of management elements.

Table 1. CBP Phase 6.0 Nutrient Management Expert Panel Membership

Name	Jurisdiction	Affiliation	Role
Frank Coale	Maryland	University of Maryland	Panel Chair
Deanna Osmond	North Carolina	North Carolina State University	Panel Member
Doug Beegle	Pennsylvania	Penn State University	Panel Member
Jack Meisinger	Maryland	USDA-Agriculture Research Service	Panel Member
Tom Fisher	Maryland	University of Maryland Center for Environmental Science	Panel Member
Quirine Ketterings	New York	Cornell University	Panel Member
Chris Brosch	Delaware	Delaware Department of Agriculture	Watershed Technical Workgroup representative
Matt Johnston	Maryland	University of Maryland, CBPO	Modeling Team representative
Technical support provided by Mark Dubin (University of Maryland, CBPO), Lindsey Gordon (CRC Staffer), and Steve Dressing (Tetra Tech).			

CBPO – Chesapeake Bay Program Office; CRC – Chesapeake Research Consortium; USDA – U.S. Department of Agriculture

9 Practice Definitions

Nutrient management has four basic components: the nutrient source, rate, timing, and placement. Each of these four components of NM are managed at the field or sub-field scale in a manner to support crop productivity, achieve high nutrient use efficiency by the growing crop, and to minimize nutrient loss to the environment. The four components of NM planning interact with each other on a site-specific basis and are modified by site-specific field management, soil properties, and weather conditions. Thus, the Panel defines Nutrient Management as the implementation of a site-specific combination of nutrient source, rate, timing, and placement into a strategy that seeks to optimize agronomic and environmentally efficient utilization N and P. Improvement in nutrient-use efficiency necessitates documentation of NM implementation strategies that are suitable for independent verification.

Nutrient management also provides other important benefits to the agricultural and the environmental communities. These benefits include long-standing educational opportunities conducted in various venues for a wide variety of audiences that convey the fundamentals of NM and state-of-the-science practices and assessment tools. It is essential that an initial baseline for NM implementation is established that allows estimation of progress over time. Application of NM BMPs

will interrelate with other agricultural nonpoint source BMPs and communication with other BMP Expert Panels is essential to define appropriate implementation and crediting.

Nutrient management for Phase 6.0 of the Chesapeake Bay Program Watershed Model (the Phase 6 model) is separated into independent sets of practice elements for N and P management due to the marked difference in the use, fate, and transport of these nutrients in agricultural systems. The structures for both N and P nutrient management are similar, however, with supplemental management elements stacked onto a required core set of management elements.

Practice Name(s)

- Nitrogen (N) Core Nutrient Management Estimated Manure Analysis BMP
- Nitrogen (N) Core Nutrient Management On-Site Manure Analysis BMP
- Phosphorus (P) Core Nutrient Management Estimated Soil & Manure Analysis BMP
- Phosphorus (P) Core Nutrient Management On-Site Soil & Manure Analysis BMP
- Nitrogen (N) Rate Supplemental Nutrient Management BMP
- Nitrogen (N) Placement Supplemental Nutrient Management BMP
- Nitrogen (N) Timing Supplemental Nutrient Management BMP
- Phosphorus (P) Rate Supplemental Nutrient Management BMP
- Phosphorus (P) Placement Supplemental Nutrient Management BMP
- Phosphorus (P) Timing Supplemental Nutrient Management BMP

Core Nutrient Management BMPs

The elements of the N Core Nutrient Management BMPs are found in Table 2. Application of a N Core NM BMP application rate multiplier modifies the crop- and land-use-specific N application rate goal, which is based on Land-Grant University (LGU) crop fertilization recommendations, as modified by the CBP partnership. In an effort to determine the most practicable methodology for allocating fertilizer N to satisfy crop- and land-use-specific N application rate goals, the Agriculture Workgroup compared the modified LGU recommendations for application of supplemental inorganic N fertilizer to an alternative approach based on county-level redistribution of Association of American Plant Food Control Officials (AAPFCO) N fertilizer sales data. This methodological comparison indicated that there were relatively small differences between the two methods for estimating supplemental N fertilizer applications, leading the Agriculture Workgroup to approve use of the redistributed AAPFCO fertilizer sales methodology in the Phase 6 Model. The Panel recommends that similar comparative analyses be conducted in the future to evaluate newly available fertilizer sales data and to further evaluate the redistributed fertilizer sales methodology's forecasting ability. Inconsistencies between estimates generated by the two methods should be investigated and rectified based on data source quality and consistency using contiguous or regional county-level data.

Table 2. Elements of the N Core Nutrient Management BMPs

NITROGEN Core Nutrient Management On-Site Manure Analysis BMP (ALL applicable core elements required to be implemented and verified)
N rate according to LGU recommendations at field management unit level
Manure analysis and volume using test values to determine nitrogen content
Spreader/applicator calibration
Yield estimates and cropping plan at field management unit level
Cropping and manure history at field management unit level
NITROGEN Core Nutrient Management Estimated Manure Analysis BMP (ALL applicable core elements required to be implemented and verified)
N rate according to LGU recommendations at field management unit level
Manure analysis and volume using book values to determine nitrogen content
Spreader/applicator calibration
Yield estimates and cropping plan at field management unit level
Cropping and manure history at field management unit level

The elements of the P Core Nutrient Management BMPs are found in Table 3. Application of a P Core NM BMP application rate multiplier modifies the crop- and land-use-specific P application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. A significant modification imposed by the CBP partnership was the assumption that all agricultural acres in the CBW had a soil-test P concentration that corresponded with the "medium" soil test interpretive category. The Panel recognized that, in the absence of soil-test P concentration data, assumed soil-test P concentrations were necessary to facilitate CBP model processes. However, the Panel also recognized that implementation of the universal "medium" soil-test P assumption infused a high level of site-specific uncertainty into the modeled P application rate. In general, the inherent uncertainty in P application rate resulting from the adoption of the universal "medium" soil-test P concentration assumption is expected to be similar to or greater than the magnitude of the P application rate modifications resulting from implementation of P Core NM BMP application rate multipliers.

In practice, LGU recommendations for P application are based on crop- and site-specific soil-test P concentration. Currently, soil-test P concentration data are not available to the CBP. The Panel recommends that, in the future, crop- and site-specific soil-test P concentration data should be collected, aggregated to the appropriate scale, summarized to eliminate disclosure of confidential business information, and utilized as the foundation for determining P application rate goals and the appropriate application of P Core NM BMPs. In the absence of soil-test P data and soil-test P based application rate goals, soil-test P concentration must be assumed and, in turn, utilized to create artificial P application rate goals. Additionally, in the absence of soil-test P data, county-level redistribution of CBW AAPFCO P fertilizer sales data may serve as a useful surrogate for determining P application rate goals.

Field management shall be considered compliant with P fertilization recommendations when P application recommendations resulting from site-specific environmental risk assessments (i.e. P Index, P Site Index, P Management Tool, etc.) allow higher P application rates than the standard LGU soil-test based recommendations, after accounting for the site-specific potential for P loss to streams. In another example, Virginia nutrient management planners may utilize a more restrictive method known as the Phosphorus Environmental Threshold (PET) in lieu of soil-test P based recommendations when evaluating application of organic nutrient sources. Using the PET method, P from organic sources may be applied to fields that test less than a regionally-specified degree of soil P saturation, as quantified by Mehlich 1 soil-test P concentration. By physiographic region, the PET soil-test P thresholds are: 135 ppm – Eastern Shore & Lower Coastal Plain; 136 ppm - Middle & Upper Coastal Plain & Piedmont; and 162 ppm - Ridge and Valley. Nitrogen applications cannot exceed crop N needs when using PET. Additional details may be found in "Virginia Nutrient Management Standards and Criteria", as revised July 2014. Other examples may be similarly applicable.

The P Core NM On-Site Soil & Manure Analysis BMP (P Core NM OSMA BMP) requires a P soil test at the field management unit level. This required element may be waived under the P Core NM Estimated Soil & Manure Analysis BMP (P Core NM ESMA BMP) if, as in the case of Pennsylvania's manure management guidelines, restrictions on manure application (rates, timing, and placement) are imposed that limit total P application rates and management to the same degree as if the site was in the high P soil test interpretive category.

Table 3. Elements of the P Core Nutrient Management BMPs

PHOSPHORUS Core Nutrient Management On-Site Soil & Manure Analysis BMP (ALL applicable core elements required to be implemented and verified)
P rate according to LGU recommendations at field management unit level
P soil tests at field management unit level
Manure analysis and volume using test values to determine phosphorus content
Spreader/applicator calibration
Yield estimates and cropping plan at field management unit level
Cropping and manure history at field management unit level
PHOSPHORUS Core Nutrient Management Estimated Soil & Manure Analysis BMP (ALL applicable core elements required to be implemented and verified)
P rate according to LGU recommendations at field management unit level
P soil tests at field management unit level. Soil testing requirement may be waived if restrictions on manure applications (rate, timing, and placement) are imposed that limit P application rates and management to the same degree as if the soil test result for phosphorus was in the "high" category.
Manure analysis and volume using book values to determine phosphorus content
Spreader/applicator calibration
Yield estimates and cropping plan at field management unit level
Cropping and manure history at field management unit level

Supplemental Nutrient Management BMPs

The Nitrogen Supplemental Nutrient Management BMPs (N Supplemental NM BMPs) involve applying a loss-reduction multiplier for the N Supplemental NM BMP elements only after satisfactory implementation of either the N Core NM On-Site Manure Analysis BMP (N Core NM OMA BMP) or the N Core NM Estimated Manure Analysis BMP (N Core NM EMA BMP). Multiple advanced site assessments and N management tools may be utilized to inform the application of the appropriate N adjustment practices, but do not represent a N loss reduction credit in and of themselves. A list of example N site assessments and N management tools is given in Table 4. This list is not intended to be exhaustive. Rather, Table 4 presents examples of current techniques and tools that the Panel deems potentially useful in supporting crediting of changes in N management and recognizes that this listing will need to be updated over time as new tools and procedures are developed.

Advanced site assessments and application of N management tools that result in a verifiable implementation of a change in planned N application rate, N application timing or N application placement may result in a N Supplemental NM BMP loss reduction credit. The actual crediting of the Supplemental NM BMPs requires placing a given BMP into a N Rate, N Timing, or N Placement Supplemental NM BMP category (Tables 5 through 7). One single N Supplemental NM BMP loss reduction multiplier may be credited for each of the N Rate, N Timing, and N Placement categories. The actual values for these Supplemental NM BMP loss reduction multipliers are presented later in this report (Table 14). Supplemental N NM BMP loss reduction credits for N rate, N timing, and N placement are stackable, e.g., multiplicative with diminishing returns for reducing environmental loss.

Table 4. Examples of advanced N site assessments and N management tools that may be used to support implementation of changes in originally planned N application rate, N application placement, and/or N application timing. Additional assessment techniques and tools may be utilized to support implemented changes in N management.

Advanced N Assessment Tools
Pre-sidedress Nitrate Test (PSNT)
Manure analysis ≤ 1 year old
On-farm replicated research
Corn Stalk Nitrate Test (CSNT)
N-loss risk assessments & models - Ammonia loss
Yield mapping
Illinois Soil Nitrogen Test (ISNT)
On-farm strip trials
N-loss risk assessments & models - Leaching loss
Fall Soil Nitrate Test (FSNT)
N-loss risk assessments & models - Denitrification losses
Whole farm balances
In-season sensors/remote sensing in general
Geo-spatial mapping

Example elements of the N Rate Supplemental NM BMP are listed in Table 5. Additional N management practices that result in reductions in the rate of applied N may be applicable.

Table 5. Elements of the N Rate Supplemental Nutrient Management BMP

N Rate Adjustment Practice (implementation of one or more BMPs required)
N rate less than LGU recommendations
Split N applications for reduced total rate
Variable rate N application at sub-field management unit level

Example elements of the N Placement Supplemental NM BMP are listed in Table 6. Subsurface injection or incorporation applies only to inorganic fertilizer N. Incorporation or injection of manure is addressed by the Phase 6 Manure Incorporation and Injection Expert Panel report with the following practices: Manure Injection, Manure Incorporation High Disturbance, and Manure Incorporation Low Disturbance. Additional N management practices that result in purposeful physical placement of N sources such that the potential for N loss to the environment is reduced and/or crop N-use efficiency is improved may be applicable.

Table 6. Elements of the N Placement Supplemental Nutrient Management BMP

N Placement Adjustment Practice (implementation of one or more BMPs required)
Subsurface injection or incorporation of applied Inorganic N
N application setbacks from water

Example elements of the N Timing Supplemental NM BMP are listed in Table 7. Additional N management practices that result in the enhanced precision of the timing of application of N sources that reduces the potential for N loss to the environment and/or improves crop N-use efficiency may be applicable.

Table 7. Elements of the N Timing Supplemental Nutrient Management BMP

N Timing Adjustment Practice (implementation of one or more BMPs required)
Split N applications
PSNT

The Phosphorus Supplemental Nutrient Management BMPs (P Supplemental NM BMPs) involve applying a loss-reduction multiplier for the P Supplemental NM BMP elements only after satisfactory implementation of either the P Core NM OSMA BMP or the P Core NM ESMA BMP. Multiple advanced site assessments and P management tools may be utilized to inform the application of the appropriate P adjustment practices, but do not represent a P loss reduction credit in and of themselves. A list of example P site assessments and P management tools is given in Table 8. This list is not intended to be exhaustive. Rather, Table 8 presents examples of current techniques and tools that the Panel deems potentially useful in supporting crediting of changes in P management and will need to be updated over time as new tools and evaluative procedures are developed.

Advanced site assessments and application of P management tools that result in a verifiable implementation of a change in planned P application rate, P application timing or P application placement may result in a P Supplemental NM BMP efficiency credit. The actual crediting of the Supplemental NM BMPs requires placing a given BMP into either a P Rate, or P Timing, or P Placement Supplemental NM BMP category (Tables 9 through 11). One single P Supplemental NM BMP loss reduction multiplier may be credited for each of the P Rate, P Timing, or P Placement categories. The actual values for these Supplemental NM BMP loss reduction multipliers are presented later in the report (Table 15). Supplemental NM BMP loss reduction credits for P rate, P timing, and P placement are stackable, e.g., multiplicative with diminishing returns for reducing environmental loss.

Table 8. Examples of advanced P site assessments and P management tools that may be used to support implementation of changes in originally planned P application rate, P application placement, and/or P application timing. Additional assessment techniques and tools may be utilized to support implemented changes in P management.

Advanced P Assessment Tools
Soil-test P remediation/declining
P Index assessment
Grid soil sampling
Manure analysis ≤ 1 year old
On-farm replicated research
Yield mapping
On-farm strip trials
Whole farm balances
Geo-spatial mapping

Example elements of the P Rate Supplemental NM BMP are listed in Table 9. Additional P management practices that result in reductions in the rate of applied P may be applicable.

Table 9. Elements of the P Rate Supplemental Nutrient Management BMP

P Rate Adjustment Practice (implementation of one or more BMPs required)
P-based manure rate based on annual crop P removal
P rate less than LGU recommendations
Variable rate P at sub-field management unit level

Example elements of the P Placement Supplemental NM BMP are listed in Table 10. The P placement practices of subsurface injection or incorporation apply only to inorganic fertilizer P. Incorporation or injection of manure P is addressed by the Phase 6 Manure Injection & Incorporation Expert Panel report with the following practices: Manure Injection, Manure Incorporation High Disturbance, and Manure Incorporation Low Disturbance. Additional P management practices that result in the purposeful physical placement of P sources such that the potential for P loss to the environment is reduced may be applicable.

Table 10. Elements of the P Placement Supplemental Nutrient Management BMP

P Placement Adjustment Practice (implementation of one or more BMPs required)
Subsurface injection or incorporation of applied inorganic P
P application setbacks from water

Example elements of the P Timing Supplemental NM BMP are listed in Table 11. Additional P management practices that result in the enhanced precision of the timing of application of P sources that reduces the potential for P loss to the environment may be applicable.

Table 11. Elements of the P Timing Supplemental Nutrient Management BMP

P Timing Adjustment Practice (implementation of one or more BMPs required)
P application in lower P-loss risk season
Split P applications

Figure 1 illustrates how the N Core NM BMPs and the N Supplemental NM BMPs are combined for credit. As described above, N Supplemental NM BMPs can only be credited if either the N Core NM OMA BMP or the N Core NM EMA BMP is implemented and verified. The N Supplemental NM BMPs do not result in additional credit unless implementation of adjustments in N rate, N placement, or N timing is verified. The N Supplemental NM BMPs are assigned to three categories: N Rate Adjustment Practices, N Placement Adjustment Practices, and N Timing Adjustment Practices. The Supplemental NM BMP loss reduction credit for each of these three categories can be obtained if implementation of at least one effective practice from each category is verified. For example, if implementation of the N Core NM OMA BMP is verified and implementation of both N application setbacks from water (a N placement adjustment) and variable rate N application (a N rate adjustment) are verified, the application rate multiplier credit may be claimed for the N Core NM OMA BMP and additional loss reduction multiplier credits may be claimed for both the N Placement Supplemental NM BMP and the N Rate Supplemental NM BMP. In this example, no additional loss reduction multiplier credit may be claimed for the N Timing Supplemental NM BMP.

