Nutrient Application Management

Definitions and Nutrient and Reduction Efficiencies of Nutrient Application Management for use in Phase 5.3.2 of the Chesapeake Bay Program Watershed Model

1. **Crop Group Nutrient Application Management**
2. **Field Level Nutrient Application Management**
3. **Adaptive Nutrient Management**

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

Introduction

Nutrient Management Plans on agricultural lands is a practice counted in the millions of acres across the Chesapeake Bay watershed. It is one of the oldest best management practices in agriculture and is the cornerstone of stewardship efforts by conservation groups, producers and jurisdictions. This document summarizes the recommendations of the Nutrient Management Expert Panel for revised definition and efficiencies for Nutrient Management (NM). NM will be replaced by Crop Group Nutrient Application Management (CGNAP) and new practices, Field Level Nutrient Application Management (FLNAM) and Adaptive Nutrient Management (ANM) are defined.

The Agriculture and Watershed Technical Workgroups approved this practice for inclusion for Phase 5.3.2 of the Chesapeake Bay Program Watershed Model (CBPWM) pending [conditions of approval] after October 7, 2013.

Nutrient Management Panel Members

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Practice Definitions

- The purpose of CGNAM is to replace the current version of NM in P5.3.2 of the CBPWM
    - The current definition of NM is inadequate and vague.
    - The current credit for NM is inconsistent and does not reflect the best professional judgment (BPJ) of national experts on the suite of practices regarding the change from a pre-BMP condition and land grant university recommendations of the 1970s and early 1980s; a time in agriculture that pre-dates the CBPWM simulation period.
- FLNAM is a new practice that reflects the substantive change in NM addressing phosphorus applications and methods by the land grant universities and jurisdictional policies circa 1995.
- ANM is a new practice in line with NRCS standard practice 590, which will credit the reductions in lost nutrients consistent with an adaptive management approach to nutrient applications and management on agricultural lands.
- These suite of practices will work in tiers where a higher tier practice receives additional nutrient reduction efficiencies exceeding cumulative effect of the lower tiers.

Tier 1) Crop Group Nutrient Application Management: 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), 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; (4) N based application rates consistent with LGU recommendations for fields receiving manure.

Tier 2) Field Level Nutrient Application Management: Implementation of a formal nutrient management planning is documented and supported with records consistent with efficient use of nutrients for both crop production and environmental management. Nutrient applications are based on: (1) standard yield goals per soil type, or historic yields within field management units; (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 and LGU guidelines; (4) *fields* assessed for phosphorus loss risk with a LGU phosphorus risk assessment tool and (5) other conservation tools necessary for proper nutrient source, rate, timing and placement to improve nutrient use efficiency.

Tier 3) Adaptive Nutrient Management: Implementation of Tier 2 Nutrient Application Management (NAM), plus nutrient management contains multi-year monitoring of nutrient use efficiency with the results of this monitoring being integrated into future nutrient management planning. This process evaluates and refines the standard LGU nutrient recommendations using field/subfield specific multiple season records. It further promotes the coordination of amount (rate), source, timing, and placement (method of application) of plant nutrients to further reduce nutrient losses while maintaining economic returns. In addition to the field assessments in Tier 2 NAM, it must include the following elements.

- Multi-year, on-going records from tests or trials including
- Field/subfield level soil test P (STP) and
- A nitrogen assessment including but not limited to Illinois Soil Nitrogen Test (ISNT), Corn Stalk Nitrate Test (CSNT), Pre-sidedress Nitrate Test (PSNT) and/or in-field monitoring/strip trials with yield determination to improve upon the standard land grant university recommendations for application

AND/OR

- Precision application technologies to more accurately deliver and record recommendations.

Effectiveness Estimates

- CGNAM consistent with the definition is proposed for the CBPWM to have an effectiveness estimate of
    - 9.25% total nitrogen (TN) reduction and 10% total phosphorus (TP) reduction from landuses high-till with manure (HWM) and low-till with manure (LWM).
    - 5% TN and 8% TP reduction from landuses high-till without manure (HOM), pasture (PAS), hay receiving nutrients (HYM), alfalfa (ALF), and nursery (URS).
    - Riparian pasture (TRP) and Hay without nutrients (HYO) are still excluded from being eligible for any form of nutrient management.

