Appendix 4
Crop & Manure Management Information

Appendix 4 is used to determine a planned manure rate for each Crop Management Unit (CMU)/Field included in the nutrient management plan. It includes a record of the required soil test analysis results, soil test recommendations, planned crop information, adjustments to soil test recommendations, net nutrient requirements, balanced and planned manure rates, and a final nutrient balance which accounts for all nutrients applied to each CMU/Field.

Regulatory Requirements

For the specific regulatory requirements regarding the soil analysis, refer to "Section 83.292 – Determination of Nutrients Needed For Crop Production" of the Act 38 regulations. All soil tests used in the nutrient management plan must be current within three years.

For the specific regulatory requirements regarding the nutrient application calculations, refer to "Section 83.292 – Determination of Nutrients Needed For Crop Production", "Section 83.293 – Determination of Nutrient Application Rates", and "Section 83.294 – Nutrient Application Procedures" of the Act 38 regulations.

Soil Sampling Procedures

Representative soil samples should be obtained using accepted soil sampling methods as outlined in Part 1, Section 2, "Soil Testing" in the Penn State Agronomy Guide.

It is recommended that a single soil test sample not represent more than 20 acres. One soil test sample can represent multiple fields grouped in a crop management unit (must have similar soil capabilities and management histories) as long as the sample does not represent more than 20 acres. If a single field is larger than 20 acres, a single soil test sample may be used to represent this field.

Crop Year(s)

The crop year(s) must be noted on the Nutrient Management Plan Summary. Planning for each CMU/Field is summarized in the Nutrient Management Plan Summary. The planning information summarized in the summary must be for one crop year. Under Act 38, nutrient management plans cover three crop years. Two approaches can be used to address multiple crop years in a single plan.

- One option is to plan for one crop year in the initial nutrient management plan. Updates for subsequent crop years would be submitted annually prior to the beginning of the next crop year. See NMP Submission in this manual for guidance on what is to be included in these annual updates. Plan updates must be submitted, but are not considered plan amendments, and therefore do not require approval. See Section VI – Plan Amendments and Transfers in this manual for more information on plan amendments.
- Another option is to submit three sets of annual plans for each of the three crop years in the nutrient management plan time-frame. See NMP Submission in this

manual for guidance on what is to be included in these three year plan submissions.

Nutrient Management Plan Format

Act 38 regulations require that all nutrient management plans use a standard format for organizing and presenting the required plan elements. The Nutrient Management Program has developed a spreadsheet which includes all the required plan elements and performs most of the necessary calculations using the data entered. All plans developed and submitted for approval must use the current version of the NMP spreadsheet.

The current version is one posted on the Nutrient Management Program website: http://panutrientmgmt.cas.psu.edu/.

Completing NMP Spreadsheet: Appendix 4

The row titles from Appendix 4 in the Standard Format NMP Spreadsheet are used as the outline below to provide guidance for completing Appendix 4. The focus will be on the information entry points. The information entry points are identified in the NMP Spreadsheet with yellow shading. Most of the calculations are completed internally within the spreadsheet. Several of the rows are populated from these calculations. This will be noted below where applicable.

Appendix 4 Features

Several features are provided in Appendix to facilitate planning.

- Copy
- Paste
- Reset CMU Information
- Multiple Applications
- Split Applications
- Delete Multiple Application

To copy and paste CMU/Field information use the “Copy” and “Paste” buttons. Select the CMU/Field ID to be copied and then click the “Copy” button. Select the CMU/Field ID where the information is to be pasted and click on the “Paste” button.

To delete or reset CMU/Field information, select the CMU/Field ID and click the Reset button.

For multiple or split nutrient applications on a CMU, all CMU/Field IDs must be the same. A unique identifier for some or all of the applications may be included by using a hyphen to separate the CMU/Field ID and the unique identifier. For example, for a spring and fall nutrient application on CMU/Field ID 23, any of the following approaches can be used:

- "23-Spring" and "23-Fall"
- "23" and "23-Fall"

- "23-Spring" and "23"
- "23" for both applications

By using this method, the P Index information for all applications will be entered into the P Index. In Appendix 4, this can be completed by using the "Multiple/Split Application" button. When using this Multiple/Split feature:

1. Select the CMU/Field ID with the initial application.
2. Indicate if this is a "Multiple" or "Split" application.
3. Enter the CMU/Field ID for the field receiving the multiple or split application (refer to the directions above).
4. Select the CMU/Field ID cell where the next manure application will be planned.
5. Click the OK button.

To delete a multiple manure application, select the CMU/Field ID for the field where the Multiple Application is to be removed and click the “Delete Multiple App.” button.

The Multiple Application feature is not a “live” link in the NMP Spreadsheet. Therefore, if a planned manure application rate is changed in a Multiple Application scenario, steps 1 to 5 listed above will need to be repeated. In step 4, do not select a blank CMU/Field ID. Instead select the existing CMU/Field ID for the multiple application.