Figure 2 illustrates how the P Core NM BMPs and the P Supplemental NM BMPs are combined for credit. As described

above, P Supplemental NM BMPs can only be credited if either the P Core NM OSMA BMP or the P Core NM ESMA BMP is implemented and verified. The P Supplemental NM BMPs do not result in additional credit unless implementation of adjustments in P rate, P placement, or P timing is verified. The P Supplemental NM BMPs are assigned to three categories: P Rate Adjustment Practices, P Placement Adjustment Practices, and P Timing Adjustment Practices. The Supplemental NM BMP loss reduction credit for each of these three categories can be obtained if implementation of at least one effective practice from each category is verified. For example, if implementation of the P Core NM OSMA BMP is verified and implementation of both P application setbacks from water (a P placement adjustment) and P-based manure rate based on annual crop P removal (a P rate adjustment) are verified, the application rate multiplier credit may be claimed for the P Core NM OSMA BMP and additional loss reduction multiplier credits may be claimed for both the P Placement Supplemental NM BMP and the P Rate Supplemental NM BMP. In this example, no additional loss reduction multiplier credit may be claimed for the P Timing Supplemental NM BMP.

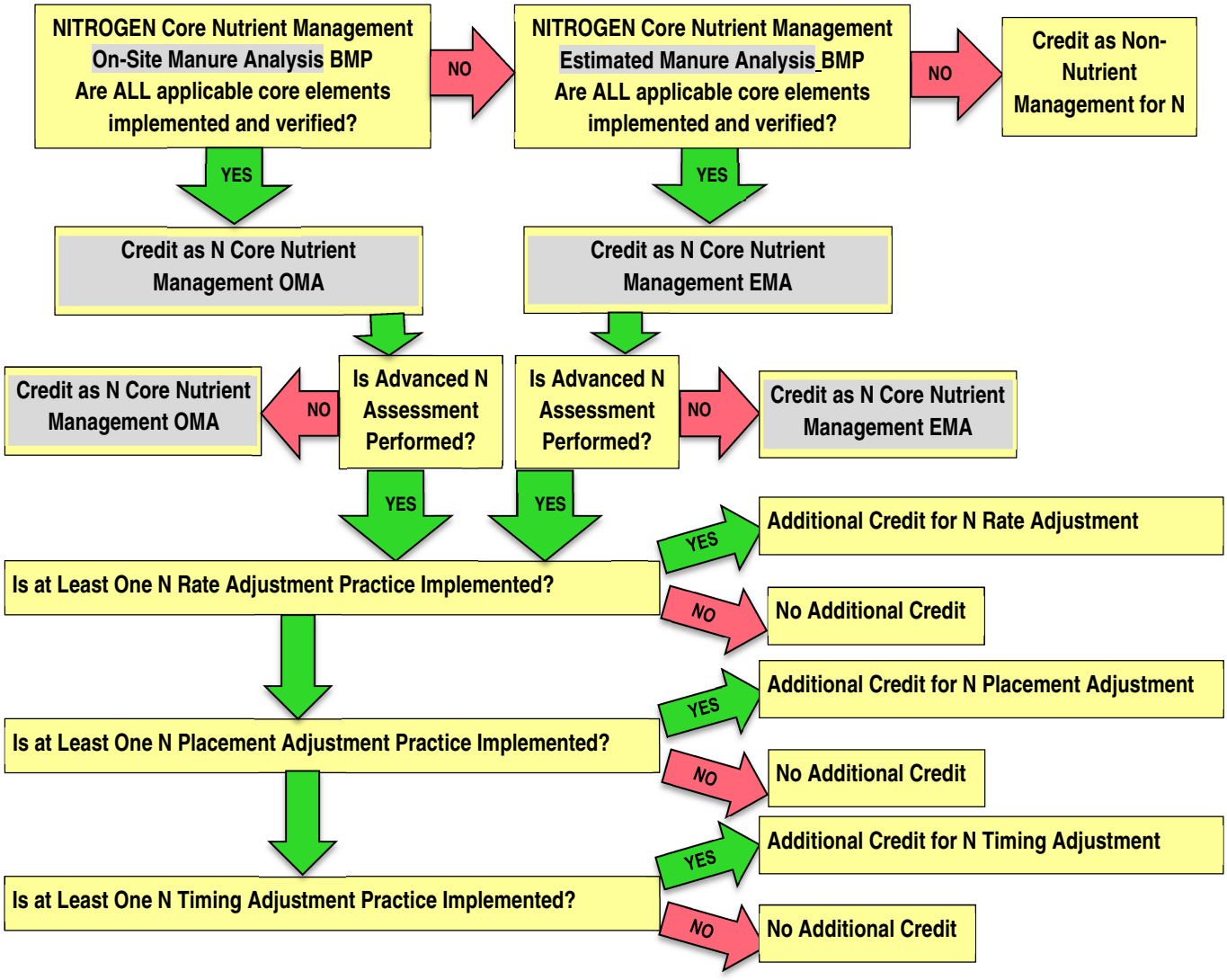

Figure 1. Linkage of Core and Supplemental N Nutrient Management Practices

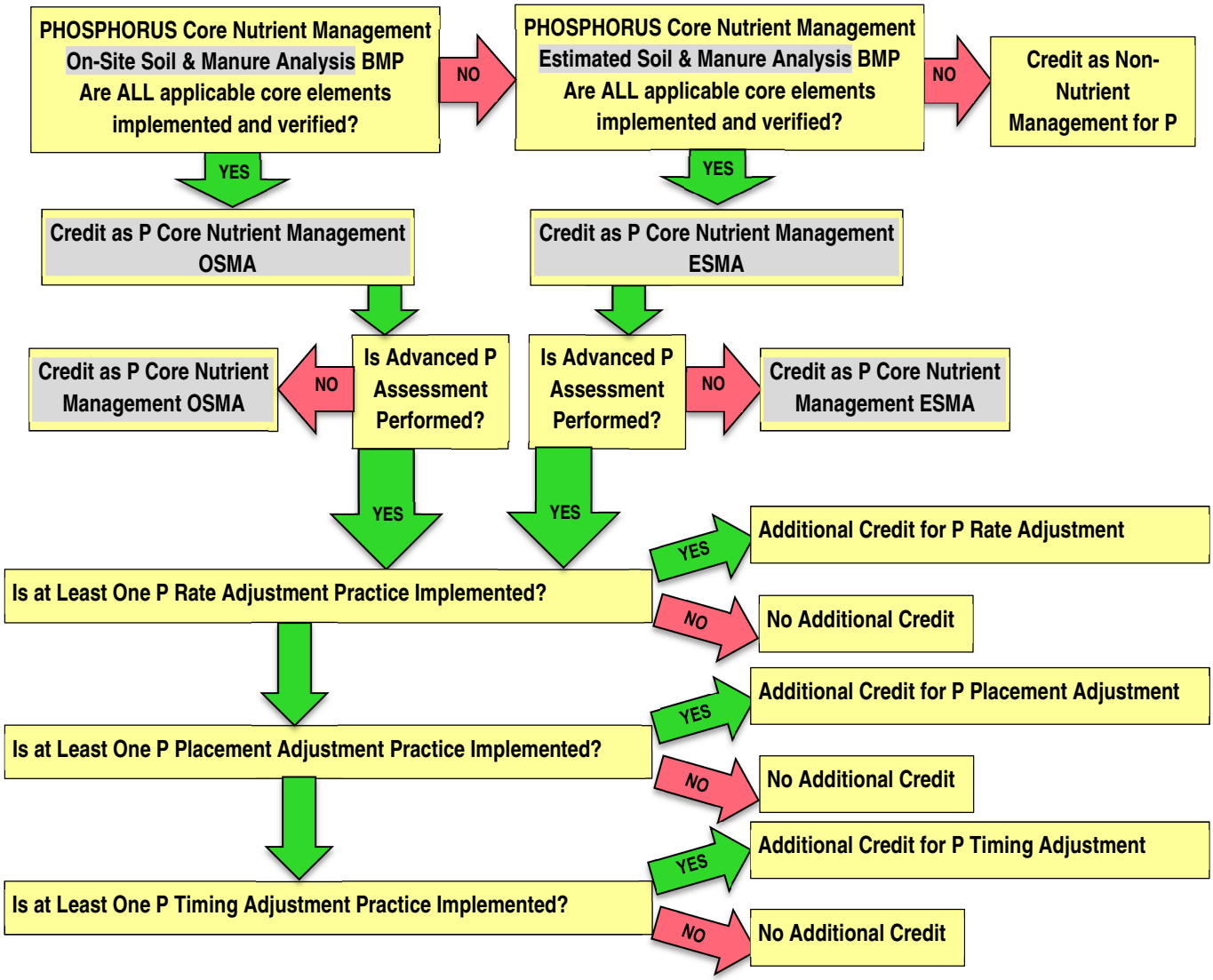

Figure 2. Linkage of Core and Supplemental P Nutrient Management Practices

9.1 NM Core and Supplemental Element Detailed Definitions

To better enable the CBP partnership and state agency partners to understand and apply the recommendations of the NM Panel to their unique programs and production systems, the following section provides additional descriptive details to each of the NM Core BMPs and Supplemental NM BMPs.

9.2 Nitrogen Core NM BMP Elements

Nitrogen Core NM On-Site Manure Analysis

- All five elements, as applicable to the agricultural operation, are required to be implemented and verified at the field management unit level to receive credit.
- N rate according to LGU recommendations at field management unit.
    - The elements of the N Core Nutrient Management On-Site Manure Analysis BMP are found in Table 2. Application of a N Core NM BMP OMA efficiency modifies the crop- and land-use-specific N application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. In an effort to determine the most practicable methodology for allocating fertilizer N to satisfy crop- and land-use-specific N application rate goals, the Agriculture Workgroup compared the modified LGU recommendations for application of supplemental inorganic N fertilizer to an alternative approach based on

county-level redistribution of AAPFCO N fertilizer sales data. This methodological comparison indicated that there were relatively small differences between the two methods for estimating supplemental N fertilizer applications, leading the Agriculture Workgroup to approve use of the redistributed AAPFCO fertilizer sales methodology in the Phase 6 Model. The Panel recommends that similar comparative analyses be conducted in the future to evaluate newly available fertilizer sales data and to further evaluate the redistributed fertilizer sales methodology's forecasting ability. Inconsistencies between estimates generated by the two methods should be investigated and rectified based on data source quality and consistency using contiguous or regional county-level data.

- If applied N application rates are below the applicable CBP partnership modified application rates, the N application system may still qualify for credit as an equivalent N Core system if it meets the remaining four N Core elements.
- A "field management unit" is described by the NM Panel as a common land management unit defined by the farm operator that includes similar annual crop production and management systems, and associated nutrient application system. The field management unit can represent any field, collection of multiple fields, or sub-portions of a single field that are managed the same way, with similar history and cropping practices.

- Manure analysis and volume.
  - Estimation of manure produced and nutrient analysis of that manure must be used in the planning process.
  - Manure nutrient analyses must be derived from manure sample testing using standard laboratory protocols.
  - If a laboratory manure analysis is used to adjust the nutrient application, the laboratory analysis must be less than three-years old.
  - If laboratory analysis of manure is not available, as in the case of new, expanded or modified livestock and poultry operations, published book values (as described above) may be used for a maximum of three years, after which time laboratory analysis data must be utilized to satisfy N Core NM BMP requirements.
- Spreader/applicator calibration.
  - The equipment being used to perform the nutrient applications by the farm operator needs to be documented and verified that the machine(s) have been calibrated either according to manufacturer specifications or by standard calibration practices, preferably within one year of the application.
  - The custom applicator and equipment calibration certifications for commercial applicators can be used as an equivalent verification documentation for calibrated nutrient applications.
- Yield estimates and cropping plan at field management unit level.
  - Annual yield estimates for field management units should be based on field yield samples, calibrated electronic yield monitors, or field specific grain elevator receipts.
  - Historic yield goals are determined using a standardized method of averaging annual yields over time to account for annual variability (e.g. average yield is based on best three out of the past five years).
  - A less preferred but equivalent method is to use standard USDA soil productivity book values for estimating applicable yields.
  - The cropping plan refers to the planting and harvesting of the specific crop(s) for which the field nutrient applications were based. An example of a field that would not qualify under this required element is when the nutrient application was based on the plant requirements for grain corn but, due to in-season management decisions, the field was planted to soybeans instead.
- Cropping/manure history at field management unit level.
  - As part of developing a planned nutrient application rate, the farm operator or custom applicator considered legume residual N credits based on LGU or national agricultural service (e.g., USDA) recommendations.
  - The manure application history during the crop rotation must be considered, including appropriate manure mineralization crediting.
  - Verified documentation of manure mineralization N credits are included as part of the nutrient balance to account for at least the three prior years.
  - Legume residual N credits are included as part of the nutrient balance to account for at least the immediately preceding year.
- Nutrient management practice documentation.
  - The NM Panel defined the N Core NM OMA BMP to require full implementation of a defined and applicable set of fundamental elements in order to receive the BMP credit. Independent documentation and verification

that all of the required elements of the N Core NM OMA BMP were implemented is required.
    - The five elements that constitute the N Core NM OMA BMP may or may not be components of a formal Nutrient Management Plan. The required nutrient management documentation could be in the form of a formal federal-, state-, or county-reviewed and certified nutrient management program plan, a non-certified formal nutrient management plan developed by a federal- or state-certified plan writer, or detailed documentation and an informal management plan compiled by an operator or private consultant that met the Panel's BMP recommendations.
- Equivalent Practices
    - States may propose equivalent practices to satisfy these requirements that must be approved by the Agriculture Workgroup.

Nitrogen Core NM Estimated Manure Analysis

- All five elements, as applicable to the agricultural operation, are required to be implemented and verified at the field management unit level to receive credit.
- N rate according to LGU recommendations at field management unit.
    - The elements of the N Core Nutrient Management Estimated Manure Analysis BMP are found in Table 2. Application of a N Core NM BMP EMA efficiency modifies the crop- and land-use-specific N application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. In an effort to determine the most practicable methodology for allocating fertilizer N to satisfy crop- and land-use-specific N application rate goals, the Agriculture Workgroup compared the modified LGU recommendations for application of supplemental inorganic N fertilizer to an alternative approach based on county-level redistribution of AAPFCO N fertilizer sales data. This methodological comparison indicated that there were relatively small differences between the two methods for estimating supplemental N fertilizer applications, leading the Agriculture Workgroup to approve use of the redistributed AAPFCO fertilizer sales methodology in the Phase 6 Model. The Panel recommends that similar comparative analyses be conducted in the future to evaluate newly available fertilizer sales data and to further evaluate the redistributed fertilizer sales methodology's forecasting ability. Inconsistencies between estimates generated by the two methods should be investigated and rectified based on data source quality and consistency using contiguous or regional county-level data.
    - If applied N application rates are below the applicable CBP partnership modified application rates, the N application system may still qualify for credit as an equivalent N Core system if it meets the remaining four N Core elements.
    - A "field management unit" is described by the NM Panel as a common land management unit defined by the farm operator that includes similar annual crop production and management systems, and associated nutrient application system. The field management unit can represent any field, collection of multiple fields, or sub-portions of a single field that are managed the same way, with similar history and cropping practices.
- Manure analysis and volume.
    - Estimation of manure produced and nutrient analysis of that manure must be used in the planning process.
    - Published manure nutrient analyses from LGUs, national agricultural agencies (e.g., USDA-ARS, USDA-NRCS), national or regional farm service organizations, or historical analyses generated from very similar, local and consistently managed industry-contracted operations may be used.
- Spreader/applicator calibration.
    - The equipment being used to perform the nutrient applications by the farm operator needs to be documented and verified that the machine(s) have been calibrated either according to manufacturer specifications or by standard calibration practices, preferably within one year of the application.
    - The custom applicator and equipment calibration certifications for commercial applicators can be used as an equivalent verification documentation for calibrated nutrient applications.
- Yield estimates and cropping plan at field management unit level.
    - Annual yield estimates for field management units should be based on field yield samples, calibrated electronic yield monitors, or field specific grain elevator receipts.
    - Historic yield goals are determined using a standardized method of averaging annual yields over time to account for annual variability (e.g. average yield is based on best three out of the past five years).