    - Logic written into the CBPWM NM landuses (NHI, NHO, NLO, NHY, NPA and NAL) should be retained for Expert panel use, but should not be used to calculate any loads related to CGNAM.
- The effectiveness estimate will be simulated as an edge of stream reduction in the reporting county from the non-BMP landuse edge of stream load.
- Expert Panel considered changing the efficiencies based on geography, but didn't deem it necessary or prudent based on the limited timeline for report turnaround and lifespan of this interim recommendation.

Justification for Recommended Effectiveness Estimates of CGNAM

- In the absence of historic surveys on nutrient applications to crops Bay-wide, representative NM and non-nutrient management application rates were determined based on historic (i.e. antecedent to the CBPWM simulation period) and c. 1995 LGU agronomy guides (antecedent to the on-set of FLNAM in appearing agronomy guides). Historic LGU agronomy guides evaluated by panelists recommended between 40-15% more plant available nitrogen than c. 1995 LGU guides. This change in recommendations was unanimously agreed to serve as a proxy for pre-NM conditions on corn acres across the Chesapeake Bay Watershed. A 20% difference in Non-NM and NM nitrogen applications was determined to be a conservative estimate for the literature search. Other crops of significant acreage (i.e. soy, wheat, alfalfa) did not have consistently lower recommended application rates from LGU agronomy guides and proxy non-NM application rates could not be determined.
  This proxy was used in conjunction with Expert panel summarized literature comparing application rates, yields and spring or fall residual soil fall nitrate on corn. First, the NM yield was determined from the paper. A current LGU nitrogen application rate was calculated as well as a proxy non-NM, 1.2xNM, N application rate. Study application rates or yields were plotted against residual soil N and a change in soil N resulting from a 20% nutrient reduction to NM rates. Across 2 fully summarized studies in MD, one fully summarized study in VA and partially summarized studies in PA and NY, the panel considered 15% reductions in fall soil N to be expected Bay-wide.
  In order to not violate the P5.3.2 CBPWM calibration, a sensitivity analysis was performed on a 2007 progress scenario where three runs were performed. One run where P5.3.2 acres were modeled with current methods of determining non-NM application rates (see v2.4 Scenario Builder documentation), another where P5.3.2 acres were modeled with current NM application rates and a third where non-NM rates on corn were replaced with rates 1.2 times higher than the current P5.3.2 CBPWM NM rate. These runs were named after the average nitrogen application rate of each scenario and summarized at different landuses in each state and across the whole Bay watershed.
  The Panel agreed the most prudent estimate of the nutrient management proxy was to compare the landuse pair HWM and LWM that simulate row crops across the simulate runs. The standard average effectiveness estimate calculated in the comparison between NM and current Non-NM runs for all other NM modeled landuses (HYW, HOM, PAS, ALF) was the only defensible efficiency the panel could chose before the CBP

deadline. The efficiency was chosen to replace the current NM landuses and also be available to nursery acres (URS).

- The Expert Panel unanimously chose the corn application rate proxy approach to affect all crops in the HWM landuse. The majority of acres in this landuse are in corn in 2007.
- While the Expert Panel agrees that the current version of NM calculating application rates based on yield is consistent with the concept of CGNAM, the yields from the NASS Ag Census included in the CBPWM, are far too low to have efficiencies reduce those loads. The corresponding application rates to efficiencies reflecting the BPJ of the Panel would not produce realistic yields on the landscape.
- Increases in pollution from this practice with regards to literature were not identified. Anecdotal evidence of producers increasing their nutrient application rates was considered to be inconsequential Bay-wide and would be limited to producers using commercial fertilizers too conservatively based on the cost, was less of a consideration.
- The panel discussed and agreed that the change in manure mineralization estimates of manure through subsequent LGU agronomy guide publications added a significant amount of conservativeness to the efficiency estimate. Through the period of agronomy guides reviewed, annual nitrogen mineralization from animal manure used applied to land increased.
- The Panel was careful to exclude effects from other practices in combination with CGNAM like timing and placement and especially manure management structures by using best-case-scenario considerations included in the model and many scientific papers and based the effectiveness solely on LGU recommendation changes over time.

