Bureau of Clean Water October 1, 2021

PA Department of Environmental Protection
Nutrient Credit Trading Program
Manure Treatment Technology Nutrient Credit Calculation Methodology

SUMMARY

Nutrient credits may be generated in the Chesapeake Bay (CB) watershed ("Watershed") using manure destruction technologies (combustion, gasification, digestion, composting, separation, chemical treatment, etc.). These practices are part of the Manure Treatment Technologies (MTT) nutrient credit category. The following calculation methodology for nutrient credit generation was developed by a team of staff from Pennsylvania, Maryland, Virginia, the US EPA, and USDA, with APEX (Agricultural Policy/Environmental eXtender) Model assistance from WRI (World Research Institute) and TIAER (Texas Institute for Applied Environmental Research at Tarleton State University). This nutrient trading methodology is planned to be incorporated into the Chesapeake Bay Nutrient Tracking Tool (CBNTT). CBNTT uses the APEX model to estimate nitrogen, phosphorus, and sediment reductions at the field scale, then uses an adjustment factor to equate the reductions to what would be expected from the Chesapeake Bay Watershed Model (CBWM). The adjustment factor adjusts the edge of field (EOF) nutrient load estimated by APEX for both attenuation from edge of field to edge of stream (EOS) and attenuation from EOS to edge of river (EOR). In addition to accounting for attenuation from the edge of the field to the river, the adjustment factor also serves to calibrate APEX results to the Phase 6 CBWM outputs, thus accounting for differences in the models that go beyond scale.

MTT results in the destruction or transformation of manure that would have otherwise been considered by the Bay model to be applied to fields within the Watershed. Nutrient reductions from MTT are derived from reduced manure applications in the watershed (offset by increased commercial fertilizer application). Credits are only generated by estimating the resulting reduction in nutrients reaching the Bay: the difference between the amount of applied manure nutrients that would have reached the Bay if the manure were applied in the Watershed and the amount of nutrients that will still reach the Bay from these fields using commercial fertilizer as the nutrient source. Other practices, such as Nutrient Management Core Nitrogen and Core Phosphorus, would need to be reported/applied to show that the nutrients applied via commercial fertilizer meet the agronomic need of the crop and are not applied in overabundance to mimic the "loss" of manure nutrients in the given area.

Calculating nutrient reduction credits for pollutant reduction activities (PRA) that fall under this category requires the collection and submission of site-specific data documenting the nutrient flow paths through the facility.

Agriculture based PRA result in pounds of nutrient reductions EOS on the fields associated with the activity. These nutrient reductions are not completely transferred to the CB due to natural attenuation. To determine nutrient reductions to the CB, a combination of stream to river and river to Bay delivery factors is applied as appropriate to account for the means of nutrient transport to the bay. The combination of these delivery factors is referred to as the Edge of Tide (EOT) delivery ratio and is used to convert the pounds of reduction at the site associated with the PRA to "credits", which are pounds of reduction at the CB EOT.

The calculation of the total credits generated from MTT nutrient reductions includes three components: estimated nutrient reductions generated from avoided land application of manure; estimated load from nutrients that re-enter the Watershed from MTT byproducts; and application of attenuation and uncertainty factors consistent with EPA guidance.

- Estimated nutrient reductions resulting from the implementation of MTT can come from several sources, depending on the type of technology being implemented. For manure destruction technologies, nutrient credit-generating processes include:
    - *Nutrient reductions from avoided land application of manure*: Removal of manure nutrients from farmland that were considered to be receiving the manure through land application before the implementation of the technology and will no longer be receiving the manure upon the implementation of the technology.
- Estimated load of nutrients re-entering the Watershed. MTT activities may also result in several by-products that return nutrients to the watershed. Any nutrients returned to the Watershed throughout the manure destruction process must be subtracted from the estimated nutrient reductions in order to generate the true basis for crediting the MTT technology. For manure destruction technologies, byproducts resulting in nutrient credit decreases may include:
    - *Volatilized Emissions from the Technology Process*: Environmentally reactive nitrogen-containing gasses (e.g., ammonia, NO_X) released to the environment from the treatment facility during the storing or processing of the manure that result in atmospheric deposition within the Watershed
    - *Solid/Liquid Products or Byproducts from the Technology Process*: Nutrient-containing products or byproducts produced during the process that are applied to lands within the Watershed