- A less preferred but equivalent method is to use standard USDA soil productivity book values for estimating applicable yields.
- The cropping plan refers to the planting and harvesting of the specific crop(s) for which the field nutrient applications were based. An example of a field that would not qualify under this required element is when the nutrient application was based on the plant requirements for grain corn but, due to in-season management decisions, the field was planted to soybeans instead.

o Cropping/manure history at field management unit level.
- As part of developing a planned nutrient application rate, the farm operator or custom applicator considered legume residual N credits based on LGU or national agricultural service (e.g., USDA) recommendations.
- The manure application history during the crop rotation must be considered, including appropriate manure mineralization crediting.
- Verified documentation of manure mineralization N credits are included as part of the nutrient balance to account for at least the three prior years.
- Legume residual N credits are included as part of the nutrient balance to account for at least the immediately preceding year.

o Nutrient management practice documentation.
- The NM Panel defined the N Core NM EMA BMP to require full implementation of a defined and applicable set of fundamental elements in order to receive the BMP credit. Independent documentation and verification that all of the required elements of the N Core NM EMA BMP were implemented is required.
- The five elements that constitute the N Core NM EMA BMP may or may not be components of a formal Nutrient Management Plan. The required nutrient management documentation could be in the form of a formal federal-, state-, or county-reviewed and certified nutrient management program plan, a non-certified formal nutrient management plan developed by a federal- or state-certified plan writer, or detailed documentation and an informal management plan compiled by an operator or private consultant that met the Panel's BMP recommendations.

o Equivalent Practices
- States may propose equivalent practices to satisfy these requirements that must be approved by the Agriculture Workgroup.

9.3 Phosphorus Core NM BMP Elements

Phosphorus Core NM On-Site Soil & Manure Analysis

o All six elements, as applicable to the agricultural operation, are required to be implemented and verified at the field management unit level to receive credit.

o P application rate according to LGU recommendations at field management unit level.
- P application rate recommendations that are higher than the CBP Partnership-modified P application rates are allowable when the recommended rate is the outcome of a P-loss risk assessment tool that describes the risk of P loss to be low.
- Application of a P Core NM On-Site Soil & Manure Analysis BMP application rate multiplier modifies the crop- and land-use-specific P application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. In practice, LGU recommendations for P application are based on crop- and site-specific soil-test P concentration. Currently, soil-test P concentration data are not available to the CBP. The Panel recommends that, in the future, crop- and site-specific soil-test P concentration data should be collected, aggregated to the appropriate scale, summarized to eliminate disclosure of private confidential business information, and utilized as the foundation for determining P application rate goals and the appropriate application of P Core NM OSMA BMPs.
- In the absence of soil-test P based application rate goals, county-level redistribution of CBW AAPFCO P fertilizer sales data may serve as a surrogate.
- If applied P application rates are below the applicable LGU prescribed rates, and/or the CBP partnership modified application rates, the P application system may still qualify for credit as an equivalent P Core NM OSMA system if it meets the remaining five P Core NM OSMA elements.

- A "field management unit" is described by the NM Panel as a common land management unit as defined by the farm operator with a similar annual crop production and management systems, and associated nutrient application system. The field management unit can represent any field, collection of multiple fields, or sub-portions of a single field that are managed the same way, with similar history and cropping practices.

o P soil tests at field management unit level.
  - A soil laboratory analysis is required to be obtained from the field management unit using standard soil testing protocols.
  - If a laboratory soil analysis being used to adjust the nutrient application, it must be less than three-years old.

o Manure analysis and volume.
  - Estimation of manure produced and nutrient analysis of that manure must be used in the planning process.
  - Manure nutrient analyses must be derived from manure sample testing using standard laboratory protocols.
  - If a laboratory manure analysis is used to adjust the nutrient application, the laboratory analysis must be less than three-years old.
  - If laboratory analysis of manure is not available, as in the case of new, expanded or modified livestock and poultry operations, published book values (as described above) may be used for a maximum of three years, after which time laboratory analysis data must be utilized to satisfy P Core NM BMP requirements.

o Spreader/applicator calibration
  - The equipment being used to perform the nutrient applications by the farm operator needs to be documented and verified that the machine(s) have been calibrated either according to manufacturer specifications or by standard calibration practices, preferably within one year of the application.
  - The custom applicator and equipment calibration certifications for commercial applicators can be used as an equivalent verification documentation for calibrated nutrient applications.

o Yield estimates and cropping plan at management unit level
  - Annual yield estimates should be based on field yield samples, calibrated electronic yield monitors, or field specific grain elevator receipts.
  - Historic yield goals are determined using a LGU or state standardized method of averaging annual yields over time to account for annual variability (e.g. average yield based on the best three out of the past five years).
  - A less preferred but equivalent method is to use standard USDA soil productivity book values for estimating applicable crop yield.
  - The cropping plan refers to the planting and harvesting of the specific crop(s) for which the field nutrient applications were based. An example of a field that would not qualify under this required element is when the nutrient application was based on the plant requirements for grain corn but, due to in-season management decisions, the field was planted to soybeans instead.

o Cropping/manure history at field management unit level
  - As part of developing a planned nutrient application rate, the farm operator or custom applicator considered residual P credits based on LGU or national agricultural service (e.g., USDA) recommendations.
  - The manure application history during the crop rotation must be considered, including appropriate residual soil P crediting.
  - Residual soil P credits are included as part of the nutrient balance to account for at least the immediately preceding year.

o Nutrient management practice documentation.
  - The NM Panel defined the P Core NM OSMA BMP to require full implementation of a defined and applicable set of fundamental elements in order to receive the BMP credit. Rather, independent documentation and verification that all of the required elements of the P Core NM OSMA BMP were implemented is required.
  - The six elements that constitute the P Core NM OSMA BMP may or may not be components of a formal Nutrient Management Plan. The required nutrient management documentation could be in the form of a formal federal-, state-, or county-reviewed and certified nutrient management program plan, a non-certified formal nutrient management plan developed by a federal- or state-certified plan writer, or detailed documentation and an informal management plan compiled by an operator or private consultant that met the Panel's BMP recommendations.

o Equivalent Practices

- States may propose equivalent practices to satisfy these requirements that must be approved by the Agriculture Workgroup.

Phosphorus Core NM Estimated Soil & Manure Analysis

- All six elements, as applicable to the agricultural operation, are required to be implemented and verified at the field management unit level to receive credit.
- P application rate according to LGU recommendations at field management unit level.
  - P application rate recommendations that are higher than the CBP Partnership-modified P application rates are allowable when the recommended rate is the outcome of a P-loss risk assessment tool that describes the risk of P loss to be low.
  - Application of a P Core NM Estimated Soil & Manure Analysis BMP application rate multiplier modifies the crop- and land-use-specific P application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. In practice, LGU recommendations for P application are based on crop- and site-specific soil-test P concentration. Currently, soil-test P concentration data are not available to the CBP. The Panel recommends that, in the future, crop- and site-specific soil-test P concentration data should be collected, aggregated to the appropriate scale, summarized to eliminate disclosure of private confidential business information, and utilized as the foundation for determining P application rate goals and the appropriate application of P Core NM ESMA BMPs.
  - In the absence of soil-test P based application rate goals, county-level redistribution of CBW AAPFCO P fertilizer sales data may serve as a surrogate.
  - If applied P application rates are below the applicable LGU prescribed rates, and/or the CBP partnership modified application rates, the P application system may still qualify for credit as an equivalent P Core NM ESMA system if it meets the remaining five P Core NM ESMA elements.
  - A "field management unit" is described by the NM Panel as a common land management unit as defined by the farm operator with a similar annual crop production and management systems, and associated nutrient application system. The field management unit can represent any field, collection of multiple fields, or sub-portions of a single field that are managed the same way, with similar history and cropping practices.
- ~~o~~ The requirement for having a P soil test may be waived if restrictions on manure application (rates, timing, placement), are imposed that limit P application rates and management to the same degree as if the site's soil was in the high soil-test P interpretive category.
  - P nutrient applications may be based on annual crop removal at the field management unit level as an equivalent P Core element, assuming the site's soil was in the high soil-test P interpretive category.
- Manure analysis and volume.
  - Estimation of manure produced and nutrient analysis of that manure must be used in the planning process.
  - Published manure nutrient analyses from LGUs, national agricultural agencies (e.g., USDA-ARS, USDA-NRCS), national or regional farm service organizations, or historical analyses generated from very similar, local and consistently managed industry-contracted operations may be used.
- Spreader/applicator calibration
  - The equipment being used to perform the nutrient applications by the farm operator needs to be documented and verified that the machine(s) have been calibrated either according to manufacturer specifications or by standard calibration practices, preferably within one year of the application.
  - The custom applicator and equipment calibration certifications for commercial applicators can be used as an equivalent verification documentation for calibrated nutrient applications.
- Yield estimates and cropping plan at management unit level
  - Annual yield estimates should be based on field yield samples, calibrated electronic yield monitors, or field specific grain elevator receipts.
  - Historic yield goals are determined using a LGU or state standardized method of averaging annual yields over time to account for annual variability (e.g. average yield based on the best three out of the past five years).
  - A less preferred but equivalent method is to use standard USDA soil productivity book values for estimating applicable crop yield.
  - The cropping plan refers to the planting and harvesting of the specific crop(s) for which the field nutrient applications were based. An example of a field that would <u>not</u> qualify under this required element is when the

nutrient application was based on the plant requirements for grain corn but, due to in-season management decisions, the field was planted to soybeans instead.

- Cropping/manure history at field management unit level
  - As part of developing a planned nutrient application rate, the farm operator or custom applicator considered residual P credits based on LGU or national agricultural service (e.g., USDA) recommendations.
  - The manure application history during the crop rotation must be considered, including appropriate residual soil P crediting.
  - Residual soil P credits are included as part of the nutrient balance to account for at least the immediately preceding year.
- Nutrient management practice documentation.
  - The NM Panel defined the P Core NM ESMA BMP to require full implementation of a defined and applicable set of fundamental elements in order to receive the BMP credit. Rather, independent documentation and verification that all of the required elements of the P Core NM ESMA BMP were implemented is required.
  - The six elements that constitute the P Core NM ESMA BMP may or may not be components of a formal Nutrient Management Plan. The required nutrient management documentation could be in the form of a formal federal-, state-, or county-reviewed and certified nutrient management program plan, a non-certified formal nutrient management plan developed by a federal- or state-certified plan writer, or detailed documentation and an informal management plan compiled by an operator or private consultant that met the Panel's BMP recommendations.
- Equivalent Practices

States may propose equivalent practices to satisfy these requirements that must be approved by the Agriculture Workgroup.

9.4 Nitrogen Supplemental NM BMPs

- Advanced N Assessment Tools.
  - Documentation needed of the use of one or a combination of these tools.
  - These tools should guide implementation of N rate, placement, or timing.
  - Conducting these assessments or using these tools have no impact unless they lead to an informed change in implementation of N rate, N placement or N application timing.
  - This list is not exhaustive or comprehensive, and only represents a selection of examples that would constitute tools resulting in an implementation change.
- N Rate Adjustment Practices.
  - By implementing one or more of the practices listed, an additional N credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
  - Within the N Rate Adjustment Practice, the rate of application can be less than the LGU recommendation or consistent with partnership approved rate applications, but in order to receive supplemental credit, the rate of application must be below the rate listed for the N Core NM OMA BMP or the N Core NM EMA BMP.
  - Split applications over time per crop. Total amount of N application may or may not change, but the application is divided into multiple, lower-rate applications throughout the year.
  - Variable rate N application implies that N is applied at a variety of different application rates at the sub-field scale within a management unit based on historical data of spatially variable crop response due to soil type, drainage, etc. or due to in-season data from optical crop sensors.
- N Placement Adjustment Practices.
  - By implementing one or more of the practices listed, an additional N credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
  - Where the N nutrient source is physically located or placed relative to the soil surface.

- Subsurface injection or incorporation of applied inorganic N.
- Immediate incorporation generally means within 24 hours of application.
- N application setbacks from water: purposefully not applying N to cropped and hay land areas adjacent to surface water bodies. Setbacks must meet the minimum standards required under applicable local, state, or federal programs and laws.
- Applies to both manure and fertilizer.
- Credit applies to entire field management unit.

o N Timing Adjustment Practices.

- By implementing one or more of the practices listed, an additional N credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
- Split applications over time per crop. Total amount of N does not change, but application is divided into multiple applications throughout the year.

9.5 Phosphorous Supplemental NM BMPs

o Advanced P Assessment Tools.

- Documentation needed of the use of one or a combination of these tools.
- These tools should guide implementation of rate, placement, or timing.
- Conducting these assessments or using these tools have no impact unless they lead to an informal change in implementation of rate, placement, or timing.
- This list is not exhaustive or comprehensive, and only represents a selection of example that would constitute tools resulting in an implementation change.

o P Rate Adjustment Practices.

- By implementing one or more of the practices listed, an additional P credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
- Within the P Rate Adjustment Practice, the rate of application can be less than the LGU recommendation or consistent with partnership approved rate applications, but in order to receive supplemental credit, the rate of application must be below the rate listed for the P Core NM OSMA BMP or the P Core NM ESMA BMP.
- Variable rate P application implies that P is applied at variety of different applications rates at the sub-field scale within the management unit based spatially variable crop response due to soil type, drainage, etc. or due to in-season data from optical crop sensors.
- A P-based manure application rate equivalent to annual crop P removal is an equivalent rate adjustment practice.

o P Placement Adjustment Practices.

- By implementing one or more of the practices listed, an additional P credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
- Where the P nutrient source is physically located or placed relative to the soil surface.
- Subsurface injection or incorporation of applied inorganic P.
- Immediate incorporation generally means within 24 hours of application.
- Phosphorus application setbacks from water: purposefully not applying P to cropped and hay land areas adjacent to surface water bodies. Setbacks must meet the minimum standards required under applicable local, state, or federal programs and laws.
- Applies to both manure and fertilizer.
- Credit applies to entire field management unit.
- Application of manure on different fields based on the P Index assessment that results in manure application on a lower P Index rated field rather than a higher P Index rated field.

- P Timing Adjustment Practices.
  - By implementing one or more of the practices listed, an additional P credit will be applied. However, implementing more than one of the practices captured under each supplemental practice category will only result in one credit for the practice adjustment.
  - Split applications over time per crop. Total amount of P does not change, but application is divided into multiple applications throughout the year.
  - P application in lower P-loss risk season.
  - Purposeful change the timing of manure application based on the P Index assessment that results in manure application at a time during the calendar year when the P Index assessment indicates a lower risk for P loss.
  - Split applications over time per crop. Total amount of P application may or may not change, but the application is divided into multiple, lower-rate applications throughout the year.

10 Effectiveness Estimates

This section begins with a brief summary of the recommended N and P multiplier values for N and P Core NM BMPs and for loss reduction multipliers for N and P Supplemental NM BMPs. This summary is followed by a discussion of the rationale and use of specific data values from the available literature to develop the recommended multiplier values. Finally, details are provided on how the recommended application rate multiplier values for Core NM BMPs and loss reduction multipliers for the Supplemental NM BMPs can be combined to reflect actual N and P management and overall effectiveness at a specific location.

10.1 Summary of Effectiveness Estimates

All numeric values for the N Core NM On-Site Manure Analysis BMP and the P Core NM On-Site Soil & Manure Analysis BMP application rate multipliers and the Supplemental NM BMP loss reduction multipliers have been defined by the Panel. Numeric values for the N Core NM Estimated Manure Analysis and the P Core NM Estimated Soil & Manure Analysis BMP application rate multipliers have been defined by the Agriculture Workgroup. See section 3.3 for a detailed discussion of how these values are applied in the determination and crediting of overall NM BMP effectiveness for N and P.

3.1.5. N Core NM BMPs

The proposed application rate multipliers for N Core NM OMA and EMA BMPs for each applicable agricultural land use category are given in Table 12. These application rate multipliers are based on state LGU recommendations, as modified by the CBP partnership, and apply to the nutrient application rate goal, or input side, of nutrient management modeling scheme. Each value represents a multiplicative modifier of the crop- and land-use-specific N application rate goal utilized in the CBP models.

Table 12. Core N Nutrient Management Application Rate Multiplier Values

Land Use	Nutrient Management BMP		
	Nitrogen Core *Non-Nutrient Management* BMP Application Rate Multiplier	Nitrogen Core *Nutrient Management* Estimated Manure Analysis Rate Multiplier	Nitrogen Core *Nutrient Management* On-Site Manure Analysis Rate Multiplier
Full Season Soybeans	1.20	1.10	1.00
Grain w/ Manure	1.30	1.15	1.00
Grain w/o Manure	1.20	1.10	1.00
Legume Hay	1.20	1.10	1.00
Silage w/ Manure	1.40	1.20	1.00
Silage w/o Manure	1.20	1.10	1.00
Small Grains and Grains	1.20	1.10	1.00
Small Grains and Soybeans	1.20	1.10	1.00
Specialty Crop High	1.30	1.15	1.00
Specialty Crop Low	1.20	1.10	1.00
Other Agronomic Crops	1.10	1.05	1.00
Other Hay	1.00	1.00	1.00
Pasture	1.00	1.00	1.00

3.1.6. P Core NM BMPs

The proposed application rate multipliers for P Core NM OSMA and ESMA BMPs for each applicable agricultural land use category are given in Table 13. These application rate multipliers are based on state LGU recommendations, as

modified by the CBP partnership, and apply to the nutrient application rate goal, or input side, of the nutrient modeling scheme for both NM and non-NM acres. Each value represents a multiplicative modifier of the crop- and land-use-specific P application rate goal utilized in the CBP models. For crops and land uses in which manure is applied, manure applications that result in manure P application rates that are greater than or equal to the crop-specific P application need results in the prohibition of application of additional fertilizer P. An exception to the prohibition of supplemental fertilizer P addition following manure application is the utilization of relatively small quantities of starter fertilizer P, typically applied subsurface in the planting row, according to LGU recommendations. For crops and land uses in which manure is applied, the total quantity of manure P associated with the total manure application rate should be allocated to the subject acreage.