Crop Management Units/Field ID

Appendix 4 uses a column for each CMU/Field. Identification of CMUs or fields should start with the farm map. Field identification on the farm map should be at the individual mono-crop field strip level. A CMU is defined in the regulations as “The portion of cropland, hayland and pasture, including a field, a portion of a field, or group of fields, on an agricultural operation that has a unique management history (same rotation and manure history), similar production capability, and that will be managed uniformly as a distinct unit.” The identification of CMUs or fields must be consistent with the operation maps and the P Index. This identification must be meaningful to the farmer. Using the operator’s established field identification system is recommended.

It is recommended that the nutrient management plan be developed on a field-by-field basis.

For the remainder of this section the term “field” will be used to refer to fields or CMUs.

Acres

The plan shall include the acreage for each field.

Soil Test Report Date

The date listed on the report for each field is entered in this row.

Laboratory Name

The name of the laboratory performing the soil analysis must be listed for each report.

There is no requirement to use only the Penn State Agricultural Analytical Services Laboratory (AASL) for soil analysis. However, the laboratory used must follow recommended procedures for Pennsylvania soils. The recommended soil testing methods for PA are: Water for pH, Mehlich Buffer for Lime Requirement, and Mehlich-3 for P, K, Ca, and Mg. **All soil tests must use the Mehlich 3 test for phosphorus.**

In addition, the laboratory must follow recommended procedures outlined in "The Recommended Soil Testing Procedures for the Northeastern United States", Bulletin #493, published by the University of Delaware, or other Commission approved procedures.

While soil testing labs that do business in Pennsylvania use the appropriate methods and do high quality analyses, there are often significant differences in recommendations from these labs compared to Penn State recommendations. See guidance below for developing appropriate recommendations for Act 38 nutrient management plans.

Soil Test Levels (Mehlich-3 P & K)

Soil analysis levels must be reported for ppm Mehlich-3 P, and ppm K and pH. If the laboratory used does not report P & K in ppm the reported levels must be converted to ppm. To convert pounds of P_2O_5 to pounds of P divide by 2.3. To convert pounds of K_2O to pounds of K divide by 1.2. To convert pounds of P or K to ppm, divide by 2. Record conversion calculations in Appendix 10.

P Index Part A

The four P Index, Part A questions that trigger the completion of Part B of the P Index must be answered for each field. Use the drop-down box to select the specific description to reflect the answers to the four questions.

- If all four of the P Index Part A questions for a field are answered "No", select "**No to all Part A questions"**. **"N-Based"** will be entered in the field below.
- If any of the four P Index Part A questions for a field are answered "Yes", select the appropriate individual question or combination of questions. **"Part B"** will be entered in the field below.
- There is an alternative for a field that would require Part B of the P Index based on the four questions. A management decision can be made to apply no phosphorus (fertilizer and/or manure) to this field. In that case **"No P Applied"** should be selected. **"No P Applied"** will be entered in the field below and Part B of the P Index will not be completed.

All fields noted as **"Part B"** will be included in Appendix 5 and the CMU/Field ID, all Part A criteria, and Part B source factors will be automatically entered into the Appendix 5 - P Index.

Crop

The plan must list the crop planned for each field for the specific crop year. If a needed crop does not appear in the default NMP Spreadsheet crop options, a crop can be entered into the spreadsheet by completing the following steps:

1. Go to the “Crop List Options” worksheet and enter the crop name.
2. Go to Table 1 and enter the nitrogen recommendation per unit of yield unit and the crop. For legume crops not receiving manure enter zero.
3. Go to Table 3 and enter the phosphorus and potash removal per unit of yield and the crop yield unit.

The crop name entered will now appear as a crop selection option in Appendix 4.

Planned Yield

The plan shall include the realistic expected crop yields for each field. Based on the crop selected the appropriate units, bu/A or tons/A, will be entered by the spreadsheet.

If actual yield records are available during the development of the initial plan, it is recommended that the expected crop yields be based on these records. At the time of the required three-year reviews of approved nutrient management plans, yield goals for the updated or amended plans are required to be based on yield records.

For the development of the initial plan where actual yield records are not available, realistic expected crop yields are determined by the operator and the specialist, and approved by the Commission or delegated conservation district. These yields should be consistent with soil type and climate production capabilities. Pennsylvania soil capability and productivity guidance is available in the Penn State Agronomy Guide, Table 1.1-1.

Yields significantly higher than those generally acceptable for the given soil type will need to be documented and justified through the use of various records such as yield records or an acceptable explanation of the particular management practices that will be implemented on the farm to increase yields over those generally expected. Various management practices, such as plant populations, crop variety selection, irrigation, subsurface drainage, pest and disease scouting, etc. can have an impact on the crop yields for a given operation or field. Therefore, it may be appropriate to set expected yield goals at a level different than the book values found in the Penn State Agronomy Guide and county Soil Surveys. Professional judgment should be used in determining if a particular yield goal is realistic for an individual operation in a given location.

Pastures provide a unique challenge in determining yields. While it difficult to measure the amount of dry matter removed by grazing animals, there is much research that has documented yield potential based on soil fertility, forage species, and management. This information has been summarized in a one-page factsheet. Planners should use Estimating Forage Yields For Pastures when determining pasture yields to be used in nutrient management plans. This factsheet is available at: http://panutrientmgmt.cas.psu.edu/pdf/pr_pasture_yield200708.pdf.