Once the net number of nutrient reductions generated by the technology is calculated, other factors must be applied as appropriate to determine the number of credits available for sale. Credits represent the total net nutrient reductions adjusted by the following factors:

- *The EOT Delivery Ratio* is an adjustment factor that accounts for natural attenuation that occurs between EOS and the Chesapeake Bay EOT. This factor converts pounds of reduction at EOS to EOT credits (pounds of reduction delivered to the Bay).
- *The Credit Reserve* is a percentage of the generated credits which are set aside by the agency administering the nutrient credit trading program to address pollutant reduction failures that may be experienced when implementing PRA.
- *The Uncertainty Ratio* is determined by each jurisdiction and based on the credit generating source and end use. Uncertainty ratios are used to address existing sources of uncertainty that are not implicitly addressed in credit calculations and BMP efficiency values. Such sources of uncertainty include, but are not limited to: lag times in reductions observed at the Chesapeake Bay; land use changes, weather, and variations in soils; and variations found with in-field hydrology. These uncertainty factors are relevant for inclusion when calculating nutrient credits associated with MTTs recognizing that these credits, calculated using land application assumptions and modeling

techniques, are used to negate measured excesses of nutrient discharge at an NPDES permitted facility. EPA's 2014 Technical Memorandum titled "Accounting for Uncertainty in Offset and Trading Programs" supports the need to include an uncertainty factor in this calculation. This memorandum directs the states to consider an uncertainty factor as follows:

  - When a trading transaction is conducted between a credit-generating nonpoint source and a credit-purchasing point source, EPA expects an uncertainty ratio of at least 2:1 to be used, unless otherwise justified as explained in the technical memorandum. When direct and representative monitoring of a nonpoint source is performed at a similar level to that performed at traditional NPDES point sources (WWTP and Industrial sources), and there is a consistency in operation of the nonpoint source, an uncertainty ratio as low as 1:1 may be appropriate. In such cases, EPA expects the jurisdictions to demonstrate that the lower ratio is justified and protective of water quality.
  - Verification of practice implementation, such as documenting the amount of manure or nutrients destroyed, does not substitute for direct monitoring of pollutant loads entering a receiving stream or other discharge point.

- *Additional factors* as determined by each state may also need to be considered when calculating the number of credits available for sale, or that are required to be purchased by the buyer (e.g. inter-basin trading factors).

MANURE TREATMENT TECHNOLOGY (MTT) NUTRIENT CREDIT CALCULATION METHODOLOGY

I. Estimating Nutrient Reductions:

A. Avoided Land Application of Manure (N_A & P_A)

It is anticipated that the calculation of reductions from avoided land application of manure will be done within CBNTT, including the calculation of baseline requirement values and nutrient EOS reductions, which will be converted to EOT credits through the application of the delivery factor and other state-specific trading ratios. The following methodology is provided to explain how CBNTT will do the calculation and to allow for this calculation to be performed in the absence of the CBNTT.

It is assumed that when manure generated in the Watershed is treated in an MTT facility, the associated nutrients that were once being applied to cropland in the form of manure in order to meet crop needs will be replaced as necessary to meet crop needs through the application of commercial fertilizer. For cases where the state determines that certain crop types would not be fertilized when mechanically applied manure is removed from the land use (such as hay or pasture lands), then replacement fertilizer would not need to be factored into this equation. Replacing manure with commercial fertilizer may result in reduced nutrient runoff as determined through the APEX and Chesapeake Bay Watershed models.