Table 13. Core P Nutrient Management Application Rate Multiplier Values

Land Use	Nutrient Management BMP		
	Phosphorus Core *Non-Nutrient Management* BMP Application Rate Multiplier	**Phosphorus Core *Nutrient Management* Estimated Manure Analysis Rate Multiplier**	**Phosphorus Core *Nutrient Management* On-Site Manure Rate Multiplier**
Full Season Soybeans	1.50	1.25	1.00
Grain w/ Manure	3.00	2.00	1.00
Grain w/o Manure	1.50	1.25	1.00
Legume Hay	1.00	1.00	1.00
Silage w/ Manure	3.00	2.00	1.00
Silage w/o Manure	1.50	1.25	1.00
Small Grains and Grains	1.50	1.25	1.00
Small Grains and Soybeans	1.50	1.25	1.00
Specialty Crop High	2.00	1.50	1.00
Specialty Crop Low	2.00	1.50	1.00
Other Agronomic Crops	1.50	1.25	1.00
Other Hay	1.00	1.00	1.00
Pasture	1.00	1.00	1.00

3.1.7. N Supplemental Nutrient Management BMPs

The Panel's proposed loss reduction multipliers for N Supplemental NM BMPs for each applicable agricultural land use category are given in Table 14. These values are multiplicative modifiers that apply to edge-of-stream delivery of N, on the output side of the CBP modeling scheme, and can only be applied if the requirements for either the N Core NM OMA or the N Core NM EMA BMP are met.

Table 14. N Supplemental Nutrient Management BMP Loss Reduction Multiplier Values

Land Use	Nutrient Management BMP		
	N Rate *Supplemental* BMP Loss Reduction Multiplier	**N Placement *Supplemental* BMP Loss Reduction Multiplier**	**N Timing *Supplemental* BMP Loss Reduction Multiplier**
Full Season Soybeans	1.00	1.00	1.00
Grain w/ Manure	0.85	0.95	0.90
Grain w/o Manure	0.95	0.97	0.95
Legume Hay	1.00	1.00	1.00
Silage w/ Manure	0.85	0.95	0.90
Silage w/o Manure	0.95	0.97	0.95
Small Grains and Grains	0.95	0.97	0.90
Small Grains and Soybeans	0.95	0.97	0.90
Specialty Crop High	0.85	0.95	0.95
Specialty Crop Low	0.95	0.97	0.95
Other Agronomic Crops	0.95	0.97	0.95
Other Hay	1.00	0.97	0.95
Pasture	1.00	1.00	1.00

3.1.8. P Supplemental Nutrient Management BMPs

The Panel's proposed loss reduction multipliers for P Supplemental NM BMPs for each applicable agricultural land use category are given in Table 15. These values are multiplicative modifiers that apply to edge-of-stream delivery of P, on the output side of the CBP modeling scheme, and can only be applied if the requirements for either the P Core NM OSMA BMP or the P Core NM ESMA BMP are met.

Table 15. P Supplemental Nutrient Management BMP Loss Reduction Multiplier Values

Land Use	Nutrient Management BMP		
	P Rate *Supplemental* BMP Loss Reduction Multipliers	**P Placement *Supplemental* BMP Loss Reduction Multipliers**	**P Timing *Supplemental* BMP Loss Reduction Multipliers**
Full Season Soybeans	0.95	0.90	0.99
Grain w/ Manure	0.90	0.80	0.80
Grain w/o Manure	0.95	0.90	0.99
Legume Hay	0.99	0.90	0.99
Silage w/ Manure	0.90	0.80	0.80
Silage w/o Manure	0.95	0.90	0.99
Small Grains and Grains	0.95	0.90	0.99
Small Grains and Soybeans	0.95	0.90	0.99
Specialty Crop High	0.95	0.90	0.99
Specialty Crop Low	0.95	0.90	0.99
Other Agronomic Crops	0.95	0.90	0.99
Other Hay	1.00	0.90	0.99
Pasture	1.00	1.00	1.00

10.2 Development of Application Rate Multipliers and Loss Reduction Multipliers for Core NM BMPs and Supplemental NM BMPs

The Panel developed the proposed Phase 6 NM application rate multiplier estimates and loss reduction multiplier estimates through a synthesis of applicable scientific literature (see References section) and the collective best professional judgment of the NM Panel members (see Table 1). The membership of the Panel represents over 150 years of direct involvement in research, implementation and education on agricultural nutrient management practices. The entire body of research represented by the citations presented in the References section provided the foundation for the Panel's professional assessment of the rate and loss reduction multipliers for the proposed NM BMPs. The multiplier values presented for the Core NM BMPs and the Supplemental NM BMPs represent either a collection of required elements or represent the impact of numerous applicable on-site management practices. Therefore, in order to develop broadly pertinent NM BMP multiplier values, multiple sources of information and data were necessarily synthesized through the expert lens of the Panel.

For both N and P BMPs, nutrient management practices are implemented at either the field or sub-field level. The diverse landforms, hydrology, climate and cropping systems of the agricultural landscapes in the CBW have a multitude of impacts on biogeochemical transformations of N and P in the agro-ecosystem. Changes in hydrological pathways alone can have dramatic effects on nutrient loads to streams when viewed from the Atlantic Coastal Plain to the Appalachian Plateau. Therefore, site-specific physical conditions and management factors have a strong influence on the effectiveness of imposed conservation practices. Nutrient management BMP effectiveness must represent the average condition over a wide range of real-world scenarios. Thus, it was incumbent upon the Panel to distill numerous lines of evidence to arrive at a single multiplier value for each of the N and P BMPs that could be applied equitably across the CBW.

Below are examples of specific analyses that were used to inform the NM Panel in its application of best professional judgment to determine NM BMP application rate multipliers (for the N Core NM OMA BMP and the P Core NM OSMA BMP) and loss reduction multipliers. The NM BMP application rate multipliers for the N Core NM EMA BMP and the P Core NM ESMA BMP were determined based on the best professional judgment of the Agriculture Workgroup in light of the application rate multipliers determined for the N Core Non-Nutrient Management BMP and N Core NM OMA BMP in Table 12 and the P Core Non-Nutrient Management BMP and P Core NM OSMA BMP in Table 13.

N Core and P Core NM BMPs

The reduction in nutrient application rates for N Core and P Core NM BMPs were determined based on historical (i.e., before the Chesapeake Bay Program Watershed Model (CBPWM) simulation period of 1985) and modern LGU agronomy guides (i.e., during the calibration period of the CBPWM (Table 16). Historical LGU agronomy guides (pre-1985) evaluated by Phase 5.3.2 NM Panel members recommended a range of 15–40 percent more plant-available N than CBPWM calibration period LGU guides. In addition, the principal basis for application rate difference between non-NM and NM for N is a reduction in the fertilizer N requirement for corn from 1.2 lbs. N/bu. of expected yield in earlier LGU recommendations to 1.0 lbs. N/bu. of expected yield in current LGU recommendations. This reduction is supported by data from Coale (2000) who examined corn yield response to fertilizer N rate with the associated post-harvest fall soil residual NO_3-N concentration. These findings are reflected in the values for grain and silage found in Table 12 for N Core NM OMA BMPs. Because other crops of significant acreage did not have consistently or significantly lower recommended N application rates when the historical (pre-1985) and current from LGU agronomy guides were compared, these agricultural land uses were assigned more conservative values in Table 12.

N Core NM BMP multiplier values for Other Hay and Pasture were set at 1.00 because the CBP Partnership's modification of the LGU N application recommendations created a uniform and much-reduced N application rate goal for these two agricultural land uses that included an assumed implementation rate of NM BMPs across the entire CBW. Therefore, the Panel could not apply a N application rate BMP multiplier other than 1.00 to these two land uses.

Table 16. LGU Agronomy Guide Recommendations for Corn N Fertilizer Application Rate Before and During CBPWM Calibration Period. Values Presented Are Pounds of Plant Available N (PAN) Per Bushel of Expected Corn Yield

Land Grant University	**Pre-calibration Recommendation**	**Calibration period Recommendation**
North Carolina State University	1.4 lbs. PAN[1]	1.0 lbs. PAN
Pennsylvania State University	1.3[2]	1.0[3]
University of Maryland	1.2[4]	1.0[5]

[1] North Carolina State University Extension. 1979 Agronomy Guide. North Carolina State University. Raleigh, NC.
[1] Penn State Extension. 1981 Agronomy Guide. The Pennsylvania State University, College of Agriculture Extension Service. University Park, PA.
[1] http://extension.psu.edu/agronomy-guide/cm/sec2/sec24e3
[1] Coop. Ext. Serv. 1981. Fertilizer Recommendations, sheet 3, corn for grain on medium textured soils without manure. Univ. MD Coop. Ext. Serv., College Park, MD.
[1] Coale, F.J. 1995. Plant nutrient recommendations based on soil tests and yield goals. Agronomy Mimeo No. 10, Coop. Ext. Serv. and Agronomy Dept. Univ. MD, College Park, MD

P application rate multiplier values for P Core NM OSMA BMPs are greater for land uses with manure versus the corresponding land use without manure. Historically (pre-1985), manure applications managed without attention to NM guidelines resulted in P application rates at least three times higher, and probably more, than would be expected under P-based nutrient management. For non-manured production systems operating outside of NM guidelines, fertilizer P over-application would not be expected to be nearly as great as when manure is the primary nutrient source. These findings are reflected in the values for grain and silage found in Table 13 for P Core NM OSMA BMPs. As for N Core NM, P Core NM BMP multiplier values for Other Hay and Pasture were set at 1.00 because the CBP Partnership's modification of the LGU P application recommendations created a uniform and much-reduced P application rate goal for these two agricultural land uses that included an assumed implementation rate of NM BMPs across the entire CBW. Therefore, the Panel could not apply a P application rate BMP multiplier other than 1.00 to these two land uses.

N Rate, N Placement, and N Timing Loss Reduction Multipliers

Several assessments of the PSNT have resulted in N reduction rates of 6 to 42 percent, with most demonstrating reductions of 17 percent or greater. A three-year study of corn/rye on a manured silt-loam soil in Vermont by Durieux et al. (1995) reported that use of the PSNT reduced nitrate leaching potential by resulting in an average reduction in fall residual NO_3-N (nitrate N) of 56 percent compared to N applications based on traditional LGU N recommendations. On average, fall N application was reduced by 29 percent (150 lbs. N/ac. to 107 lbs. N/ac.) due to application of the PSNT. This exceeds the largest credit (15 percent loss reduction) given for N Rate Supplemental BMPs (Table 14). The reduced potential for nitrate leaching due to PSNT application was confirmed by Guillard et al. (1999) in a two-year lysimeter study on a sandy-loam soil that demonstrated an average reduction in NO_3-N leaching of 63%, compared to corn fertilized according to standard LGU recommendations. Fall N leaching loss was reduced by an average of 42 percent, from 196 kg N/ha (175 lbs. N/ac.) to 113 kg N/ha (101 lbs. N/ac.), a change also greatly exceeding the N Rate Supplemental BMP credits shown in Table 14.

Data from quarterly or annual reports from in-field nutrient management consultants were used to summarize PSNT activities and results under the Maryland (Steinhilber 2015) and Virginia (Sexton 2015) Nutrient Management Programs. The Maryland summaries covered three years, encompassing a total of 2,690 ac. from the Piedmont and 27,850 ac. from the Coastal Plain. The average estimated reduction in total fertilizer N application resulting from implementing the PSNT, compared to using university recommendations without the PSNT, was 20% and 6% for the Piedmont and Coastal Plain regions, respectively. Sexton (2015) reported on a 5,325-ac. evaluation of the PSNT conducted in Virginia's Shenandoah Valley consisting of 1,246 PSNT tests that compared university recommendations with and without the PSNT (Fitzgerald and Baird 2014). The Virginia results showed that use of the PSNT resulted in an estimated average savings of 30 lbs. N/ac., or a 20% N fertilizer application reduction for 29% of the PSNT evaluations and a savings of 60 lbs. N/ac., or a 40% N fertilizer application reduction, for another 28% of the PSNT evaluations. The remaining 43% of the PSNT evaluations resulting in unchanged fertilizer N application rate recommendations. The average percent reduction of fertilizer N application across the Virginia Piedmont study was 17%, which is consistent with the Maryland Piedmont estimate. Additionally, a two-year study in New York on a loamy-sand soil that monitored tile drainage from silage corn

grown in relatively large (18 m^2) isolated plots reported an average reduction in NO_3-N losses of 42% for the PSNT treatment, compared to the non-PSNT standard LGU recommendation (Sogbedji et al. 2000). Fall N loss rates were reduced by 25% (134 kg N/ha to 100 kg N/ha or 120 lbs. N/ac. to 89 lbs. N/ac.) due to application of the PSNT.

Studies on the CSNT and ISNT showed results similar to those for the PSNT. In New York, results reported by Ketterings et al. (2014, 2011a, 2011b), Wharton et al. (2010), and Hong et al. (2010) suggest that about 40% of tested corn silage fields were rated in the excess category and following the recommendations of the CSNT would result in a 20 to 30% reduction in N application. Kyveryga et al. (2010) reported that of 215 fields receiving liquid swine manure, about 30% of fields were found to be unresponsive to additional N (beyond 25 lbs. N/ac. starter). Extending this percentage over all silage corn fields under CSNT, recommendations derived from CSNT would have resulted in 15 to 30 lbs. N/ac. application reduction annually, representing a 20 to 30% reduction over standard N rate recommendations. Results of multi-year N rate trials on silage corn in New York over three crop years showed that about 50% of tested fields were non-responsive to additional N fertilizer and, therefore, the ISNT assessment would recommend no additional N application beyond starter N at 25 lbs. N/ac. (Lawrence et al. 2009, Klapwyk et al. 2006, Lawrence et al. 2008, Ketterings et al. 2009). Because these fields would otherwise have received a recommended application of 75 to 125 lbs. N/ac., managing N applications based on the ISNT results reduced N applications on the affected fields by 50 to 100 lbs. N/ac. Discounting this reduction because only half of corn silage fields were determined to be non-responsive by ISNT gives an estimated 25 to 50 lbs. N/ac. reduction in N applications to silage corn, a reduction of 33 to 40% in total N applications.

Using unpublished data from studies conducted throughout Virginia, the Phase 5.3.2 Nutrient Management Expert Panel compared N application rates to corn for the Virginia Tech Corn Algorithm (VTCA) applied via the GreenSeeker® system versus the standard farmer's N rate methods (Phase 5.3.2 Nutrient Management Expert Panel 2015). Over 15 sites in 4 years, the average VTCA N rate was 24 kg/ha (approximately 20%) less than the standard farmer's rate, with no significant difference in grain yields. Additionally, data from field scale demonstrations from a total of 1600 ac. over two years demonstrated a 10% decrease in N rate applied with no difference in corn yields (Virginia NRCS CIG 69-33A7-1131, final report). These data demonstrate the ability to reduce N application rates while maintaining crop yields. Other Virginia data for wheat (Thomason et al. 2011 and Virginia NRCS CIG 69-33A7-1131, final report) suggest that N rates for wheat could be decreased by approximately 7% with no change in yield.

The FSNT provides an adaptive management tool for simultaneously improving economic production of small grains by identifying sites where small grains need starter N, and also reducing nitrate-N loss to groundwater by not fertilizing N sufficient sites just before the fall-winter-spring water-recharge season when most nitrate leaching occurs (Forrestal et al. 2014, Meisinger et al. 2015). The N reduction efficiency for the FSNT was estimated from four years of lysimeter nitrate-N leaching data (Pers. comm., J. Meisinger 2015) using the intact soil-column lysimeter described in Palmer et al. (2011) and following the sample collection and analysis methods described in Meisinger et al. (2015). The lysimeter treatments were replicated twice each year with winter wheat receiving either a starter-N application of 30 lbs. N/ac. or no starter-N. Lysimeter drainage monitored NO_3-N leaching continuously between planting and the "green-up" development stage. These treatments were repeated in 1997-98, 1998-99, 1999-2000, and 2009-2010 wheat growing seasons. The final lysimeter-based N loss reduction efficiency was estimated to be 10%.

In the long term, achieving a balance between nutrient imports and exports at the whole farm level (and later at the watershed level) is believed to be an effective way to minimize nutrient surpluses, manage soil nutrient levels, and reduce runoff and leaching losses. For livestock farms, the whole farm nutrient balance approach has been invaluable in identifying opportunities for reducing N and P imports, making better use of on-farm nutrient sources, identifying the need for more land for nutrient recycling, and increasing nutrient exports. As shown over several years of research on 54 New York dairy farms, nutrient balance reductions averaged 29% for N and 36% for P (Soberon et al. 2015, Cela et al. 2014a and 2014b). However, the observed reductions are attributable primarily to changes in feed formulation and management, rather than fertilizer management.