Again it should be stressed that after the first 3-year time frame, yield goals used in the plan are to be based on the yield records that are required to be maintained for the operation. After three years of implementing the nutrient management plan, if yields do

not average at least 80% of the planned yield, the plan must be amended to be consistent with the documented yield levels.

Soil Test Recommendation (lb/A)

The nutrient recommendations for nitrogen, phosphorus, and potassium must be based on the current soil test results recorded in Appendix 4 for each field. Typical crop nutrient removal rates are not to be substituted for nutrient recommendations. An exception is the nitrogen recommendation when manure is being applied to legume crops.

Labs other than the Penn State Agricultural Analytical Services Laboratory (AASL) may be used for soil analysis. While soil testing labs that do business in Pennsylvania use the appropriate methods and do high quality analyses, there are often significant differences in recommendations from these labs compared to Penn State recommendations. Because Penn State recommendations are based on research done under Pennsylvania soil and climate conditions and management systems, **the recommendations used for the development of Act 38 plans must be consistent with the AASL recommendations.**

The AASL recommendations are available on-line at: http://www.aasl.psu.edu/. Use the "Soil Test Recommendations Handbook For Agronomic Crops" to develop recommendations for crops not listed on the soil test report, changes in yield levels, or to adjust recommendations from labs whose recommendations are not consistent with Pennsylvania conditions. To determine a Penn State recommendation using soil test results from another lab all that is needed are the soil test levels in ppm, the crop to be grown, and the expected yield level. With this information it is simple to look up the Penn State recommendation for any crop based on results from any reputable lab that uses the recommended soil test methods for Pennsylvania.

Recommendation tables are also provided for common double cropping scenarios in Pennsylvania and Conservation Reserve Program (CRP) cool and warm season grasses. The AASL double crop recommendation tables must be used for double crop situations rather than using two separate recommendations for the same field over one crop year. AASL recommendation tables for CRP grasses can be used for Conservation Reserve Enhancement Program (CREP) recommendations.

All cool season CRP cool season plantings must include a legume. A one-time manure application may be used to meet part or all of the recommended nutrient requirements before or at planting. Additional nitrogen is not recommended after the establishment year. No manure or nutrients may be applied before or at planting of CRP warm season plantings. Any recommended nutrients may be applied during the second growing season following germination. Manure may be applied at the rate limited by phosphorus or potassium recommended rate. Manure applications may not be made to meet nitrogen uptake rate. CRP grasses should be evaluated every 5-10 years for acceptable plant cover. At that time the soil should be retested to determine if pH and nutrient levels are still adequate to maintain cover.

One aspect that is not clear when using the tables is what values to use when expected yields fall between the yield goals listed or when ppm P or K values fall between the values listed. The following guidelines are based on how the lab makes recommendations in these cases. For yield goals that fall between those listed use the next highest yield column. For ppm P or K values that fall between those listed use the next higher value on the respective table.

Other Nutrients Applied (lb/A)
Planned fertilizer applications are those applications, such as starter and liquid N fertilizer that may be applied as a pesticide carrier, that will occur regardless of the amount of manure applied. It does not include supplemental fertilizer applied to meet crop requirements not met by planned manure applications. This is a farmer management decision that must be determined during data collection for plan development.

P Index Application Method
Use the drop down menu to select the appropriate application method. This information indicates how any P containing fertilizer included in "Other Nutrients Applied" above will be applied. This is required in the spreadsheet to complete the Phosphorus Index.

Manure History Description & Residual Manure N (lb/A)
A significant amount of manure nitrogen is organic nitrogen and not available for crop production in the year it is applied. This organic nitrogen becomes available for crop production over a period of years. The accumulated organic nitrogen from past manure applications can contribute a considerable amount of nitrogen to the current crop.

There are two ways to determine the amount of residual manure nitrogen. These options are outlined in the Penn State Agronomy Guide. Both options rely on the manure application history, particularly the frequency of manure application, provided by the operator for each field. This is noted as the number of years out of the past five years that a field has received manure. In addition, option 2 requires the type of manure, the manure analysis and the application rates for each year in the past 5 that manure was applied to a field.

- Option 1 uses the Penn State Agronomy Guide, Table 1.2-14B. This method is commonly called the "Total N Method". Based on the frequency of manure application over the past five years the appropriate residual nitrogen value is determined. **This option cannot be used for atypical manures.**

  Use the drop down menu to select the manure history description. Based on the history selected, the appropriate residual manure N value will be entered in the row below.

- Option 2 uses the Penn State Agronomy Guide, Table 1.2-15. This method provides a more refined estimate of residual manure nitrogen that utilizes the chemical manure analysis that provides the amount of ammonium N and organic N in the manure to calculate the amount of residual nitrogen. This method is

commonly called the “N Fractions Method”. **This option must be used for atypical manures.**

To calculate Manure N Residual using Agronomy Guide Table 1.2-15, go to the Manure N Residual Calculator worksheet. On this worksheet, all Manure N Residual scenarios calculated using Agronomy Guide Table 1.2-15 can be entered. For each scenario, the Residual N ID will be available in the Manure History Description drop-down list in Appendix 4 and based on this selection, the overall Manure N Residual Value will be entered into Appendix 4.