Determination of nutrient reductions attributed to converting from manure to commercial fertilizer as a nutrient source requires various information:

- The assumed location of previous manure application based on the location of the manure generating facility and the type of manure
- The assumed amount of manure previously applied in each location based on the state developed standard crop scenario relevant to the location, manure, and crop type
- The nutrient content of the previously applied manure based on site-specific manure tests or Land Grant University figures if site-specific tests are not available
- Nutrient management assumed to be previously used on sites where the manure was applied in the past based on the state developed standard crop scenario relevant to the given location
- Assumed nutrient management that will be used on sites where the manure was applied in the past and the site will be transitioned to commercial fertilizer use based on the state developed standard crop scenario relevant to the given location
- The assumed crop rotations and management of the farms that were formerly receiving manure based on the state developed standard crop scenario relevant to the given location
- The assumed crop rotations and management practices of the farms that are no longer receiving manure because of the MTT facility based on the state developed standard crop scenario relevant to the given location
- The delivery factor for the assumed past application site(s)
- The prevalent soil type for the assumed past application site(s) based on the major soil types found in the assumed application area

For the purpose of calculating nutrient credits associated with MTT, manure generated within the watershed is assumed to have been applied within the Chesapeake Bay watershed prior to the implementation of the treatment technology. These applications may encompass subwatersheds outside of the state of origin of the manure.

If there is more than one manure source providing manure to the MTT facility, separate calculations for manure sources with different delivery ratios will need to be completed and combined to determine generated credits.

Edge Of Field (EOF) nutrient load per acre (EOF_{NM}, EOF_{NC}, & EOF_{PM}, EOF_{PC}):
CBNTT will use the data provided to calculate the EOF nutrient load per acre in APEX. To estimate the reductions that are associated with averaged data for avoided land application of manure, a team, aided by local agricultural consultants, has developed typical cropping and manure/commercial fertilizer application scenarios as well as typical commercial fertilizer application scenarios for each region as identified by the state agency. These typical scenarios for average data will be used for nutrients applied before and after the transition from manure to commercial fertilizer to determine EOF.

Edge Of Stream (EOS) nutrient load reduction per acre (EOS_{NRed} & EOS_{PRed}):
The APEX model results for each basin/scenario represent the EOF loads with and without manure applications. The EOF loads estimated by APEX are adjusted to EOS loads by application of the adjustment factor. The adjustment factor adjusts both for both delivery from EOF to EOS as well as accounting for differences between the APEX and CBWM models. When APEX results are adjusted to EOS, they can be compared with the TMDL baseline value to determine if they meet the water quality trading baseline. If the EOS loads are greater than the baseline, then the baseline value is used.

Edge Of Stream (EOS) nutrient load reduction per acre (EOS_{NRed} & EOS_{PRed}):

$$EOS_{NRed} = (EOF_{NM}AF_N) - (EOF_{NC}AF_N) \quad \text{OR} \quad (EOS_{TMDLNbaseline}) - (EOF_{NC}AF_N)$$

$$EOS_{PRed} = (EOF_{PM}AF_P) - (EOF_{PC}AF_P) \quad \text{OR} \quad (EOS_{TMDLPbaseline}) - (EOF_{PC}AF_P)$$

Where:

- EOS_{NRed} = Edge of Stream nitrogen load reduction (pounds) per acre
- EOF_{NM} = Edge of Field nitrogen load (pounds) per acre for manure
- EOF_{NC} = Edge of Field nitrogen load (pounds) per acre for commercial fertilizer
- AF_N = Nitrogen Adjustment factor
- $EOS_{TMDLNbaseline}$ = Edge of Stream TMDL baseline load (pounds) per acre

- EOS_{PRed} = Edge of Stream phosphorus load reduction (pounds) per acre
- EOF_{PM} = Edge of Field phosphorus load (pounds) per acre for manure
- EOF_{PC} = Edge of Field phosphorus load (pounds) per acre for commercial fertilizer
- AF_P = Phosphorus Adjustment factor
- $EOS_{TMDLPbaseline}$ = Edge of Stream TMDL baseline load (pounds) per acre