N reduction efficiencies from timing N applications were estimated by comparing corn yields from replicated N-response trials over many site-years (Fox et al. 1986, Fox and Piekielek 1993, Pers. Comm. J Meisinger 2015). These studies compared yield vs. N applied (as urea-ammonium-nitrate) at planting, or N applied just before the crop begins its rapid

period of growth. Corn had the most N-response trials, which were summarized by fitting separate quadratic regression functions for each timing at each site-year of data, and then estimating the economic optimum N rate (EONR) for corn grain valued at $4.00/bu. and N priced at $0.50 per pound. These regressions allowed estimation of the EONR and associated yield, which provided a method to compare optimum rates for N applied at planting vs. at a later time that was in harmony with crop N demand. A plot-based N reduction efficiency was estimated as the difference between the EONRs at planting vs. the delayed application, divided by the planting EONR. There were also adequate data from the Coastal Plain (21 site-years) and the Piedmont (18 site-years) regions to estimate separate N reduction efficiencies. These calculations produced a Coastal Plain estimated N reduction efficiency of about 16%, with the corresponding estimate for the Piedmont of 9%. The Coastal Plain higher N-timing reduction efficiency is likely due to the region having more coarse-textured soils and more shallow rooting depths than the Piedmont. These reductions support the N Timing Supplemental BMP Efficiency values in Table 14, as do the documented PSNT-based N reduction rates of 6 to 42% (with most demonstrating reductions of 17 percent or greater) described above.

N-timing reduction efficiencies for wheat were estimated from two-years of field-plot total N uptake data from a study that compared an all-at-green-up application with a 50-50 split of N between green-up and an application approximately one month later (Gravelle et al. 1988). Four years of lysimeter nitrate-N leaching data (Pers. comm., J. Meisinger 2015) were also used from intact soil-column lysimeters described in Palmer et al. (2011) following the sample collection and analysis methods described in Meisinger et al. (2015). The lysimeter treatments were replicated twice in each of the four years (1992-93, 1997-98, 1998-99, and 1999-2000) with winter wheat receiving either all the N at green-up, or with the same N rate applied one-third at green-up and two-thirds about a month later. These two data sources produced an average wheat N-timing reduction efficiency of about 15%, which is similar to the Coastal Plain value for corn and supportive of the N Timing Supplemental BMP Efficiency values in Table 14.

When the data summarized above are analyzed as a whole, the literature is supportive of the application of NM BMP N loss reduction multipliers within the ranges presented in Table 14. Overall, the proposed N loss reduction multipliers are numerically conservative and range from 3 to 15%, exclusive of the 0% N loss reduction multiplier that was defined for the Other Hay and Pasture land uses.

P Rate, P Placement, and P Timing Loss Reduction Multipliers

Kleinman and Sharpley (2003) packed soils into runoff boxes and broadcast with three manures (dairy, layer poultry, and swine) at six rates, from 0 to 150 kg total P (TP)/ha (0-134 lbs. TP/ac.). Manure analysis indicated that N-based manure application for silage corn of 300 kg total N (TN)/ha (268 lbs. TN/ac.)) would result in TP application rates of 70, 200, and 88 kg/ha (62, 178, and 78 lbs. TP/ac.) for the dairy, poultry, and swine manures, respectively. Application rates matching silage corn TP requirement of approximately 25 kg TP/ha (22 lbs. TP/ac.) would result in TN applications of 151, 53, and 119 kg TN/ha (135, 47, and 106 lbs. TN/ac). Application rate was related to runoff P (r^2=0.50 to r^2=0.98), due to increased concentrations of dissolved reactive phosphorus (DRP) in runoff; as application rate increased, so did the contribution of DRP to runoff TP. Assuming 150 bu./ac. yields, recommendations for silage corn are about 180 lbs. TN/ac. and 103 lbs. TP/ac. for low to optimum soil test levels (Roth and Heinrichs 2001). Rates for grain corn would be 160 lbs. TN/ac. and 76 lbs. TP/ac. The P rates applied by Kleinman and Sharpley (0-134 lbs. TP/ac.) bracket these rates, with the highest rate 1.3 and 1.8 times the silage and grain corn rates, respectively, for a 150 bu. /ac. yield.

The effect of flow time, flowpath length, and manure position on P loss in overland flow from two central Pennsylvania soils packed in boxes of varying length were examined by collecting runoff water samples from soil boxes with and without 75 kg P/ha applied as swine manure over 0.5 m of the box slope length at distances of 0 to 3.5 m from the downslope collection point (McDowell and Sharpley 2002). Dissolved reactive P concentration was more closely related to the proportion of clay in sediment of overland flow before (r =0.98) than after (r= 0.56) manure application. This was attributed to the transport of larger, low-density particles after applying manure. The concentration of dissolved P and particulate P fractions decreased with increasing flow-path length, due to dilution rather than sorption of P by surface soil during overland flow. Total P loss (mainly as particulate P) from the Watson channery silt loam was more than from Berks channery silt loam, even with manure applied. Thus, while P loss in overland flow is affected by where manure is applied relative to flowpath length, initial soil P concentration is very important when looking at areas of potential P loss within a watershed.

In the long term, achieving a balance between nutrient imports and exports at the whole farm level (and later at the watershed level) is believed to be an effective way to minimize nutrient surpluses, manage soil nutrient levels, and reduce runoff and leaching losses. For livestock farms, the whole farm nutrient balance approach has been invaluable in identifying opportunities for reducing N and P imports, making better use of on-farm nutrient sources, identifying the need for more land for nutrient recycling, and increasing nutrient exports. As shown over several years of research on 54 New York dairy farms, nutrient balance reductions averaged 29% for N and 36% for P (Soberon et al. 2015, Cela et al. 2014a and 2014b). However, the observed reductions are attributable primarily to changes in feed formulation and management, rather than fertilizer management.

Application of a P Core NM BMP application rate multiplier modifies the crop- and land-use-specific P application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. A significant modification imposed by the CBP partnership was the assumption that all agricultural acres in the CBW had a soil-test P concentration that corresponded with the "medium" soil test interpretive category. The Panel recognized that, in the absence of soil-test P concentration data, assumed soil-test P concentrations were necessary to facilitate CBP model processes. However, the Panel also recognized that implementation of the universal "medium" soil-test P assumption infused a high level of site-specific uncertainty into the modeled P application rate. In general, the inherent uncertainty in P application rate resulting from the adoption of the universal "medium" soil-test P concentration assumption is expected to be similar to or greater than the magnitude of the P application rate modifications resulting from implementation of P Core NM BMP application rate multipliers or the P NM Supplemental BMP loss reduction multipliers.

In practice, LGU recommendations for P application are based on crop- and site-specific soil-test P concentration. Currently, soil-test P concentration data are not available to the CBP. The Panel recommends that, in the future, crop- and site-specific soil-test P concentration data should be collected, aggregated to the appropriate scale, summarized to eliminate disclosure of confidential business information, and utilized as the foundation for determining P application rate goals and the appropriate application of P Core NM BMPs. In the absence of soil-test P data and soil-test P based application rate goals, soil-test P concentration must be assumed and, in turn, utilized to create artificial P application rate goals.

10.3 Method for Applying Core and Supplemental Multiplier Values

The overall BMP efficiencies for N and P nutrient management are derived from a combination of application rate multipliers for the Core Nutrient Management BMPs (N or P) with their corresponding Supplemental Nutrient Management BMP (N or P) loss reduction multipliers. The N Core NM BMP and P Core NM BMP address the rate of nutrient application while the N Supplemental NM BMPs and P Supplemental NM BMPs address the transport of applied nutrients. The overall effectiveness values (one for N and one for P) are calculated as the combined effect of changes in nutrient application rate and nutrient transport caused by the implementation of Core and Supplemental NM BMPs. Specific details regarding how these combinations are calculated and applied are provided below.

Nitrogen

Application of the N Core NM BMP application rate multiplier credit modifies the crop- and land-use-specific N application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. These multipliers apply to the nutrient application rate goal, or input side, of CBP nutrient modeling scheme for both NM and non-NM acres. Each multiplier value represents a multiplicative modifier of the crop- and land-use-specific N application rate goal utilized in the CBP models.

Application of loss reduction multiplier credits for N Supplemental NM BMP elements requires satisfactory implementation of all respective N Core NM BMP elements (either NM OMA or NM EMA). The N Supplemental NM BMP multipliers apply multiplicative modifiers to edge-of-stream delivery of N, on the output side of the CBP modeling scheme, and can only be applied if the requirements for either N Core NM BMP are met. Multiple advanced site assessments and N management tools may be utilized to inform the application of appropriate N adjustment practices, but do not represent a N credit in and of themselves. Advanced site assessments and application of N management tools that result in implementation of a verifiable change in planned N application rate, N application timing, or N application

placement may result in a N Supplemental NM BMP loss reduction multiplier credit. N Supplemental NM BMP credits for N rate, N timing, and N placement are stackable. Only one Supplemental NM BMP credit for N rate, one Supplemental NM BMP credit for N timing, and one Supplemental NM BMP credit for N placement may be applied.

Phosphorus

Application of the P Core NM BMP application rate multiplier credit modifies the crop- and land-use-specific P application rate goal, which is based on LGU crop fertilization recommendations, as modified by the CBP partnership. These multipliers apply to the nutrient application rate goal, or input side, of the nutrient modeling scheme for both NM and non-NM acres. Each multiplier value represents a multiplicative modifier of the crop- and land-use-specific P application rate goal utilized in the CBP models. For crops and land uses in which manure is applied, manure applications that result in manure P application rates that are greater than or equal to the crop-specific P application need results in the prohibition of application of additional fertilizer P. For crops and land uses in which manure is applied, the total quantity of manure P associated with the total manure application rate is allocated to the subject acreage.

Application of the loss reduction multiplier credits for P Supplemental NM BMP elements requires satisfactory implementation of all respective P Core NM BMP elements (either NM OSMA or NM ESMA). The P Supplemental NM BMP multipliers apply multiplicative modifiers to edge-of-stream delivery of P, on the output side of the CBP modeling scheme, and can only be applied if the requirements for either P Core NM BMP are met. Multiple advanced site assessments and P management tools may be utilized to inform the application of the appropriate P adjustment practices, but do not represent a P credit in and of themselves. Advanced site assessments and application of P management tools that result in a verifiable implementation of a change in planned P application rate, P application timing, or P application placement may result in a P Supplemental NM BMP loss reduction multiplier credit. Supplemental BMP credits for P rate, P timing, and P placement are stackable. Only one Supplemental NM BMP credit for P rate, one Supplemental NM BMP credit for P timing, and one Supplemental NM BMP credit for P placement may be applied.

Summary

As described above and under *Practice Definitions*, there is one opportunity for crediting per each Supplemental NM BMP category for N and P. There are three such categories each for N and P Supplemental BMPs: rate, timing, and placement. Application of a loss-reduction multiplier for the N Supplemental NM BMP elements can only occur after satisfactory implementation of either the N Core NM OMA BMP or the N Core NM EMA BMP. The N Supplemental NM BMP loss reduction credit for each of these three categories (rate, timing, and placement) can be obtained if implementation of at least one effective practice from each category is verified. Similarly, application of a loss-reduction multiplier for the P Supplemental NM BMP elements can only occur after satisfactory implementation of either the P Core NM OSMA BMP or the P Core NM ESMA BMP. The P Supplemental NM BMP loss reduction credit for each of these three categories (rate, timing, and placement) can be obtained if implementation of at least one effective practice from each category is verified. N Supplemental NM BMP loss reduction credits for N rate, N timing, and N placement are stackable, as are P Supplemental NM BMP loss reduction credits for P rate, P timing, and P placement. The approach for applying both core and supplemental nutrient management multiplier values is summarized in Table 17. Figures 3-6 illustrate the decision tree for assigning credits.

Table 17. Summary of Method for Applying Nutrient Management Multiplier Values

Nutrient Management BMP	Action of BMP	How the math works
Nitrogen Core **Non-Nutrient Management** BMP	Modifies N application rate goal on the nutrient input side	Multiplier value is applied to the LGU N application rate goal
Nitrogen Core **Nutrient Management** BMP (OMA or EMA)	Modifies N application rate goal on the nutrient input side	Multiplier value is applied to the LGU N application rate goal
N Rate Supplemental NM BMP	Modifies edge of field N loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field N load
N Placement Supplemental NM BMP	Modifies edge of field N loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field N load
N Timing Supplemental NM BMP	Modifies edge of field N loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field N load
Phosphorus Core **Non-Nutrient Management** BMP	Modifies P application rate goal on the nutrient input side	Multiplier value is applied to the LGU P application rate goal
Phosphorus Core **Nutrient Management** BMP (OSMA or ESMA)	Modifies P application rate goal on the nutrient input side	Multiplier value is applied to the LGU P application rate goal
P Rate Supplemental NM BMP	Modifies edge of field P loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field P load
P Placement Supplemental NM BMP	Modifies edge of field P loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field P load
P Timing Supplemental NM BMP	Modifies edge of field P loss to the stream on the outflow side	Multiplier value is applied to the calculated edge of field P load

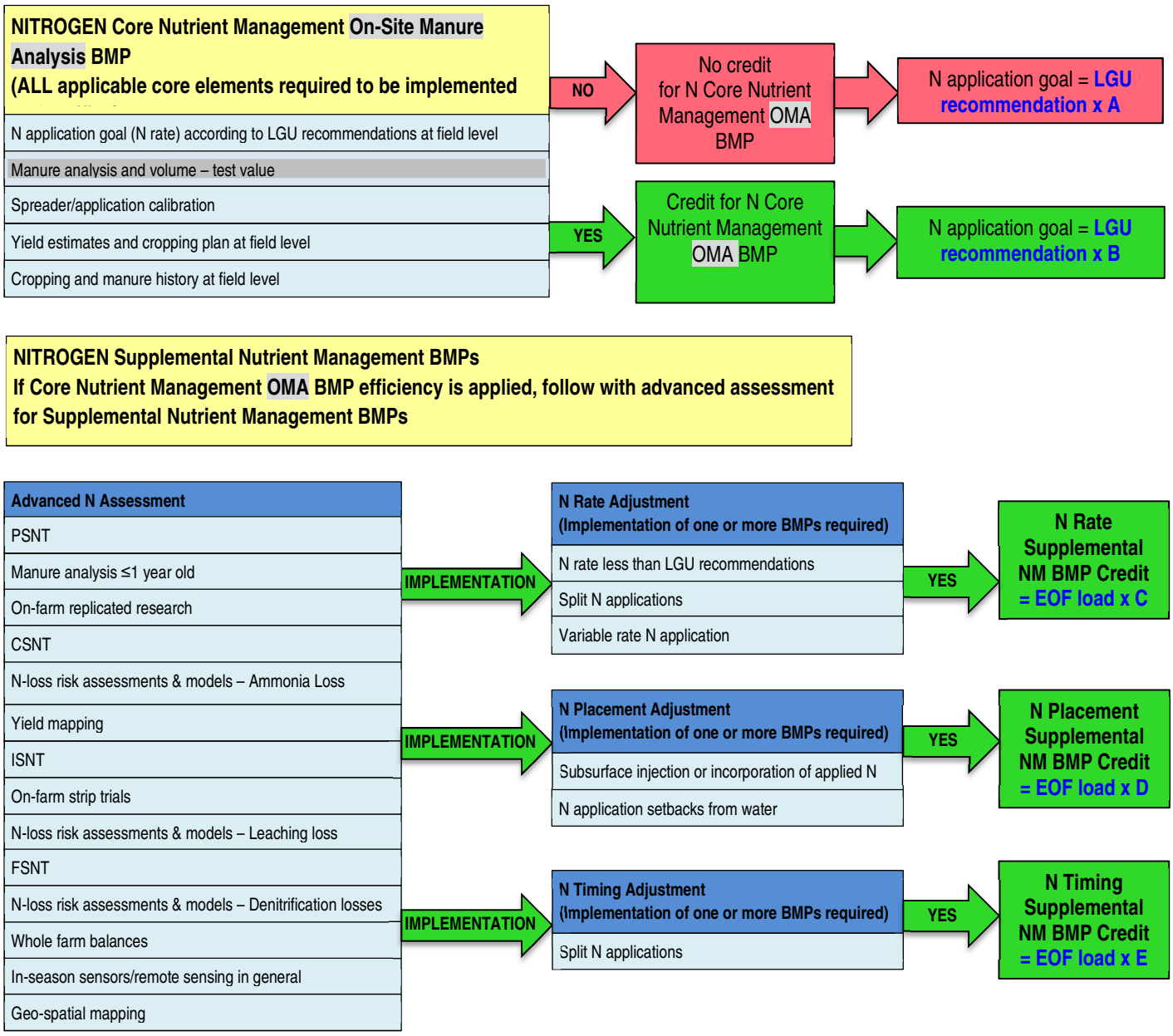

Figure 3. Assignment of N Nutrient Management Credits. Variables A and B refer to the land use specific N Core Non-Nutrient Management BMP application rate multiplier and the N Core Nutrient Management On-Site Manure Analysis BMP application rate multiplier, respectively, as presented in Table 12. Variables C, D and E refer to the land use specific N Rate Supplemental NM BMP loss reduction multiplier, the N Placement Supplemental NM BMP loss reduction multiplier and the N Timing Supplemental NM BMP loss reduction multiplier, respectively, as presented in Table 14. EOF is edge of field.