The Manure N Residual Calculator must be included in Appendix 10.

If a manure group that is not part of the current NMP is being used to calculate the Residual N using Table 1.2-15, create a Manure Group in Appendix 3, enter only the Manure Nutrient Information and indicate in the Manure Group Description that this Manure Group is for the Residual N Table 1.2-15 calculation only. Do not enter manure generation or animal group information for this manure group.

IMPORTANT NOTE ON RESIDUAL N FOR LEGUME CROPS: For legume crops that are not receiving manure no manure residual nitrogen value is listed in the plan. However, if manure is planned for legume crops, manure residual nitrogen must be accounted for in the plan.

Legume History Description & Residual Legume N (lb/A)
As legume crop fields are converted to non-legume crop production, nitrogen fixed in the soil by the legume crop can provide a significant amount of nitrogen for the next crop. The base nutrient recommendations from the soil test report for each field on the operation must be adjusted for residual nitrogen from legume crops.

The amount of residual legume nitrogen contributed by forage legumes is dependent on the type of legume crop, soil productivity group and the percent of stand and by yield for soybeans. Use the information provided by the operator and the Penn State Agronomy Guide, Table 1.2-7 to determine the amount of residual legume nitrogen that each rotated legume crop will contribute to the next crop.

If complete information was provided with the soil sample, the legume N credit will be listed on the Penn State soil test report and can be deducted from the recommendation.

Use the “Select” button to select the appropriate legume history for each field. Based on the history selected, the appropriate residual legume N value will be entered in the box to the right. If a needed legume history is not a default selection in the spreadsheet, a legume history can be entered by completing the following steps:

1. Go to the Table 4 worksheet.
2. Enter a legume history ID under the “Management Conditions” heading and associated residual legume N value under the “Nitrogen Credit (lb N/A) heading.

Once the above steps have been completed, the legume history will be a selection option in Appendix 4.

Many crop production systems in Pennsylvania will have fields or crop groups that have both a manure and legume history. In these cases, the nitrogen recommendation should be adjusted for both manure and legume N residuals.

Net Nutrients Required (lb/A)

Before a manure rate can be determined, the net amount of nutrients required for each crop must be calculated. The amount of nutrients from planned fertilizer applications, residual manure nitrogen, and residual legume nitrogen are subtracted from the soil test recommendations to determine the net nutrients required.

These values are calculated and entered automatically by the spreadsheet.

Manure Group

The first step in calculating a balanced manure rate for nitrogen is the selection of the manure group that will be applied to meet the nutrient needs on a particular field. See Appendix 3 for a more detailed explanation of manure groups.

Use the “Select” button to select the desired manure group for this field. This is list is created from the manure groups from Appendix 3. When selecting a manure group make sure that there is manure available in that manure group that has not yet been allocated. The running balances for each manure group are displayed in the manure group selection screen. As manure is allocated to a field the spreadsheet calculates the total amount allocated and subtracts this amount from the previous balance.

Application Season & Application Management

Each manure group by definition has a season of application. In addition, it must be determined if the manure will be incorporated or not, and if so, how quickly will it be incorporated.

Use the “Select” button to select the “Manure Application Timing” or season and the “Manure Application Method”.

Nutrients must be applied to fields during times and conditions that will hold the nutrients in place for crop growth, and protect surface water and groundwater in accordance with the approved manure management practices as described in the plan. The longer manure is in or on the soil before crops use the nutrients, the more those nutrients, especially nitrogen, have the potential to be lost through volatilization, denitrification, leaching, and erosion. The season in which manure is applied will also affect the nutrient availability for crops.

The Winter Manure Application Matrix must be used to assess all fields being proposed for winter manure application. The completed Winter Application Matrix, addressing each of the fields proposed for winter application of manure must be included in Appendix 10.

Availability Factors

Only a portion of total manure nitrogen is available to the crop during the season of application. A significant amount of manure nitrogen is in the organic form and not available during the first growing season. Under even the best of conditions only about 50% (75% for poultry manure) of the nitrogen in the manure is available to the crop in the year it is spread. In addition, varying amounts of nitrogen are lost due to volatilization. The incorporation of applied manure and the timing of incorporation control the amount of nitrogen loss due to volatilization after application. Surface-applied manure can potentially lose large amounts of nitrogen to the air if it is not incorporated mechanically or by at least ½ inch of rain or other added water.

The planned manure incorporation time provided by the farmer, the type of manure, the season of manure application, and the expected time of crop utilization of the nitrogen are used to determine the appropriate nitrogen availability factor.

There are two options which can be used to determine availability factors and to calculate the amount of available nitrogen in the manure. Option 1, the "Total N Method", is the most common method and uses the Penn State Agronomy Guide, Table 1.2-14A. **This option cannot be used for atypical manures.** Option 2, called the "N Fractions Method", provides a more refined estimate of available manure nitrogen that utilizes the amount of ammonium N and organic N in the manure determined by chemical analysis and uses the Penn State Agronomy Guide, Table 1.2-15. **This option must be used for atypical manures.**

For typical manures only, values for manure N availability and residual manure N from Tables 1.2-14 and 1.2-15 may be used interchangeably throughout one nutrient management plan or within one field.