EOS (lb/acre) Example*

$EOS_{NRed} = (EOF_{NM}AF_N) - (EOF_{NC}AF_N)$ *OR* $(EOS_{TMDLNbaseline}) - (EOF_{NC}AF_N)$

$= (18 * 1) - (7.5 * 1)$ *OR* $27.75 - (7.5 * 1)$

$[EOF_{NM}A_{FN} = 18]$ *is less than* $[EOS_{TMDLNbaseline} = 27.75]$ *so use* $EOF_{NM}AF_N$

$= (18 * 1) - (7.5 * 1)$

= 10.5 lb of nitrogen load reduction per acre

* *Assuming no-till corn nitrogen application in a PA river basin*

Edge Of Stream (EOS) nutrient load reduction per ton of manure processed (EOS_{NRedT} & EOS_{PRedT}):
Once the EOS load reduction value per acre has been determined, it is converted to show reductions per ton of manure by dividing lbs/acre EOS load by the standard application rate determined by the state team developing typical cropping and nutrient management practices. This will vary based on wet vs dry tonnage.

Edge Of Stream (EOS) nutrient load reduction/ton of manure processed (EOS_{NRedT} & EOS_{PRedT}):

$$EOS_{NRedT} = EOS_{NRedAc} / AR_{IndN}$$

$$EOS_{PRedT} = EOS_{PRedAc} / AR_{IndP}$$

Where:

- EOS_{NRedT} = Edge of Stream nitrogen load reduction (pounds) per ton of manure processed
- EOS_{NRedAc} = Edge of Stream nitrogen load reduction (pounds) per acre
- AR_{IndN} = State team derived standard nitrogen application rate

- EOS_{PRedT} = Edge of Stream phosphorus load reduction (pounds) per ton of manure processed
- EOS_{PRedAc} = Edge of Stream phosphorus load reduction (pounds) per acre
- AR_{PIndP} = State team derived standard phosphorus application rate

EOS (lb/Ton) Example*

$EOS_{NRedT} = EOS_{NRedAc} / AR_{IndN}$
= 10.5 / 3
= 3.5 lb of nitrogen load reduction per ton of manure processed

* *Assuming 3 tons per acre manure application rate*

Rate of nutrient credit generation in credits/ton (R_{NCG} & R_{PCG})
Next, the EOT delivery ratio (DR) that is appropriate for the manure application site would be applied to the weighted EOS reduction/ton manure value to derive the rate of credit generation (R_{CG}) in credits/ton manure. As described previously, if the location of previous manure application is unknown, an average delivery ratio based on the type of manure and location of the manure source will be used.

Rate of nutrient credit generation (R_{NCG} & R_{PCG}):

$$R_{NCG} = EOS_{NRedT}\ DR_N$$

$$R_{PCG} = EOS_{PRedT}\ DR_P$$

Where:

- R_{NCG} = Rate of nitrogen credit generation per ton of manure processed
- EOS_{NRedT} = Edge of Stream nitrogen load reduction (pounds) per ton of manure processed
- DR_N = EOT Nitrogen Delivery Ratio for the surface water that previously received nutrient load from manure

- R_{PCG} = Rate of phosphorus credit generation per ton of manure processed
- EOS_{PRedT} = Edge of Stream phosphorus load reduction (pounds) per ton of manure processed

- DR_P = EOT Phosphorus Delivery Ratio for the surface water that previously received nutrient load from manure

R_{NCG} *(Credits/Ton) Example**

R_{NCG} = EOS_{NRedT} DR_N

*= 3.5 * 0.5 = 1.75 credits per ton of manure processed*

* *Assuming an Edge of Tide delivery ratio for N of 0.50*

Nutrient credit generation (N_A & P_A):

Once the rate of credit generation (R_{CG}) in credits/ton has been determined, the total nutrient credits generated from replacement of the processed manure by commercial fertilizer (N_A & P_A) can be calculated by multiplying the rate per ton by the total tonnage of manure processed from the corresponding manure source (M_M).