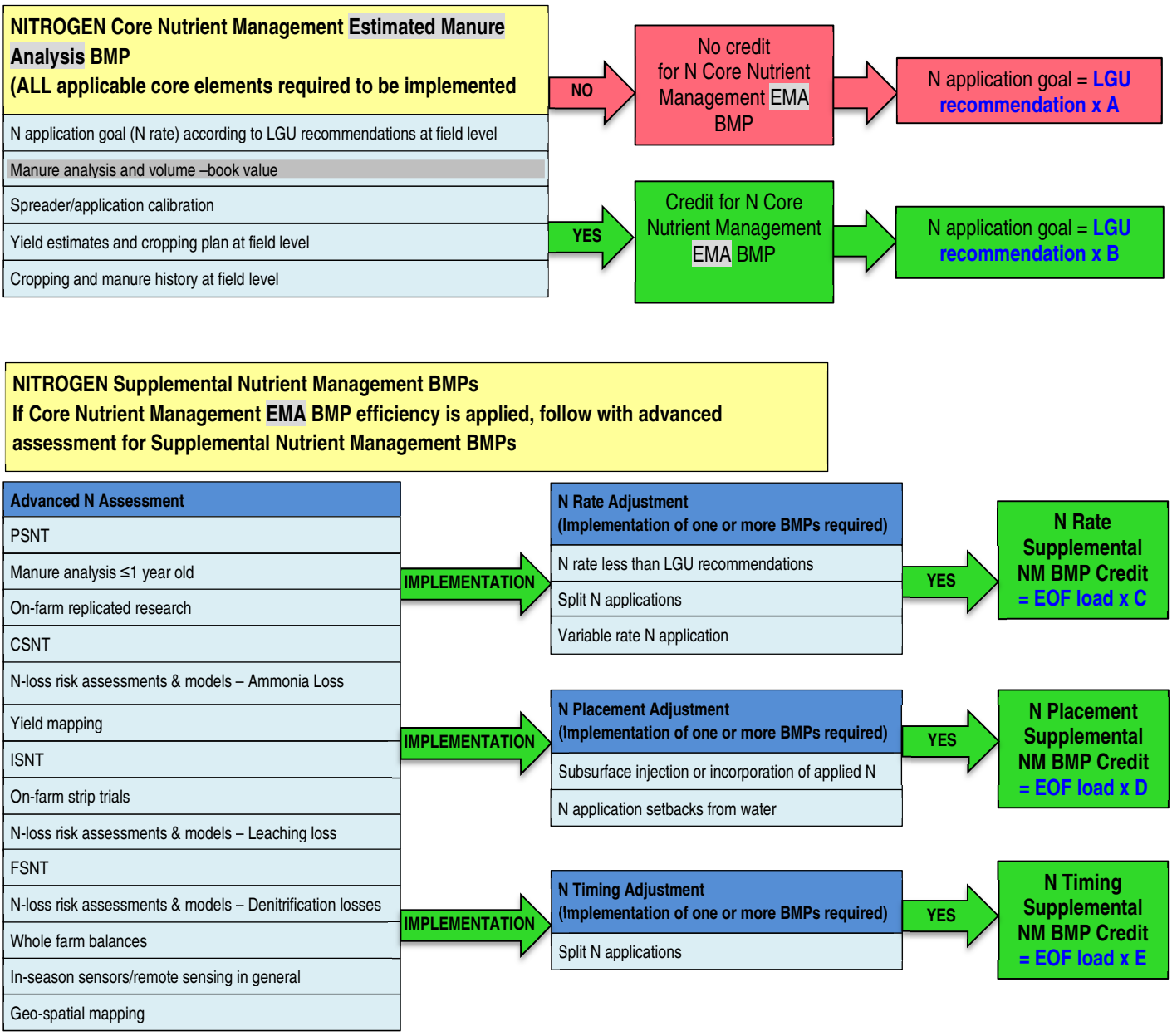

Figure 4. Assignment of N Nutrient Management Credits. Variables A and B refer to the land use specific N Core Non-Nutrient Management BMP application rate multiplier and the N Core Nutrient Management Estimated Manure Analysis BMP application rate multiplier, respectively, as presented in Table 12. Variables C, D and E refer to the land use specific N Rate Supplemental NM BMP loss reduction multiplier, the N Placement Supplemental NM BMP loss reduction multiplier and the N Timing Supplemental NM BMP loss reduction multiplier, respectively, as presented in Table 14. EOF is edge of field.

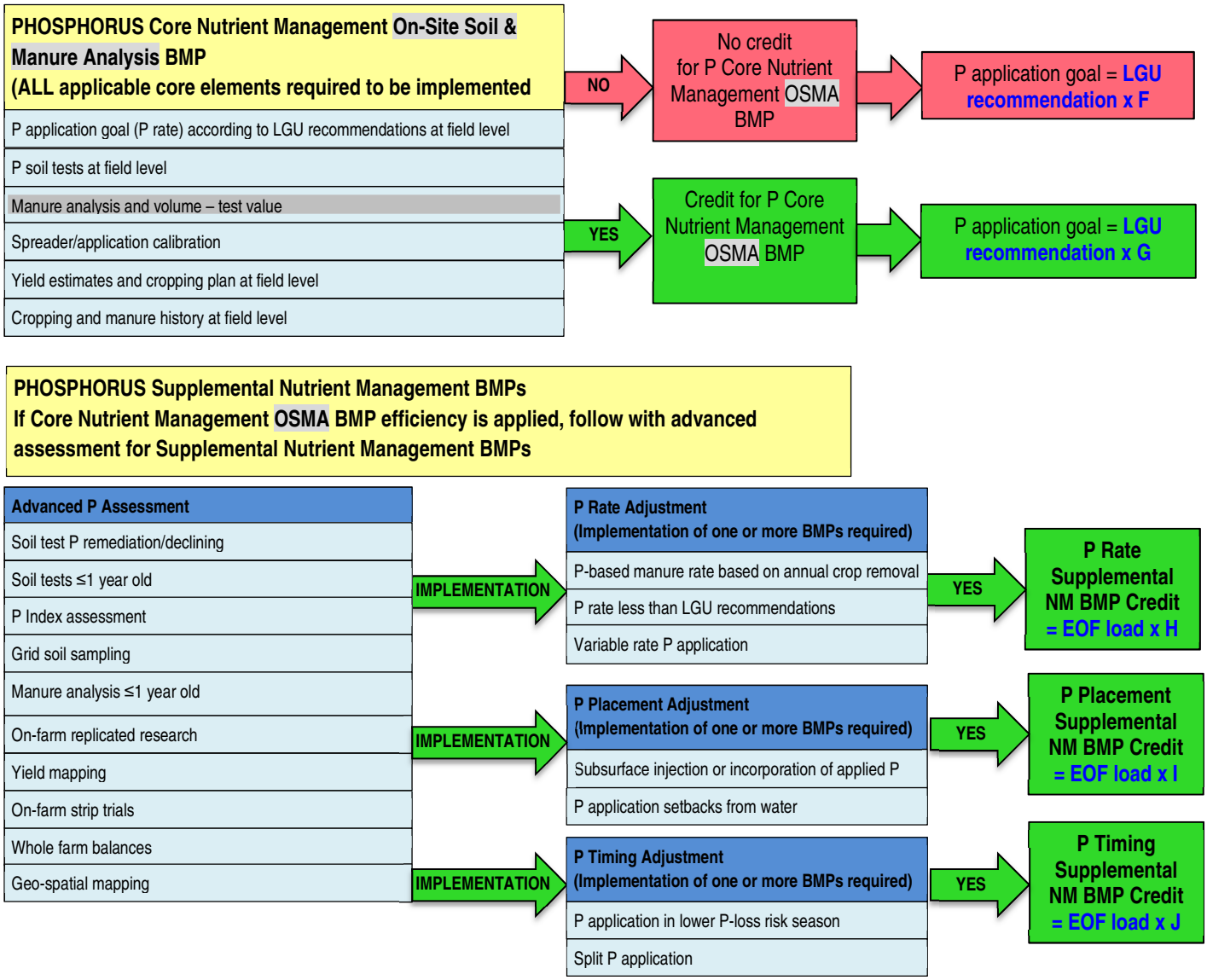

Figure 5. Assignment of P Nutrient Management Credits. Variables F and G refer to the land use specific P Core Non-Nutrient Management BMP application rate multiplier and the P Core Nutrient Management OSMA BMP application rate multiplier, respectively, as presented in Table 13. Variables H, I and J refer to the land use specific P Rate Supplemental NM BMP loss reduction multiplier, the P Placement Supplemental NM BMP loss reduction multiplier and the P Timing Supplemental NM BMP Loss reduction multiplier, respectively, as presented in Table 15. EOF is edge of field.

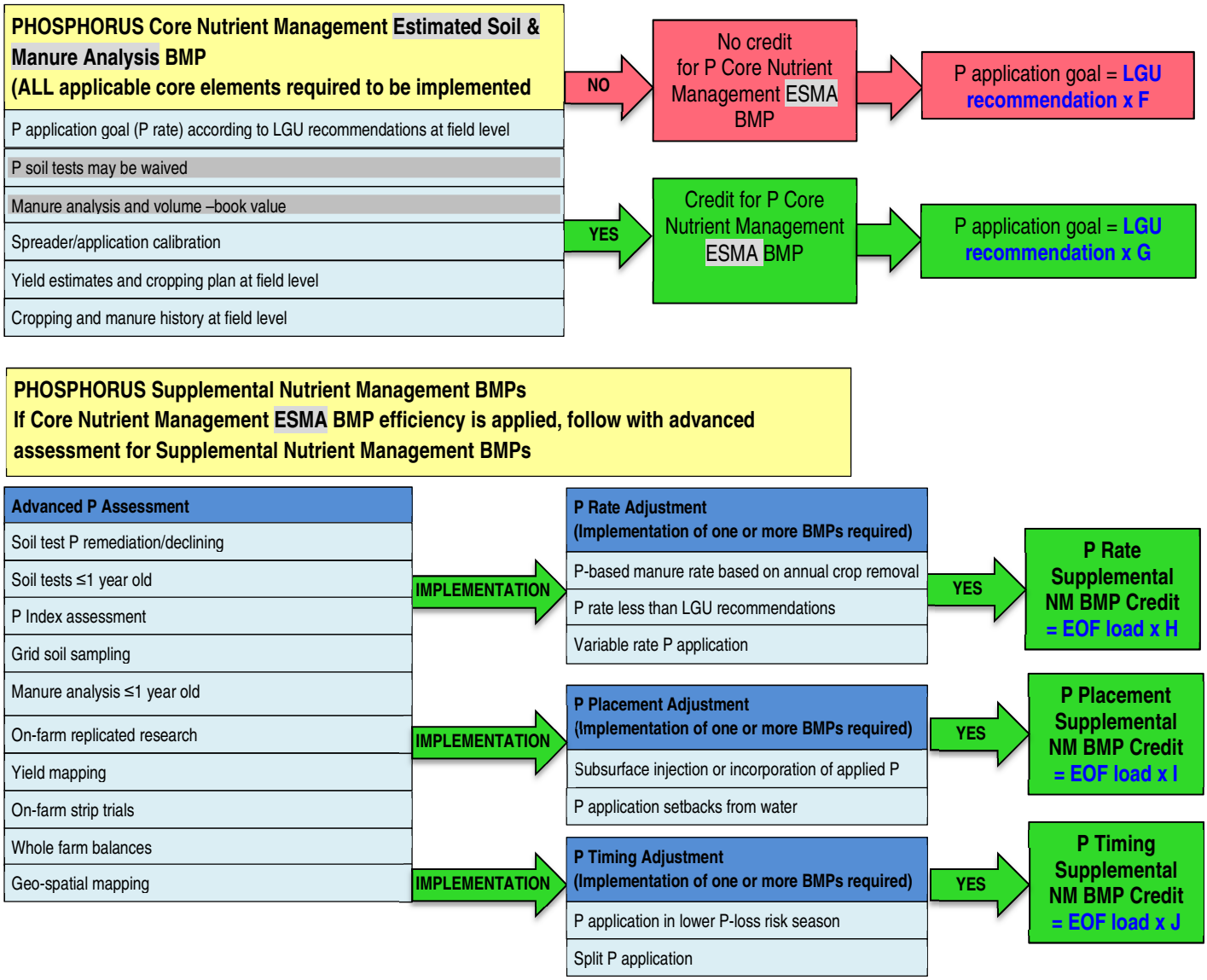

Figure 6. Assignment of P Nutrient Management Credits. Variables F and G refer to the land use specific P Core Non-Nutrient Management BMP application rate multiplier and the P Core Nutrient Management ESMA BMP application rate multiplier, respectively, as presented in Table 13. Variables H, I and J refer to the land use specific P Rate Supplemental NM BMP loss reduction multiplier, the P Placement Supplemental NM BMP loss reduction multiplier and the P Timing Supplemental NM BMP Loss reduction multiplier, respectively, as presented in Table 15. EOF is edge of field.

11 Review of Literature and Data Gaps

11.1 The Available Science for N BMPs

Crop- and land-use-specific N application rate goal should be based on LGU crop fertilization recommendations, as modified by the CBP partnership. In an effort to determine the most practicable methodology for allocating fertilizer N to satisfy crop- and land-use-specific N application rate goals, the Agriculture Workgroup compared the modified LGU recommendations for application of supplemental inorganic N fertilizer to an alternative approach based on county-level redistribution of AAPFCO N fertilizer sales data. This methodological comparison indicated that there were relatively small differences between the two methods for estimating supplemental N fertilizer applications, leading the Agriculture Workgroup to approve use of the redistributed AAPFCO fertilizer sales methodology in the Phase 6 Model. The Panel maintains that LGU recommendations should continue to serve as the foundation for crop and land-use-specific N

application goals and suggests that similar comparative analyses be conducted in the future as new fertilizer sales data become available. Inconsistencies between estimates generated by the two methods should be further investigated and rectified based on data source quality and consistency with contiguous or regional county-level data.

Nutrient management practices are implemented at either the field or sub-field level. The diverse landforms, hydrology, climate and cropping systems of the agricultural landscapes in the CBW have a multitude of impacts on biogeochemical transformations of N in the agro-ecosystem. Changes in hydrological pathways alone can have dramatic effects on crop N utilization efficiency and N loads to streams when viewed from the Atlantic Coastal Plain to the Appalachian Plateau. Therefore, site-specific physical conditions and management factors have a strong influence on the effectiveness of imposed conservation practices. Nutrient management BMP effectiveness must represent the average condition over a wide range of real-life scenarios. Thus, it was incumbent upon the Panel to distill numerous lines of evidence to arrive at a single crediting value for N BMPs that could be applied equitably across the CBW.

11.2 The Available Science for P BMPs

Similar to N, crop and land-use-specific P application rate goal should be based on LGU crop fertilization recommendations, as modified by the CBP partnership. However, in practice, LGU recommendations for P application are based on crop- and site-specific soil-test P concentration. Currently, soil-test P concentration data are not available to the CBP. The Panel recommends that, in the future, crop- and site-specific soil-test P concentration data should be collected, aggregated to the appropriate scale, summarized to eliminate disclosure of private confidential business information, and utilized as the foundation for determining P application rate goals and the appropriate application of P Core NM BMPs. In the absence of soil-test P based application rate goals, county-level redistribution of AAPFCO P fertilizer sales data may serve as a surrogate. An essential assumption that must be imposed when county-level redistribution of AAPFCO P fertilizer sales data is utilized in lieu of site-specific soil-test P concentration data is the assumption of a county-average soil-test P concentration. Currently, a “medium” soil-test P condition was assumed for all situations and locations. Imposition of the “medium” soil-test P assumption across the entire CBW is a gross over-simplification of the complex site-specific biogeochemical processes and on-site management practices that determine P fate and transport in the agro-ecosystem. The CBP should strive to rectify this shortcoming in future iterations of the modeling suite.

As stated above relative to N, nutrient management practices are implemented at either the field or sub-field level. The diverse landforms, hydrology, climate and cropping systems of the agricultural landscapes in the CBW have a multitude of impacts on biogeochemical transformations of P in the agro-ecosystem. Therefore, site-specific physical conditions and management factors have a strong influence on the effectiveness of imposed conservation practices. Nutrient management BMP effectiveness must represent the average condition over a wide range of real-life scenarios. Thus, it was incumbent upon the Panel to distill numerous lines of evidence to arrive at a single crediting value for the P BMPs that could be applied equitably across the CBW.

12 Application of Practice Estimates

12.1 Load Sources

Nutrient management can be applied to specified land uses everywhere within the Chesapeake Bay watershed. The N Core BMP and the P Core BMP, as well as the N and P Supplemental NM BMPs, apply to each of the partnership approved Phase 6 agricultural land uses listed in Table 18.