Based on the selection of "Manure Group", "Application Season" and "Application Management" options selected, the appropriate Total N or Ammonium N and Organic N values will be entered automatically by the spreadsheet. When using Option 2 select the appropriate season from the Manure Application Timing list which has "1.2-15" appended onto the season name.

P Index Application Method

Use the drop down menu to select the appropriate application method. This is required in the spreadsheet to complete the Phosphorus Index.

N Balanced & P Removal Balanced Manure Rates (ton or gal/A)

The spreadsheet calculates and automatically enters balance manure rates for both nitrogen and phosphorus removal. In addition, the spreadsheet calculates and automatically enters the amount of net P removal.

The P Removal Balance Manure Rate would only be used for fields on the operation that require a P removal manure rate as determined by the Part B of the P Index.

P Index Value

This value is calculated in Appendix 5 for fields that require Part B of the P Index and entered here automatically by the spreadsheet after the planned manure rate has been entered below. This box remains blank and shaded gray for "N-Based" fields.

Planned Manure Rate (ton or gal/A)

The planned manure rate will be based on either nitrogen or phosphorus as determined by the P Index.

1. If the P Index, Part A above is "N-Based" any rate less than or equal to the calculated N balanced manure rate is acceptable. The desired planned rate is entered in this box. Selection of an actual planned rate is discussed in more detail below under "**Considerations for Selecting a Planned Manure Rate.**"

2. For fields that require the P Index, Part B a desired rate less than or equal to the calculated N balanced rate should be entered in the box. This is a "proposed rate" because the rate must be evaluated by the P Index. The proposed rate is often the N based rate that would be used if there were no P Index considerations. If the P Index Value is less than 80, this planned rate based on nitrogen is acceptable and may be used for this field.

   However, if the P Index Value is greater than 80, two options are available. One option is to reduce the planned manure rate until the P Index Value is less than 80. Another option is to select and enter a planned manure rate less than the P Removal Balanced Manure Rate.

Again see the section below on **"Considerations for Selecting a Planned Manure Rate."**

Considerations for Selecting a Planned Manure Rate

The specific planned manure application rates must be based on the calibration of the manure application equipment used on the operation to ensure that the planned application rate is attainable. Therefore, the manure application equipment used on the operation must be calibrated to determine the specific attainable application rates. This information will provide the planner with a listing of the application rates that are realistic for the operation. Rates for solid manure should be rounded to whole ton numbers. The planner, in consultation with the operator, should select 2 or 3 application rates that are practical and attainable for the equipment on the operation. **Where possible use rates that the farmer is already using and verified by spreader calibration as long as they do not exceed the maximum based on N or P as discussed above.**

In some cases a P Removal Balanced Rate may be very low and not allow for planning a rate that is practical for the operation's application equipment. A phosphorus banking rate for up to three years may be allowed based on obtaining approval from the State Conservation Commission. If permission is granted, the rate must not exceed the net nitrogen requirement in the year of application and may not elevate the P Index Value into the Very High management guidance category.

However, it is critical to understand that the calculated balanced manure application rate is not an exact number but an estimate. This is particularly due to the fact that each of the factors used in all of the calculations above contain a significant degree of variation. Variations occur in the soils on individual fields; manure nutrient content from load to load; spreading equipment limitations; weather variations from year to year, etc. In addition, book values are, at best, good averages based on research but do not necessarily reflect the management and conditions on a specific operation.

The purpose of the balanced manure application rate is to provide a target for determining a practical planned application rate for the field. The planner should utilize their professional judgment in determining a practical planned manure application rate that meets the management needs of the operator without exceeding the balanced manure application rate.

Where only portions of a given field are to receive manure or other nutrients, these fields should be broken down into sub-fields for the purpose of planning and record keeping. For example, where a field has manure applied to half of it and there is no manure applied to the other half, the field should be broken down into sub-fields (possibly A and B) in the plan and in the records. The fertilizer or other manure source of nutrients required on the part of the field where the original manure is not applied must be determined and included in the plan. This will assure that the planner properly balances the nutrient needs of these separate portions of the field.

In the spreadsheet there is a button for “Multiple/Split Applications”. Selecting “Split Application” will copy the basic information for the field to the neighboring column in the spreadsheet to facilitate calculation of the nutrient need for the other part of the field without reentering all of the data.

Depending on the rate determined, multiple applications may be necessary in order to minimize possible nutrient pollution or other difficulties that may occur in managing the land to grow the particular crop (i.e. too much manure applied to drive the equipment over, too much manure to allow for the proper establishment of a seedbed, or too much manure to keep in place when it is applied). Single applications of liquid or semisolid manure applications may not exceed rates of 9,000 gallons per acre. If the planned manure rate exceeds 9,000 gallons per acre, the plan must designate separate applications each less than 9,000 gallons. Application rates greater than 9000 gallons per acre may be used if based on the calculation of infiltration rate and water holding capacity of the application sites. In addition, approval must be obtained from the Commission.