Nutrient credit generation (N_A & P_A):

$$N_A = R_{NCG} M_M$$

$$P_A = R_{PCG} M_M$$

Where:

- R_{NCG} = Rate of nitrogen credit generation per ton of manure processed
- R_{PCG} = Rate of phosphorus credit generation per ton of manure processed
- M_M = the total mass of manure treated (in tons) from the manure source

N_A (total N credits from avoided land application) Example*

N_A = R_{NCG} M_M

*= 1.75 * 10,000*

= 17,500 N credits generated from avoided land application of manure

* *Assuming 10,000 tons of manure processed*

II. Credit Decreases: Nutrient Reintroduction (N_{VDec}, N_{ADec}, P_{ADec})

Manure Treatment Technologies that involve the destruction or transformation of manure may result in reintroduction of environmentally available nutrients back into the watershed. Each step in the process must be carefully monitored and sampled to determine where reintroduction could occur and the extent of the reintroduction. Environmentally available nutrient reintroduction that returns to the Watershed must be subtracted from the credits generated by nutrient reductions to the CB as calculated in "I." above to accurately account for credit generation. This can include volatilized, liquid, and solid nutrient-containing byproducts such as ammonia and NO_X emissions, wastewater, and ash, as well as products that will incorporate the nutrient-containing byproducts and be applied within the Watershed, such as spent mushroom substrate.

A. Nitrogen credit decrease due to redeposition of volatilized non-N_2 nitrogen:

Mass of nitrogen in non-N_2 compounds being reintroduced to the environment (NVDec):
Non-N_2 nitrogen being released into the environment during technology process (N_{VDec}) can result from dryer exhaust, gasification emissions, and other processes. The amount of different volatilized compounds that are reintroduced to the environment needs to be measured and then the amount of N in the compounds calculated. This is done by multiplying the mass of the compound by the molecular weight ratio of N to the compound.

Mass of nitrogen in non-N_2 compounds being reintroduced to the environment (N_{VDec}):

$$M_{NNH3V} = M_{NH3V} * (N/NH_3 \text{ ratio})$$
$$M_{NNOxV} = M_{NOxV} * (N/NO_X \text{ ratio})$$

Where:

- M_{NNH3V} = mass of volatilized ammonia nitrogen (lbs) released into the environment
- M_{NH3V} = mass of volatilized ammonia (lbs) released into the environment
- M_{NNOxV} = mass of volatilized NO_X nitrogen (lbs) released into the environment
- M_{NOxV} = mass of volatilized NO_X (lbs) released into the environment

M_{NNH3V} (lbs of Ammonia N and NO_X N reintroduced into the watershed) Example*

*M_{NNH3V} = M_{NH3V} * (N/NH_3 ratio)*
*= 50 * 0.82*
= 41 lbs ammonia N volatilized and reintroduced to the environment

*M_{NNOxV} = M_{NOxV} * (N/NO_X ratio)*
*= 5,000 * 0.47*
= 2,350 lbs NO_X N volatilized and reintroduced to the environment

* *50 lbs of ammonia and 5,000 lbs of NO_X measured released at the treatment facility*

Nitrogen credit reduction due to volatilized non-N_2 nitrogen (N_{VDec}):
Once the amount of N in measured volatilized compounds has been calculated, then how much of that N makes it to the Chesapeake Bay needs to be determined. This is done by multiplying the mass by the delivery ratio of the compound for the appropriate state basin/watershed.