Table 18. Land Uses to Which the Nutrient Management Practices Apply

Land Use	Description
Full Season Soybeans	Soybeans ineligible for double cropping
Grain with Manure	Corn or sorghum for grain eligible for manure application and ineligible for double cropping
Grain without Manure	Corn or sorghum for grain ineligible for manure application and ineligible for double cropping
Silage with Manure	Corn or sorghum for silage eligible for manure application and ineligible for double cropping
Silage without Manure	Corn or sorghum for silage ineligible for manure application and ineligible for double cropping
Legume Hay	Legume forage crops eligible for manure
Small Grains and Grains	Small grains and grains other than corn or sorghum eligible for manure and ineligible for double cropping
Small Grains and Soybeans	Soybeans double cropped with small grains and ineligible for manure
Specialty Crop High	Specialty crops with relatively high nutrient inputs with some crops eligible for manure
Specialty Crop Low	Specialty crops with relatively low nutrient inputs with some crops eligible for manure
Other Agronomic Crops	Other high commodity row crops such as tobacco, cotton, etc., with some crops eligible for manure
Other Hay	Non-legume forage crops eligible for manure
Pasture	Grazed land that receives direct manure deposition from animals

12.2 Practice Baseline

The Panel recommends that historic implementation on a state-by-state basis be based on the premise that the baseline of 1985 is set at zero, or near zero acres for N Core NM BMP implementation and the highest level of implementation be represented at 2015 reported implementation acreages. Similarly, the zero baseline for the P Core NM BMP should be set to the date when each state introduced P-based NM requirements and the highest level of implementation be represented at 2015 reported implementation acreages. Due to the differences between state Nutrient Management program initiation dates and implementation reporting for the six-state partnership, the "baseline" year is recommended to reflect these state partnership differences. Thus, the initial Nutrient Management implementation year for each state will be unique.

The increasing level of historic implementation between the state Nutrient Management Program initiation year and the 2015 reported implementation acreages represent two points in time on a state-by-state basis. The intervening annual representation of implementation acreages may be represented as a linear progression, in the absence of robust implementation data. Historic implementation estimation shall consider additional sources of N and P reduction credits commensurate with State Quality Assurance Project Plans (QAPPs) currently in place, given they are consistent with the BMPs and efficiency credits described by the Panel.

In cooperation with the CBPO, a state-by-state representation of reported NM implementation is included as Appendix A. The state-by-state representation was developed for historical N Core NM and P Core NM BMP implementation.

Historical N Core NM BMP implementation methodology:

- Assume straight-line interpolation between 2015 Progress acres and a starting year for each state.
- Starting year was evaluated by looking at historic NEIEN data to determine when states started reporting information.

- 2015 Progress has acres on crop, pasture and hay. Interpolation was made for each of these categories.
- Interpolation was made in each county.
- Assume all acres on crops for New York (NY), Pennsylvania (PA), and West Virginia (WV) only apply to crop acres eligible for receiving manure.
- Assume all acres on crops for Delaware (DE), Maryland (MD) and Virginia (VA) can be distributed to crop acres with or without manure.
- All acres assumed to qualify for N Core NM BMP.

Historical P Core NM BMP implementation methodology would be similar to the N Core NM BMP implementation methodology above, except for variable starting years for each state.

A second independent source of data representing historic Nutrient Management implementation has been requested from the USDA Natural Resources Conservation Service (NRCS) Conservation Effects Assessment Project (CEAP) based on the two existing reports published on the Chesapeake Bay Watershed. The requested information will be evaluated on a HUC-4 (4-digit Hydrologic Unit Code) scale based upon the CEAP program's methodology of interviewing producers at randomly selection field points from the Natural Resources Inventory (NRI) lists. To date, analysis of the CEAP data at the HUC-4 scale across the CBW has not been conducted.

In utilizing the Panel's practice recommendations for tracking and reporting practice implementation, the Panel recommends that acres, or percentage of acres, be reported by Phase 6 land use, or grouping of similar land uses, by year as an annual practice. N and P Core NM BMPs are stand-alone practices which should be tracked and reported separately. Likewise, advanced N and P Supplemental NM BMPs should be tracked and reported separately, but only when the corresponding N or P Core NM BMP elements have been met by the Panel's recommended practice definitions.

The Panel's recommendation for tracking and reporting NM BMP implementation is that acres, or percentage of acres, be reported by Phase 6 land use, or grouping of similar land uses, by year as an annual practice. The N Core NM BMP and P Core NM BMP are stand-alone practices which should be tracked and reported separately. Likewise, advanced N and P Supplemental NM BMPs should be tracked and reported separately, but only when the requirements for reporting the corresponding N or P Core NM BMP have been met.

12.3 Hydrologic Conditions

The Panel represented NM BMPs that can be applied across all hydrologic conditions in the CBW.

12.4 Sediment

Panel report specifically does not address sediment losses or reductions resulting from implementation of NM BMPs.

12.5 Species of Nitrogen and Phosphorus

The Panel report focused on total N and total P and did not specify species of N or P.

12.6 Geographic Considerations

The Panel report represented NM BMPs that can be applied across all geographic areas of the CBW.

12.7 Temporal Considerations

The Panel report represented NM BMPs that may or may not have temporal considerations depending on the sequence of BMP implementation within the constraints of farm management operations.

12.8 Practice Limitations

There are no limitations to the application of NM BMPs. These practices may be applied to all agricultural land use categories in the CBW.

12.9 Potential Interactions with other Practices

The Panel recognizes that NM BMPs interact with all other agricultural practices for all agricultural land use categories in the CBW.

13 Practice Monitoring and Reporting

13.1 Phase 6.0 Nutrient Management Tracking, Verification, and Reporting

The Panel recommends that NM BMP implementation tracking, verification, and reporting on a county-by-county or state-by-state basis be based on the premise that they represent annual Non-Visual Assessment BMPs. BMP implementation will be reported annually to the CBPO as the number of acres or percentage of acres meeting the definitions and qualifications set forth by the NM Panel in this report for Core N and P NM BMPs, as well as applicable N and P Supplemental NM BMPs.

Nutrient Management BMPs represent an historic and ever-changing suite of BMPs for the CBP modeling tools over the history of the Program. As such, NM BMPs are included in the jurisdiction's verification plans that were submitted to the CBP in late 2015. As with all BMPs, the jurisdictions will be expected to document their verification protocols and procedures in their QAPP for NM BMPs that are reported to the CBPO for nitrogen and phosphorous crediting reductions under the recommended BMPs. The jurisdictions will determine if modifications of those verification plans are required after this expert panel recommendation report is approved by the CBP partnership following the BMP Protocol, and before the jurisdictions are able to start submitting these BMPs in the Phase 6 modeling tools for annual progress implementation. As the states consider how to verify NM BMPs and as they document those procedures in their QAPP, state partners should follow the existing Agriculture Workgroup's BMP Verification guidance.

http://www.chesapeakebay.net/about/programs/bmp/additional_resources

The current verification guidance from the Agriculture Workgroup (AgWG) breaks BMPs into three general categories: Visual Assessment BMPs (Single Year), Visual Assessment BMPs (Multi-Year), and Non-Visual Assessment BMPs. The complete AgWG guidance is quite extensive (79 pages long, including all tables and its own appendices) and is not restated in this section. The panel is not proposing any new or unique aspects of BMP verification for purposes of the BMPs described in this report. This section simply explains how the recommended BMPs correspond to the existing BMP verification guidance.

As described in this report, nutrient management practices are often part of a larger nutrient management system or plan that often involves multiple management and physical components (e.g., animal waste storage, manure injection and incorporation, etc.) which can be visually assessed over time. NM practices also incorporate non-visual components (e.g. nutrient application rate, timing, and placement) in addition to management plans or other documentation as needed under applicable state or federal agricultural permits and/or programs. Thus, nutrient management practices can reasonably be verified using elements of both the Non-Visual Assessment and Visual Assessment (Multi-Year) categories described by the AgWG.

Each state will determine the most appropriate methods for verifying NM BMP implementation given their specific priorities, programs, needs, and capacity. For example, one state may leverage existing site visits to farms to also verify that the operation meets applicable NM BMP definitions as per the NM Panel recommendations. Or, the state may determine that available records are detailed enough to provide sufficient verification through spot-checks. Ideally the state will leverage multiple existing and perhaps new avenues to verify that nutrient management practices and operational are sufficient to meet the NM BMP criteria as determined by a trained and/or certified independent third-party, and that the data in the operation's records are accurate and up-to-date.

Jurisdictions can follow the AgWG's guidance for Non-Visual Assessment BMPs to verify the N and P core NM BMPs recommended in this report for N and P reduction credits in the Phase 6 CBWM. Verification for Non-Visual Assessment BMPs depend more on oversight and checks on operational records or documentation rather than visual assessment of a physical structure.

The N and P reductions for Core NM BMPs described in this report are to be based on the verified required elements of the N and P Core NM BMPs following the AgWG's guidance for Non-Visual Assessment BMPs. Because it is an annually reported BMP, the most important criteria (i.e. N and P Core NM elements) should be documented somewhere in records available to the applicable state agency. Given the close association between nutrient application management and other CBP-approved BMPs (e.g., animal waste storage systems, manure transport, etc.) the state agency can potentially verify the type and amount of nutrients that were managed via one or both of the Core NM practices described by the panel. If the state agency finds that even this basic information cannot be verified through its spot-checks or other annual BMP verification procedures described in its QAPP, then the BMP cannot satisfy the definitions and expected nitrogen reductions described in this report.

When the state agency has more detailed NM information available for both reporting and verification purposes, then they may be able to report the given nutrient application system under both the defined N and P Core NM BMPs, as well as one or more of the N and P Supplemental NM BMPs. By providing separate BMPs based on additional rate, timing, and placement application management systems for the higher nitrogen and phosphorous reductions, the panel provides a framework with additional built-in elements of BMP verification. If records available to the applicable state agency do not document the implementation of additional nutrient application changes for rate, timing, and/or placement described by the panel for the N and P Supplemental NM BMPs, then the given system should not be reported under the corresponding Supplemental NM BMP, but could potentially still meet the criteria of the N and/or P Core NM BMP using the more basic information that is available. By assigning lower estimated reductions when only basic information is available, it is less likely that a reported treatment system will not provide the estimated nitrogen and phosphorous reductions developed by the panel. This reinforces the basis of BMP verification, i.e. that the reported practice is implemented and operating as intended. With more detailed information about the nutrient application management factors, verified according to the AgWG's guidance, the partnership can have more confidence that the given nutrient application system is operating more effectively to limit excess nitrogen and phosphorous from the environment.

For more information about the CBP Partnership's BMP Verification Framework

The full CBP partnership BMP Verification Framework is available online (scroll down to October 2014 Basinwide BMP Verification Framework Document):

http://www.chesapeakebay.net/about/programs/bmp/additional_resources

The current Agriculture Workgroup's BMP Verification Guidance is included in Appendix B of the full Framework Document. For the AgWG's guidance only, go here:

http://www.chesapeakebay.net/documents/Appendix%20B%20-Ag%20BMP%20Verification%20Guidance%20Final.pdf

13.2 Future Verification of Nutrient Management Practices

The Panel envisions that potential opportunities may exist in the future for utilizing alternative forms of BMP verification, including examples such as remote sensing from satellite, aerial, and drone imagery, aggregated fertilizer industry sales information, and aggregated manure hauler/broker data.

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Appendix A: Technical Requirements for Reporting and Simulating Nutrient Management BMPs in the Phase 6 Watershed Model

Background: In June, 2013 the Water Quality Goal Implementation Team (WQGIT) agreed that each BMP expert panel would work with CBPO staff and the Watershed Technical Workgroup (WTWG) to develop a technical appendix for each expert report. The purpose of the technical appendix is to describe how the expert panel's recommendations will be integrated into the modeling tools including NEIEN, Scenario Builder and the Watershed Model.

Q1. What are the individual nutrient management practices a jurisdiction may report in the Phase 6 Watershed Model?

A1. The individual practices along with their definitions are provided below.

Nitrogen Core NM On-Site Manure Analysis

Applications of nitrogen are made in accordance to ALL the following elements as applicable:

- Land-grant university recommendations for nitrogen applications at field level
- Manure analysis and volume using on-site test values to determine nitrogen content
- Calibration of spreader/applicator
- Yield estimates and cropping plan at the field level
- Cropping and manure application history at the field level

Nitrogen Core NM Estimated Manure Analysis

Applications of nitrogen are made in accordance to ALL the following elements as applicable:

- Land-grant university recommendations for nitrogen applications at field level
- Manure analysis and volume using book values to determine nitrogen content
- Calibration of spreader/applicator
- Yield estimates and cropping plan at the field level
- Cropping and manure application history at the field level

Phosphorus Core NM On-Site Soil and Manure Analysis

Applications of phosphorus are made in accordance to ALL the following elements as applicable:

- Land-grant university recommendations for phosphorus at the field level. This may include recommendations resulting from advanced assessment (i.e. P Index, etc.) that recommend higher P application rates where the risk of P loss is low.

- Soil test for phosphorus levels at the field level.
- Manure analysis and volume using on-site test values to determine phosphorus content
- Calibration of spreader/applicator
- Yield estimates and cropping plan at the field level
- Cropping and manure history at the field level

Phosphorus Core NM Estimated Soil and Manure Analysis

Applications of phosphorus are made in accordance to ALL the following elements as applicable:

- Land-grant university recommendations for phosphorus at the field level. This may include recommendations resulting from advanced assessment (i.e. P Index, etc.) that recommend higher P application rates where the risk of P loss is low.
- Soil testing requirement may be waived if restrictions on manure applications (rate, timing, and placement) are imposed that limit P application rates and management to the same degree as if the soil test result for phosphorus was in the “high” category.
- Manure analysis and volume using book values to determine phosphorus content
- Calibration of spreader/applicator
- Yield estimates and cropping plan at the field level
- Cropping and manure history at the field level

Nitrogen Rate Supplemental NM

Applications of nitrogen are made in accordance to all elements of one of the Nitrogen Core practice, and one or more of the following practices are implemented resulting in a reduction in application rate of nitrogen:

- Nitrogen application rate made at less than land-grant university recommendations
- Nitrogen applications split across the growing season resulting in lower than planned applications
- Nitrogen applications are made using variable rate goals resulting in lower than planned applications.

Nitrogen Placement Supplemental NM

Applications of nitrogen are made in accordance to all elements of one of the Nitrogen Core practice, and one or more of the following practices are implemented resulting in better placement and utilization of nitrogen:

- Applications of inorganic nitrogen are injected into the subsurface or incorporated into the soil
- Applications of nitrogen are made with setbacks from surface water features

Nitrogen Timing Supplemental NM

Applications of nitrogen are made in accordance to all elements of one of the Nitrogen Core practice, and are split across the growing season into multiple applications to increase utilization of nitrogen.

Phosphorus Rate Supplemental NM

Applications of phosphorus are made in accordance to all elements of one of the Phosphorus Core practice, and one or more of the following practices are implemented resulting in a reduction in application rate of phosphorus:

- Applications of manure are based upon annual crop removal of phosphorus rather than nitrogen
- Applications of phosphorus are made at less than land-grant university recommendations
- Phosphorus applications are made using variable rate goals resulting in lower than planned applications

Phosphorus Placement Supplemental NM

Applications of phosphorus are made in accordance to all elements of one of the Phosphorus Core practice, and one or more of the following practices are implemented resulting in better placement and utilization of nitrogen:

- Applications of inorganic phosphorus are injected into the subsurface or incorporated into the soil
- Applications of phosphorus are made with setbacks from surface water features

Phosphorus Timing Supplemental NM

Applications of phosphorus are made in accordance to all elements of one of the Phosphorus Core practice, and are made in seasons with a lower risk of phosphorus loss.

- Applications of phosphorus are split across the growing season resulting in lower than planned applications.

Q2. What are the nutrient reductions associated with core practices?

A2. Each acre reported under the core practices will have an application goal adjusted slightly from land-grant university recommendations. For example, an acre of corn not receiving manure (a crop in the Grain without Manure land use) under the Nitrogen Nutrient Management Core practice will have an application goal of 0.92 lbs. of nitrogen/bu./ac. The modified land-grant university applications will be increased by the multipliers provided in the tables below for each acre NOT under the Nutrient Management Core practice. For example, an acre of corn not receiving manure (a crop in the Grain without Manure land use) NOT under the Nitrogen Nutrient Management Core practice will have an application goal of 1.10 lbs. of nitrogen/bu./ac. (or 0.92 X 1.20). See *Example Calculation of County Crop Application Goal using Core Nutrient Management for Nitrogen Acres on Corn for Grain* below for additional details.