In the spreadsheet there is a button for “Multiple/Split Applications”. Selecting “Multiple Application” will copy the basic information for the field to the neighboring column in the spreadsheet to facilitate calculation of the remaining nutrient need and additional allowable manure application after the first application without reentering all of the data. This feature will also enter the nutrient balance after the first manure application as the net nutrients required for the next manure application. This allows for a total nutrient

balance of all nutrients applied to be determined.

Nutrient Balance After Manure (lb/A)
The spreadsheet calculates, but does not show, the amount of nutrients applied at the planned manure rate. The "Nutrient Balance After Manure" is entered automatically by the spreadsheet after subtracting the amount of manure nutrients from the net nutrients required.

Supplemental Fertilizer (lb/A)
The need for supplemental fertilizers must be addressed in the plan. If the planned manure rate is less than the balanced rate, it may be necessary to supplement with other fertilizer nutrients to meet the total nutrient requirements of the crop.

The amount of supplemental fertilizer can best be estimated from the "Nutrient Balance After Manure" values. The supplemental fertilizer amount cannot exceed the amount of N recorded in "Nutrient Balance After Manure". If the P Index, Part B evaluation limits the P application to crop P removal, the supplemental fertilizer P cannot result in total P application greater than the crop P removal.

In many cases the planner will simply include any net nutrient need as supplemental fertilizer. This will tell the operator the maximum amount of supplemental nutrients that can be applied. The farmer can then decide what if any supplemental fertilizer will be actually applied. In some cased the farmer may request specific practical supplemental fertilizer application rates be provided in the plan. This is a farmer preference.

Supplemental fertilizer nutrient amounts are entered in the Supplemental Fertilizer row.

For corn crops, the use of the pre-sidedress nitrogen or chlorophyll meter tests for corn can be recommended to determine supplemental nitrogen fertilizer needs for those instances where manure applications may not meet the total nitrogen needs of the corn crop. If these tests are used, supplemental nitrogen may be applied at rates determined by the tests regardless of the calculated nitrogen balance.

P Index Application Method
Use the drop down menu to select the appropriate application method. This is required in the spreadsheet to complete the Phosphorus Index.

Final Nutrient Balance (lb/A)
The final nutrient balance for each field is determined after all nutrient sources have been considered. This value is calculated and automatically entered by the spreadsheet.

Manure Utilized On CMU (tons or gallons)
The total amount of manure at the planned manure rate from this manure group is calculated and automatically entered by the spreadsheet.

Calculations Used By the Spreadsheet
Following are some of the calculations used internally by the spreadsheet:

Residual Manure N (Option 2 – Table 1.2-15)
The following calculation is provided to illustrate how to use Option 2 to calculate the residual nitrogen coming from past manure applications.

"Residual Manure Nitrogen" Calculation

manure application rate 1 year ago **x** organic N content **x** residual N factor 1 year ago **+**

manure application rate 2 years ago **x** organic N content **x** residual N factor 2 years ago **+**

manure application rate 3 years ago **x** organic N content **x** residual N factor 3 years ago **+**

manure application rate 4 years ago **x** organic N content **x** residual N factor 4 years ago **+**

manure application rate 5 years ago **x** organic N content **x** residual N factor 5 years ago
(a) *(b)* *(c)*
= N from past applications available in the current year
(d)

Description of "Residual Manure Nitrogen" Calculation (Option 2)

(a) **manure application rates for each year manure was applied to the field in the past 5 years**

(b) **organic nitrogen content for the manure applied in a given year in (a)** = a manure analysis with total nitrogen and ammonium nitrogen is required for this option. Organic nitrogen is the difference between total and ammonium nitrogen

(c) **residual N factor** = the residual nitrogen factor is determined by the type of manure and how long ago the manure was applied. Agronomy Guide Table 1.2-15 provides factors for 5 prior years. The five results are added together.

(d) **residual N from past manure applications available in the current year** = the pounds of residual nitrogen available this season per acre from past manure applications (the sum of the 5 years) *(calculated)*

Net Nutrients Required

"Net Nutrient Required" Calculation
(for each nutrient)

soil test recommendation **–** other nutrients **–** residual manure N **–** residual legume N **=**
(a) *(b)* *(c)* *(d)*
net nutrient need
(e)

Description of "Net Nutrients Required" Calculation

(a) **soil test recommendations** = total nutrient need per acre for the field (calculate nitrogen, phosphorous, and potassium needs separately) *(recommendations based on soil analysis results)*

(b) **other nutrients** = the amount of the particular nutrient supplied per acre by all planned fertilizer applications to be made regardless of manure application for the field *(from the farmer)*

(c) **residual manure N** = the pounds of residual manure nitrogen contributed per acre from past manure applications for the field *(calculated as described above)*

(d) **residual legume N** = the pounds of residual legume nitrogen contributed per acre for the field being rotated from a legume crop to a non-legume crop *(calculated as described above)*

(e) **net nutrient need** = the net pounds per acre of the particular nutrient needed for the field *(calculated)*

Available Nitrogen From Manure

The amount of nitrogen in the manure and the nitrogen availability factor are used to determine the amount of nitrogen available to the crop in the season of application. The amount of nitrogen in the manure is determined by manure analysis results listed in Appendix 3.