Nitrogen credit reduction due to volatilized non-N_2 nitrogen (N_{VDec}):

$$N_{VDec} = (M_{NNH3V}DR_{NH3V}) + (M_{NNOxV}DR_{NOxV})$$

Where:

- M_{NNH3V} = mass of volatilized ammonia nitrogen (lbs) released into the environment
- DR_{NH3V} = volatilized ammonia EOT delivery ratio for the manure source location (by watershed segment is recommended)
- M_{NNOxV} = mass of volatilized NO_X nitrogen (lbs) released into the environment

- DR_{NOxV} = volatilized NO_X EOT delivery ratio for the manure source location (by watershed segment is recommended)

N_{VDec} (N credits reintroduced into the watershed through volatilized N at the facility) Example*

N_{VDec} = $(M_{NNH3V}DR_{NH3V}) + (M_{NNOxV}DR_{NOxV})$
= (41 * 0.22) + (2,350 * 0.10)
= 9.02 + 235
= 244 credits to subtract from the credits generated for avoided N volatilization

* *Continuously processing facility in PA river basin*

B. Nutrient credit decrease due to liquid/solid forms of N (N_{ADec}) & P (P_{ADec})

Liquid/solid forms of N or P in byproducts applied within the Watershed can result from nutrients recovered during the process, nutrients present in byproduct materials, nutrients present in the final product, and other processes.

Mass of nutrient in compounds being reintroduced by application into the environment (M_{NutA}):
The weight of different compounds that are reintroduced into the environment and the concentration of nutrients in the compound needs to be measured. The amount of nutrient in the compounds is calculated by multiplying the mass of the compound by the molecular weight ratio of nutrient to the compound.

Mass of nutrient in compounds being reintroduced by application into the environment (M_{NutA}):

$$M_{NutA} = M_{CompA} * (\text{\% of nutrient in compound})$$

Where:

- M_{NutA} = mass of nutrient (lbs) reintroduced by application into the environment
- M_{CompA} = mass of compound (lbs) reintroduced by application into the environment

M_{NutA} ***(lbs of Ammonium sulfate N reintroduced into the watershed by application) Example****

M_{NutA} = M_{CompA} * (% of N in ammonium sulfate)
= 50 * 0.21
= 11 lbs ammonium sulfate N in byproduct applied and reintroduced to the environment

* *50 lbs of ammonium sulfate captured in the byproduct and applied to the land in the watershed*

Nitrogen credit decrease due to applied liquid/solid nitrogen end products (N_{ADec}):
Once the amount of nutrient in measured compounds has been calculated, then how much of that nutrient makes it to the Chesapeake Bay needs to be determined. This is done by multiplying the mass by the delivery ratio of the compound for the appropriate state basin/watershed.

Nitrogen credit decrease due to applied liquid/solid nitrogen end products (N_{ADec}):

$$N_{ADec} = (M_{NLA}DR_{NLA}) + (M_{NSA}DR_{NSA})$$

Where:

- M_{NLA} = mass of nitrogen in liquid byproduct applied (lbs)
- DR_{NLA} = nitrogen application EOT delivery ratio for the location where the liquid byproduct will be applied or for the manure source basin/sub-basin if the application location is unknown
- M_{NSA} = mass of nitrogen in solid byproduct applied (lbs)
- DR_{NSA} = nitrogen application EOT delivery ratio for the location where the solid byproduct will be applied or for the manure source basin/sub-basin if the application location is unknown

Phosphorus credit decrease due to applied liquid/solid phosphorus end products (P_{ADec}):

$$P_{ADec} = (M_{PLA}DR_{PLA}) + (M_{PSA}DR_{PSA})$$

Where:

- M_{PLA} = mass of P in liquid byproduct applied
- DR_{PLA} = phosphorus application EOT delivery ratio for the location where the liquid byproduct will be applied or for the manure source basin/sub-basin if the application location is unknown
- M_{PSA} is the total mass of P in solid byproduct applied
- DR_{PSA} = phosphorus application EOT delivery ratio for the location where the solid byproduct will be applied or for the manure source basin/sub-basin if the application location is unknown

N_{ADec} (credit reduction representing lbs of solid Ammonium Sulfate N reaching the Bay) Example*

N_{ADec} $= (M_{NSA}DR_{NSA})$
$= 11 * 0.4$
$= 4.4 = 4$ *N credits to subtract from the credits generated for avoided N application*

* *11 lbs of ammonium sulfate N captured in the byproduct and applied to the land in the watershed and a delivery ratio of 0.4. If additional solids or liquid byproducts containing N were to be produced, these additional sources would be calculated as shown here and added to this figure for total solid/liquid N reaching the Bay*

III. Total Credits Generated Calculation (N_G, P_G)

Calculating the total credits that can be attributed to the implementation of the Manure Treatment Technologies involves a balance of reductions and reintroductions. The credits associated with the reintroduction of nutrients back into the watershed (through emissions and byproducts from the treatment facility as well as applied nutrients coming from the products associated with the technology) must be subtracted from the credits generated from nutrient load reductions (difference in nutrient concentrations before and after the technology).