Core N Nutrient Management Application Goal Multipliers

Land Use	**Nutrient Management BMP**		
	Nitrogen Core ***Non-Nutrient Management***	**Nitrogen Core** ***Nutrient Management Estimated Manure Analysis***	**Nitrogen Core** ***Nutrient Management On-Site Manure Analysis***
Full Season Soybeans	1.20	1.10	1.00
Grain w/ Manure	1.30	1.15	1.00
Grain w/o Manure	1.20	1.10	1.00
Legume Hay	1.20	1.10	1.00
Silage w/ Manure	1.40	1.20	1.00
Silage w/o Manure	1.20	1.10	1.00
Small Grains and Grains	1.20	1.10	1.00
Small Grains and Soybeans	1.20	1.10	1.00
Specialty Crop High	1.30	1.15	1.00
Specialty Crop Low	1.20	1.10	1.00
Other Agronomic Crops	1.10	1.05	1.00
Other Hay	1.00	1.00	1.00
Pasture	1.00	1.00	1.00

Core P Nutrient Management Application Goal Multipliers

Land Use	Nutrient Management BMP		
	Phosphorus Core *Non-Nutrient Management*	**Phosphorus Core** *Nutrient Management Estimated Soil and Manure Analysis*	**Phosphorus Core** *Nutrient Management On-Site Soil and Manure Analysis*
Full Season Soybeans	1.50	1.25	1.00
Grain w/ Manure	3.00	2.00	1.00
Grain w/o Manure	1.50	1.25	1.00
Legume Hay	1.00	1.00	1.00
Silage w/ Manure	3.00	2.00	1.00
Silage w/o Manure	1.50	1.25	1.00
Small Grains and Grains	1.50	1.25	1.00
Small Grains and Soybeans	1.50	1.25	1.00
Specialty Crop High	2.00	1.50	1.00
Specialty Crop Low	2.00	1.50	1.00
Other Agronomic Crops	1.50	1.25	1.00
Other Hay	1.00	1.00	1.00
Pasture	1.00	1.00	1.00

Example Calculation of County Crop Application Goal using Core Nutrient Management for Nitrogen Acres on Corn for Grain

County Assumptions:

Acres of Corn for Grain in County: 100,000 ac.

Average Yield for County: 100 bu. /ac.

Nutrient Management Application Goal: 0.92 lbs. of N/bu.

Non-Nutrient Management Application Goal: 1.2 lbs. of N/bu.

- Calculation: (0.92 lbs. N/bu.) X (1.3)

Number of Acres under Nutrient Management: 20,000 ac.

Number of Acres under Non-Nutrient Management: 80,000 ac.

Crop Application Calculations:

Crop Application Goal for all Nutrient Management Acres: 1,840,000 lbs. N

- Calculation: (20,000 ac.) X (100 bu. /ac.) X (0.92 lbs. N/bu.) = 1,840,000 lbs. N

Crop Application Goal for all Non-Nutrient Management Acres:

- Calculation: (80,000 ac) X (100 bu. /ac.) X (1.2 lbs. N/bu.) = 9,600,000 lbs. N

Total Crop Application Goal for all Acres: 11,440,000 lbs. N

- Calculation: (1,840,000 lbs. N) + (9,600,000 lbs. N) = 11,440,000 lbs. N

Total Crop Application Goal per Acre: 114.4 lbs. N/ac.

- Calculation: (11,440,000 lbs. N) / (100,000 ac.) = 114.4 lbs. N/ac.

In this way, the acres of core nutrient management impact the overall application goal for each crop within a county. The more acres of nutrient management, the lower the goal will be, and vice versa. However, the final nutrient application rates for the calibration period are determined by the amount of manure and commercial fertilizer available within a county. Thus, the final application rate may be higher or lower than the 114.4 lbs. N/ac. described in the example above.

Q3. What are the nutrient reductions associated with the supplemental practices?

A3. Each supplemental practice will be credited as a percent reduction to estimated runoff from the appropriate land use. These percent reductions are listed in the tables below.

Nitrogen Supplemental Percent Reductions to Land Use Runoff

Land Use	Nutrient Management BMP		
	N Rate Supplemental	N Placement Supplemental	N Timing Supplemental
Full Season Soybeans	0%	0%	0%
Grain w/ Manure	15%	5%	10%
Grain w/o Manure	5%	3%	5%
Legume Hay	0%	0%	0%
Silage w/ Manure	15%	5%	10%
Silage w/o Manure	5%	3%	5%
Small Grains and Grains	5%	3%	10%
Small Grains and Soybeans	5%	3%	10%
Specialty Crop High	15%	5%	5%
Specialty Crop Low	5%	3%	5%
Other Agronomic Crops	5%	3%	5%
Other Hay	0%	3%	5%
Pasture	0%	0%	0%

Phosphorus Supplemental Percent Reductions to Land Use Runoff

Land Use	Nutrient Management BMP		
	P Rate Supplemental	**P Placement Supplemental**	**P Timing Supplemental**
Full Season Soybeans	5%	10%	1%
Grain w/ Manure	10%	20%	20%
Grain w/o Manure	5%	10%	1%
Legume Hay	1%	10%	1%
Silage w/ Manure	10%	20%	20%
Silage w/o Manure	5%	10%	1%
Small Grains and Grains	5%	10%	1%
Small Grains and Soybeans	5%	10%	1%
Specialty Crop High	5%	10%	1%
Specialty Crop Low	5%	10%	1%
Other Agronomic Crops	5%	10%	1%
Other Hay	0%	10%	1%
Pasture	0%	0%	0%

Q4. Can a state report an acre of supplemental nutrient management on an acre that does not fulfill the definition of the core practices?

A4. No. The panel recommended that every acre of supplemental nutrient management must also fully meet the definition of the associated core practice.

Q5. If an acre utilizes multiple strategies listed under a single supplemental practice's definition, should it be reported twice? For example, if a producer both sets back applications of nitrogen from surface waters AND injects inorganic nitrogen below the soil surface, should a state report the acre twice as qualifying for the Nitrogen Supplemental Placement practice?

A5. No. The panel recommended that each acre can only qualify once for each of the BMPs. However, an acre can qualify for all four types of BMPs at once. For example, an acre could be reported under the appropriate core practice and all three supplemental practices for nitrogen and phosphorus if appropriate.

Q6. How will multiple, supplemental nutrient management practices credited on the same acre impact runoff estimates?

A6. A single acre of land may qualify for up to three supplemental practices reported for each nutrient. The reductions for each practice will be combined in a multiplicative manner to impact final runoff estimates. An example calculation for a single acre of Grain with Manure with three supplemental practices for nitrogen is included below.

Initial Runoff Estimate: 20 lbs. N/ac.

Supplemental Credits Available: 15% N Rate; 5% N Placement; 10% N Timing

Final Runoff Estimate: 14.54 lbs. N/ac. = 20 lbs. N/ac. X (1-0.15) X (1-0.05) X (1-0.1)

Q7. Are the supplemental practices credited in any particular order?

A7. No. There would be no difference in the runoff reductions by re-ordering the reduction efficiencies listed in the example calculation in question 6 due to the multiplicative nature of the credit calculation.

Q8. How should a state report these practices to NEIEN?

A8. States should report the following information:

- *BMP Name:* Nitrogen Core NM; Nitrogen Core NM Estimated; Phosphorus Core NM; Phosphorus Core NM Estimated; Nitrogen Rate Supplemental NM; Nitrogen Timing Supplemental NM; Nitrogen Placement Supplemental NM; Phosphorus Rate Supplemental NM; Phosphorus Timing Supplemental NM; Phosphorus Placement Supplemental NM
- *Measurement Name:* Acres
- *Land Use:* Approved NEIEN agricultural land use classes; if none are reported, the default will be CROP
- *Geographic Location:* Approved NEIEN geographies: County; County (CBW Only); Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); State (CBW Only)
- *Date of Implementation:* Year plan was active.

Q9. Are all nutrient management practices annual?

A9. Yes. States should report the total number of acres qualifying under each practice type each year.

Q10. Can states take credit for practices on pasture?

A10. No. The panel specifically recommended reductions to application goals and runoff estimates on non-pasture acres only.

Appendix H: Conformity with WQGIT BMP Protocol

The BMP review protocol established by the Water Quality Goal Implementation Team (WQGIT 2014) outlines the expectations for the content of expert panel reports. This appendix references the specific sections within the report where the panel addressed the requested protocol criteria.

1. **Identity and expertise of panel members:** *See Table 1in Section1.*

2. **Practice name or title:**
   - *Nitrogen (N) Core Nutrient Management On-Site Manure Analysis BMP*
   - *Nitrogen (N) Core Nutrient Management Estimated Manure Analysis BMP*
   - *Phosphorus (P) Core Nutrient Management On-Site Soil & Manure Analysis BMP*
   - *Phosphorus (P) Core Nutrient Management Estimated Soil & Manure Analysis BMP*
   - *Nitrogen (N) Rate Supplemental Nutrient Management BMP*
   - *Nitrogen (N) Placement Supplemental Nutrient Management BMP*
   - *Nitrogen (N) Timing Supplemental Nutrient Management BMP*
   - *Phosphorus (P) Rate Supplemental Nutrient Management BMP*
   - *Phosphorus (P) Placement Supplemental Nutrient Management BMP*
   - *Phosphorus (P) Timing Supplemental Nutrient Management BMP*

3. **Detailed definition of the practice:** *See Section 2 for detailed definitions of Core and Supplemental N and P Nutrient Management BMPs.*

4. **Recommended N, P and sediment effectiveness estimates:** *See Table 12 (Core N Nutrient Management Efficiency Values), Table 13 (Core P Nutrient Management Efficiency Values), Table 14 (N Supplemental Nutrient Management BMP Efficiency Values), and Table 15 (P Supplemental Nutrient Management BMP Efficiency Values) in Section 3.1 for recommended TN and TP reductions for use in the Phase 6.0 Watershed Model. The panel did not recommend a sediment reduction rate for Nutrient Application Management.*

5. **Justification of selected effectiveness estimates:** *See Section 3.2 for justification of the effectiveness estimates.*

6. **List of references used:** *See Section 7 for the full list of references.*

7. **Detailed discussion on how each reference was considered:** *See Sections 3.2 and 4 for details on the review of available science.*

8. **Land uses to which BMP is applied:** *See Table 12 (Core N Nutrient Management Efficiency Values) in Section 3.1.1, Table 13 (Core P Nutrient Management Efficiency Values) in Section 3.1.2, Table 14 (N Supplemental Nutrient Management BMP Efficiency Values) in Section 3.1.3, Table 15 (P Supplemental Nutrient Management BMP Efficiency Values) in Section 3.1.4,*

Table 18 (Land Uses to Which the Nutrient Management Practices Apply) in Section 5.1 for applicable agricultural land uses.

9. **Load sources that the BMP will address and potential interactions with other practices:** *See Table 18* (*Land Uses to Which the Nutrient Management Practices Apply) in Section 5.1 for applicable load sources.*

10. **Description of pre-BMP and post-BMP circumstances and individual practice baseline:** *See Sections 2, 3, and 5.2.*

11. **Conditions under which the BMP works, including conditions where the BMP will not work, or will be less effective:** *See Section 5.*
    a. **Variations in BMP effectiveness across the watershed due to climate, hydrogeomorphic region, or other measureable factors.** *See Sections 5.3 through 5.8.*

12. **Temporal performance of BMP including lag times between establishment and full functioning:** *See Section 5.7.*

13. **Unit of measure:** *Acres or percentage of acres implementing practice.*

14. **Locations in Chesapeake Bay watershed where the practice applies:** *All acres of the applicable land uses in Table 18 (Section 5.1) in the Bay watershed.*

15. **Useful life of the BMP:** *Nutrient Application Management is intended to be represented as an annual practice, so for the purposes of this report, however, the useful life of the practice is 1 year.*

16. **Cumulative or annual practice:** *Annual.*

17. **Description of how BMP will be tracked, reported, and verified:** *See Section 6 for a discussion of how Nutrient Application Management should be tracked and reported to the Bay Program. More details are also available in the Scenario Builder Technical Appendix (Appendix A).*

18. **Ancillary benefits, unintended consequences:** *The Panel did not review Nutrient Application Management for external environmental benefits. The Panel did not identify any unintended consequences.*

19. **Timeline for a re-evaluation of the panel recommendations:** *There is currently no specific plan to re-evaluate Panel recommendations.*

20. **Outstanding issues that need to be resolved in the future and list of ongoing studies, if any:** *See Section 2 for a discussion of data needs and Section 4 for additional discussion of data gaps and future research needs.*

21. **Documentation of dissenting opinion(s):** *While no dissenting opinions were expressed or recorded, significant notes related to recommendations were recorded in Appendix D (Approved Nutrient Management Expert Panel Meeting Minutes).*

22. **Operation and maintenance requirements and how neglect alters performance:** *The requirements and performance are covered by the state programs, which in their own way document these elements.*

Appendix H: Conformity with WQGIT BMP Protocol

The BMP review protocol established by the Water Quality Goal Implementation Team (WQGIT 2014) outlines the expectations for the content of expert panel reports. This appendix references the specific sections within the report where the panel addressed the requested protocol criteria.

1. **Identity and expertise of panel members:** *See Table 1in Section1.*

2. **Practice name or title:**
   - *Nitrogen (N) Core Nutrient Management BMP*
   - *Phosphorus (P) Core Nutrient Management BMP*
   - *Nitrogen (N) Rate Supplemental Nutrient Management BMP*
   - *Nitrogen (N) Placement Supplemental Nutrient Management BMP*
   - *Nitrogen (N) Timing Supplemental Nutrient Management BMP*
   - *Phosphorus (P) Rate Supplemental Nutrient Management BMP*
   - *Phosphorus (P) Placement Supplemental Nutrient Management BMP*
   - *Phosphorus (P) Timing Supplemental Nutrient Management BMP*

3. **Detailed definition of the practice:** *See Section 2 for detailed definitions of Core and Supplemental N and P Nutrient Management BMPs.*

4. **Recommended N, P and sediment effectiveness estimates:** *See Table 12 (Core N Nutrient Management Efficiency Values), Table 13 (Core P Nutrient Management Efficiency Values), Table 14 (N Supplemental Nutrient Management BMP Efficiency Values), and Table 15 (P Supplemental Nutrient Management BMP Efficiency Values) in Section 3.1 for recommended TN and TP reductions for use in the Phase 6.0 Watershed Model. The panel did not recommend a sediment reduction rate for Nutrient Application Management.*

5. **Justification of selected effectiveness estimates:** *See Section 3.2 for justification of the effectiveness estimates.*

6. **List of references used:** *See Section 7 for the full list of references.*

7. **Detailed discussion on how each reference was considered:** *See Sections 3.2 and 4 for details on the review of available science.*

8. **Land uses to which BMP is applied:** *See Table 12 (Core N Nutrient Management Efficiency Values) in Section 3.1.1, Table 13 (Core P Nutrient Management Efficiency Values) in Section 3.1.2, Table 14 (N Supplemental Nutrient Management BMP Efficiency Values) in Section 3.1.3, Table 15 (P Supplemental Nutrient Management BMP Efficiency Values) in Section 3.1.4,*

Table 18 (Land Uses to Which the Nutrient Management Practices Apply) in Section 5.1 for applicable agricultural land uses.

9. **Load sources that the BMP will address and potential interactions with other practices:** *See Table 18 (Land Uses to Which the Nutrient Management Practices Apply) in Section 5.1 for applicable load sources.*

10. **Description of pre-BMP and post-BMP circumstances and individual practice baseline:** *See Sections 2, 3, and 5.2.*

11. **Conditions under which the BMP works, including conditions where the BMP will not work, or will be less effective:** *See Section 5.*
    a. **Variations in BMP effectiveness across the watershed due to climate, hydrogeomorphic region, or other measureable factors.** *See Sections 5.3 through 5.8.*

12. **Temporal performance of BMP including lag times between establishment and full functioning:** *See Section 5.7.*

13. **Unit of measure:** *Acres or percentage of acres implementing practice.*

14. **Locations in Chesapeake Bay watershed where the practice applies:** *All acres of the applicable land uses in Table 18 (Section 5.1) in the Bay watershed.*

15. **Useful life of the BMP:** *Nutrient Application Management is intended to be represented as an annual practice, so for the purposes of this report, however, the useful life of the practice is 1 year.*

16. **Cumulative or annual practice:** *Annual.*

17. **Description of how BMP will be tracked, reported, and verified:** *See Section 6 for a discussion of how Nutrient Application Management should be tracked and reported to the Bay Program. More details are also available in the Scenario Builder Technical Appendix (Appendix A).*

18. **Ancillary benefits, unintended consequences:** *The Panel did not review Nutrient Application Management for external environmental benefits. The Panel did not identify any unintended consequences.*

19. **Timeline for a re-evaluation of the panel recommendations:** *There is currently no specific plan to re-evaluate Panel recommendations.*

20. **Outstanding issues that need to be resolved in the future and list of ongoing studies, if any:** *See Section 2 for a discussion of data needs and Section 4 for additional discussion of data gaps and future research needs.*

21. **Documentation of dissenting opinion(s):** *While no dissenting opinions were expressed or recorded, significant notes related to recommendations were recorded in Appendix B (Approved Nutrient Management Expert Panel Meeting Minutes).*

22. **Operation and maintenance requirements and how neglect alters performance:** *The requirements and performance are covered by the state programs, which in their own way document these elements.*