"Available Nitrogen From Manure" Calculations (2 options)

Option 1

1) total N in the manure *(a)* **x** nitrogen availability factor *(b)* **=** N available from the manure *(c)*

Option 2

2) total ammonium N in the manure *(d)* **x** ammonium nitrogen availability factor *(e)* **+**
total organic N in the manure *(f)* **x** organic nitrogen availability factor *(g)* **=**
N available from the manure *(h)*

Description of "Available Nitrogen From Manure" Calculation

Option 1

(a) **total N in the manure** = the amount of total nitrogen (either in pounds per ton or pounds per 1000 gallons) in the manure *(from a manure analysis or from the Penn State Agronomy Guide book values, Table 1.2-13 when allowed (see discussion of*

manure analysis requirements in Appendix 3))

(b) **nitrogen availability factor** = the nitrogen availability factor for the current manure application based on the type of manure, the season of application, the season of crop utilization, and the days until incorporation *(Penn State Agronomy Guide, Table 1.2-14A)*

(c) **N available from the manure** = the pounds of immediately available nitrogen (per ton or 1000 gallons) from the manure application *(calculated)*

Option 2

(d,f) **ammonium N in the manure *(d)* & organic N in the manure *(f)*** = the amount of ammonium nitrogen and organic nitrogen (either in pounds per ton or pounds per 1000 gallons) in the manure *(from a manure analysis)* Note: Using the manure analysis report, organic nitrogen is calculated by subtracting ammonium nitrogen from total nitrogen.

(e,g) **nitrogen availability factors** = the ammonium and organic nitrogen availability factors for the current manure application based on the type of manure, the season of application, and the days until incorporation *(Penn State Agronomy Guide, Table 1.2-15)*

(h) **N available from the manure** = the pounds of immediately available nitrogen (per ton or 1000 gallons) from the manure application *(calculated)*

Nitrogen Balanced Manure Rate

Nitrogen balanced manure application rates are calculated by using the following equation.

"Nitrogen Balanced Manure Rate" Calculation

net crop nitrogen need **÷** N available from the manure **=** balanced manure rate
(a) *(b)* *(c)*

Description of "Nitrogen Balanced Manure Rate" Calculation

(a) **net nitrogen need** = the net pounds per acre of nitrogen needed for the field *(calculated – see "Net Crop Nutrient Needs" Calculation above)*

(b) **N available from the manure** = the pounds of immediately available nitrogen (per ton or 1000 gallons) from the manure application *(calculated - see "Amount of Nitrogen Available from Manure" Calculation above)*

(c) **balanced manure rate** = the manure application rate that would exactly meet the nitrogen needs of the crop *(calculated)*

Phosphorus Removal Balanced Manure Rate

The following series of calculations are required to determine a P Removal Balanced

Manure Rate and are required only for fields requiring Part B of the P Index.

The first step is to select a desired "proposed" manure application rate.

"P Applied At Proposed Rate" Calculation

proposed manure application rate **x** P_2O_5 from manure **=** total amount of manure P_2O_5
(a) *(b)* *(c)*

Description of the "P Applied At Proposed Rate" Calculation

Calculate the phosphorus supplied by manure:
(a) **proposed manure application rate** = the proposed manure application rate (tons or gallons) per acre *(based on calculated N-balanced rate)*

(b) **phosphorus from manure** = the pounds (per ton or 1000 gallons) from the manure analysis or book values for the proposed manure group

(c) **total amount of phosphorus supplied by manure** = the pounds of phosphorus supplied per acre by the proposed manure application rate *(calculated)*

This amount of phosphorus per acre is entered into the P Index. **At this point, the P Index assessment for the field must be completed (see Appendix 5).**

- **If the field P Index rating is Low or Medium,** the proposed rate can be used as the actual planned rate.
- **If the P Index rating is High or Very High,** a P Removal Balanced Rate must be calculated. For fields that require rates based on phosphorus removal a planned manure rate that is less than or equal to the P Removal Balanced Manure Rate must be used.

The second step is to calculate Net Crop P Removal.

"Net Crop P Removal" Calculation

planned yield **x** P_2O_5 removal per unit yield **–** P_2O_5 in any planned "other nutrients applied " **=**
(a) *(b)* *(c)*

net crop P removal
(d)

Description of "Net Crop P Removal" Calculation

(a) **planned yield** = planned yield for the crop planned

(b) **P_2O_5 removal per unit yield** = the pounds of P_2O_5 (per bushel or ton) from the Penn State Agronomy Guide, Table 1.2-9

(c) P_2O_5 in any planned "other nutrients applied" equal the amount of P_2O_5 in the planned rate of other nutrients that might be applied regardless of manure

(d) **balanced P removal manure rate** = the manure application rate that would exactly meet the net P_2O_5 needs of the crop *(calculated)*

The third step is to calculate the P Removal Balanced Manure Rate. The P Removal Manure Rate is the balanced or maximum rate of manure that would meet the net crop removal phosphorus which would fulfill the requirements for a High P Index rating between 80 and 99.