Comments on References

- The references were discussed in Panel calls and determined to have consistent enough results to warrant model runs used to determine the interim efficiencies proposed.
    - The Coale (2000), Angle and Ditsch data were summarized into charts for the panelists to compare side by side with consistent results. The Angle results were slightly lower, but mixed in other BMPs in a different season that were expected to yield results in the magnitude and direction presented when compared to Coale, Ditsch and anecdotal summaries of Jemison, van Es and Sogbedji.
    - Considerations:
        - Data was higher than current CBPWM.
        - Results were multi-year and should reflect an average of this annual practice.
        - Leaching or soil-test nitrate were evaluated as edge of field loss and this was compared to CBPWM edge of stream loss (consistent with efficiency estimates) on a BPJ basis.
        - Anecdotal evidence from Jemison paper was presented by Doug Beegle to the Expert panel in a conference call. The discussion was recorded in meeting minutes. Preliminary evidence from van Es and Sogbedji was deemed sufficient and findings are reported in Appendix A.

- Unpublished data had been presented and was given the same weight as peer reviewed journal articles and dissertation data.

Application of Practice Effectiveness Estimates

- All tiers should be reported in acres and are credited the same across the CBPWM.
- 9.25% total nitrogen (TN) reduction and 10% total phosphorus (TP) reduction from landuses high-till with manure (HWM) and low-till with manure (LWM).
- 5% TN and 8% TP reduction from landuses high-till without manure (HOM), pasture (PAS), hay receiving nutrients (HYM), alfalfa (ALF), and nursery (URS).
- Riparian pasture (TRP) and Hay without nutrients (HYO) are still excluded from being eligible for any form of nutrient management.
- Expired plans and acres not in active plans that didn't follow the plan or could not be verified should not be credited.
- The panel unanimously agreed that the LGU agronomy guide recommendations for corn application rates based on yield through time were a conservative estimate of the application rate differences between real-world Non-NM acres and those acres under a real-world plan consistent with the definition unanimously approved for CGNAM.
- The panel considered only subsurface movement of nitrogen to estimate the nutrient reduction benefit of a nutrient management rate on corn and used model exercises to estimate edge of stream phosphorus benefit on all HWM landuse crops for CGNAM as well and N and P benefits on the other aforementioned landuses and their associated crops.
- The Panel discussed that coarser, well drained soils are more susceptible to nutrient loss, even under nutrient management type BMPs.
- The Panel approved continued use of the Enhanced NM and Precision/Decision Ag at the current effectiveness and under the current definitions, but cited concern over the inconsistent interpretation of those BMPs by reporting authorities.

Temporal Considerations

- CGNAM is intended to be represented as an annual practice. All active plans, whether single or multi-year plans are intended to be represented as active and on the ground in all the years it can be verified.

Practice Limitations

- The Panel was careful to exclude effects from other practices in combination with CGNAM like timing and placement and especially manure management structures by using best-case-scenario considerations included in the model and many scientific papers and based the effectiveness solely on LGU recommendation changes over time.
- The panel discussed and agreed that the change in manure mineralization estimates of manure through subsequent LGU agronomy guide publications added a significant amount of conservativeness to the efficiency estimate. Through the period of agronomy

guides reviewed, annual nitrogen mineralization from animal manure used applied to land increased.

Modeling Considerations

- NM landuses are eliminated as the means for crediting NM.
- Non-NM landuses are to be used as the baseline for applying the approved efficiencies.
- Verification considerations were discussed and the discussion has been deferred to its own expert panel yet to be established.
- The panel commented that verifying active plans in compliance with the approved definitions presents unique challenges compared to BMPs that are visibly implemented.
- Acres not reported under a tier of NM, should be simulated as P5.3.2 CBPWM default non-NM.

Practice Monitoring and Reporting

- All NM tiers are available for reporting to all jurisdictions that have agricultural acres in crops mapped to an agricultural landuse. This condition currently exists for every state in the Chesapeake Bay watershed. The Panel indicated that all three NM tiers likely have acres available for credit in every state.
- The Panel is prepared to consider comments from the Agriculture (AgWG) and Watershed Technical workgroup (WTWG) as well as the Water Quality Goal Implementation Team (WQGIT) before final approval through on-going conference calls.
- The Panel commits to continue working on interim efficiency estimates for FLNAM and ANM after the comments related to CGNAM are addressed and approved by the WQGIT.

Data Gaps and Research Needs

- Research relating edge of stream nutrient loads to leaching or edge of field nutrient losses would be valuable to fill a gap the panel used their BPJ collectively.
- Documentation of efforts related to verifying all NM plans would be useful to develop verification protocols for all three NM tiers, but especially CGNAM.

Attachments

- AgWG NM report developed by Tetra Tech.
- Appendix A: Residual Soil Nitrogen related to Nutrient Applications and Yield Estimates
- Appendix B: Approved NM Expert Panel Conference Call Minutes

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