Net Nitrogen and Phosphorus credits generated (N_G, P_G):

Net credits generated from MTT nutrient reductions (N_G, P_G) can be calculated by adding sources of credit generation and subtracting the credit decreases associated with the PRA.

Net Nitrogen credits generated (N_G):

$$N_G = N_A - (N_{ADec} + N_{VDec})$$

Where:

- N_A = Nitrogen credits generated from replacement of applied manure with commercial fertilizer
- N_{ADec} = Nitrogen credit decrease due to liquid/solid forms of nitrogen in waste products applied within the Watershed
- N_{VDec} = Nitrogen credit decrease due to redeposition of volatilized non-N_2 nitrogen released into the environment during the treatment technology process

Net Phosphorus credits generated (P_G):

$$P_G = (P_A - P_{ADec})$$

Where:

- P_A = Phosphorus credits generated from replacement of applied manure with commercial fertilizer
- P_{ADec} = Phosphorus credit decrease due to phosphorus in byproducts applied/released into the environment within the Watershed

N_G (Net N credits generated through the implementation of the MTT) Example*

$$\begin{aligned} N_G &= N_A - (N_{ADec} + N_{VDec}) \\ &= 17{,}500 - (4 + 244) \\ &= 17{,}500 - 248 \\ &= 17{,}252 \text{ N credits generated} \end{aligned}$$

* *With 17,500 N credits generated thru the elimination of manure application, 4 N credits associated with the land application of N containing byproducts, and 244 N credits associated with the release of N containing gasses during the processing of the manure.*

IV. Sellable Credit Calculation (N_S, P_S)

Not all of the generated credits that can be attributed to the implementation of the Manure Treatment Technologies may be sold by the generator. There are additional factors that must be applied as appropriate for each state program:

- The Credit Reserve is a set percentage of the generated credits which are set aside by the agency administering the credit trading program to address pollutant reduction failures that may be experienced when implementing PRA.
- An Uncertainty Ratio to account for challenges in accurately measuring delivered pollutant load reductions and the level of confidence in implementing BMPs is also appropriate.
- Additional factors as may be determined by each state to address specific program issues may need to be considered when determining the number of sellable credits.

Nitrogen credits available for sale (N_S) (rounded to the nearest credit):

$$N_S = (N_G)(CR)(UR_N)(F)$$

Where:

- N_G = Total nitrogen credits generated attributable to the implementation of the technology

- CR = Credit Reserve established by the jurisdiction administering the program
- UR_N= Uncertainty Ratio for nitrogen established by the jurisdiction consistent with EPA guidance
- F = Factors as determined by each state, if applicable

Phosphorus credits available for sale (P_S) (rounded to the nearest credit):

$$P_S = (P_G)(CR)(UR_P)(F)$$

Where:

- P_G = Total phosphorus credits generated attributable to the implementation of the technology
- CR = Credit Reserve established by the jurisdiction administering the program
- UR_P = Uncertainty Ratio for phosphorus established by the jurisdiction consistent with EPA guidance
- F = Factors as determined by each state, if applicable
- Nutrient Trading Program

N_S (N credits generated through the implementation of the MTT available for sale) Example*:

N_S = $(N_G)(CR)(UR_N)(F)$

= *70,052 * 0.9 * 0.50*

= *31,523 N credits available to sell*

* *With 70,052 Net N credits generated by the MTT, a 10% credit reserve, a 2:1 uncertainty factor, and no other factors imposed by the program.*

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