"P Removal Balanced Manure Rate" Calculation

net crop P_2O_5 removal need *(a)* ÷ P_2O_5 available from the manure *(b)* = balanced P removal manure rate *(c)*

Description of "P Removal Balanced Manure Rate" Calculation

(a) **net crop P_2O_5 removal need** = the net pounds per acre of P_2O_5 needed for the field *(calculated – see above)*

(b) **P_2O_5 available from the manure** = the pounds of P_2O_5 (per ton or 1000 gallons) from the manure application *(from a manure analysis or from the Penn State Agronomy Guide book values, Table 1.2-13 when allowed (see discussion of manure analysis requirements in Appendix 3))*

(c) **balanced net P removal manure rate** = the manure application rate that would exactly meet the net P_2O_5 needs of the crop *(calculated)*

Manure Nutrients Applied at Planned Rate & Nutrient Balance After Manure
In order to calculate the nutrient balance after manure application for each field, the amount of nutrients supplied by the planned manure application must be calculated.

"Nutrient Balance After Manure" Calculations

Step 1: calculate the nutrients supplied by manure

planned manure application rate *(a)* **x** N available from manure *(b)* **=** total amount of available N from manure

planned manure application rate *(a)* **x** P_2O_5 from manure *(b)* **=** total amount of P_2O_5 from manure

planned manure application rate *(a)* **x** K_2O from manure *(b)* **=** total amount of K_2O from manure *(c)*

Step 2: calculate the nutrient balance after manure

net N need – N from manure = N balance after manure

net P_2O_5 need – P_2O_5 from = P_2O_5 balance after manure

net K_2O need – K_2O from manure = K_2O balance
(d) *(e, from c above)* *(f)*

Description of the "Nutrient Balance" Calculations

Step 1: Calculate the nutrients supplied by manure:
(a) **planned manure application rate** = the planned manure application rate (tons or gallons) per acre*(as determined based on N or P)*

(b) **nutrients from manure** = for nitrogen the pounds (per ton or 1000 gallons) of available nitrogen *(calculated in the "Amount of Nitrogen Available From Manure" above; for phosphorus and potassium the pounds (per ton or 1000 gallons) from the manure analysis or book values, as allowed, for the planned manure group)*

(c) **total amount of nutrients supplied by manure** = the pounds of each nutrient supplied per acre by the planned manure application rate *(calculated)*

Step 2: Calculate the nutrient balance after manure:
(d) **net nutrients required** = the net pounds of each nutrient per acre as calculated in the "Net Nutrients Required" Calculation (ca*lculated)*

(e) **nutrients supplied by manure** = the pounds of each nutrient supplied per acre by the planned manure application rate *(from c above)*

(f) **nutrient balance after manure** = the pounds per acre of the particular nutrient that are still needed in order to meet the total nutrient needs for the particular field or crop group (or in excess if it is a negative number) *(calculated)*

Supplemental Fertilizer
If an actual supplemental fertilizer and rate are known the nutrient amounts in the fertilizer rate can be calculated as shown below.

"Supplemental Fertilizer" Calculations

planned supplemental fertilizer rate **x** N fertilizer analysis **=** total amount of N from fertilizer

planned supplemental fertilizer rate **x** P2O5 fertilizer analysis **=** total amount of P_2O_5 from fertilizer

planned supplemental fertilizer rate **x** K2O fertilizer analysis **=** total amount of K_2O from fertilizer
(a) *(b)* *(c)*

Description of the "Supplemental Fertilizer" Calculations

(a) **planned supplemental fertilizer rate** = the pounds of supplemental fertilizer to be applied per acre *(calculated)*

(b) **fertilizer analysis** = the N-P-K analysis of the fertilizer to be applied

(c) **total amount of nutrients supplied by fertilizer** = the pounds of each nutrient supplied per acre by the planned supplemental fertilizer rate *(calculated)*

Final Nutrient Balance

In order to calculate the final nutrient balance, the amount of nutrients supplied by the supplemental fertilizer is subtracted from the nutrient balance after manure for each field.

"Final Nutrient Balance" Calculations

N balance after manure – N from supplemental fertilizer = final N balance

P_2O_5 balance after manure – P_2O_5 from supplemental fertilizer = final P_2O_5 balance

K_2O balance after manure – K_2O from supplemental fertilizer = final K_2O balance

(d) *(e, from c above)* *(f)*

Description of the "Final Nutrient Balance" Calculations

(d) **nutrient balance after manure** = the net pounds of each nutrient per acre as calculated in the "Nutrient Balance After Manure at Planned Rate" Calculation (ca*lculated)*

(e) **nutrients supplied by supplemental fertilizer** = the pounds of each nutrient supplied per acre by the planned supplemental fertilizer rate *(from f above)*

(f) **final nutrient balance** = the pounds per acre of the particular nutrient that are still needed in order to meet the total nutrient needs for the particular field (or in excess if it is a negative number) *(calculated)*