

## Appendix 5

# The Pennsylvania Phosphorus Index: Version 2 User's Guide

Appendix 5 provides background information and direction in the evaluation of crop management units using Pennsylvania's Phosphorus Index: Version 2. The User's Guide also includes examples detailing the integration of a P Index evaluation into a nutrient management plan developed using Pennsylvania's Standard Plan format.

The development of the User's Guide was and continues to be a collaborative effort between The Pennsylvania State University, College of Agricultural Sciences, USDA-ARS, Pasture Systems and Watershed Management Research Unit.

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## Table of Contents

Introduction to the Pennsylvania Phosphorus Index .....	3
Phosphorus Index information required for each crop management unit .....	4
Crop management units .....	5
Frequency of Phosphorus Index evaluation .....	5
Phosphorus Index evaluation for no phosphorus application areas .....	6
Phosphorus Index guidance for pastures receiving less than or equal to nitrogen balanced nutrient application rates .....	6
Phosphorus Index phase-in guidance for crop management units or fields receiving a Very High P Index Rating .....	6
Part A: Screening Tool .....	7
Part B: Source Factors .....	8
Part B: Transport Factors .....	14
Phosphorus Index calculation and interpretation.....	20
Example: Integrating the Phosphorus Index into a nutrient management plan using Pennsylvania’s standard plan format.....	23
Contacts for additional information .....	44

## **Introduction to the Pennsylvania Phosphorus Index**

Phosphorus (P) continues to be concern to farmers and other water quality stakeholders. Excess nutrients, particularly P in freshwater, increases biological activity in water systems, thereby accelerating the process called eutrophication. Eutrophication is the most common reason for impairment of surface waters for fishing, recreation, industrial and domestic water uses.

While concerns about eutrophication and the potential environmental impact of P have existed and been part of management recommendations for some time, more attention was focused on nitrogen (N) concerns. As scientific evidence clarifying the importance of P in water quality protection grew and concerns about impaired uses of surface water increased, public policy makers turned more attention to P management.

In early 2003, the U.S. Environmental Protection Agency (USEPA) adopted new regulations for Concentrated Animal Feeding Operations (CAFOs) that required nutrient management plans to address both N and P. Regulations to implement these federal requirements have been developed for Pennsylvania by The Department of Environmental Protection (DEP). Also in 2003, Pennsylvania's U.S. Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS) implemented their 590 Practice Standard for Nutrient Management which consistent with the USDA-NRCS national practice standard for nutrient management. This national practice standard requires nutrient management plans that address both N and P for farmers receiving USDA-NRCS financial or technical assistance. In 2004, the Pennsylvania State Conservation Commission (SCC) proposed revised regulations for the Pennsylvania Nutrient Management Program (Act 38) that included a P component. On October 1, 2006, the revised Act 38 regulations became effective. Currently, nutrient management plans developed to meet Act 38 requirements must include a P component. The one approach that is used in all of these Pennsylvania programs is the Phosphorus Index (P Index).

### The Phosphorus Index

The P Index is a field evaluation tool developed to identify areas with a high vulnerability or risk of P loss to surface water bodies. Consideration of critical P source and transport factors allows for effective evaluation of P loss potential from nutrient land applications. This tool identifies fields vulnerable to soluble and insoluble P loss and limits nutrient application rates or directs the implementation of management practices on these fields.

Phosphorus source factors considered in the Pennsylvania P Index are Mehlich 3 soil test P, fertilizer P application rate and method, and manure P application rate, method, and P source coefficient. The transport factors considered are soil erosion, runoff potential, subsurface drainage, distance to a receiving water body, and an evaluation of management practices impacting P transport. These factors are combined in a simple calculation to arrive at a P Index Value for the field. The P Index Value indicates whether the nutrient application rate may be limited and/or other management practices may be required to address P concerns. Management practice recommendations may include installation of best management practices to reduce transport potential, such as common erosion control practices or buffers. Alternatively, changes in the timing or

method of P application may reduce risk of P loss allowing for N-based nutrient application.

The Pennsylvania P Index was developed by scientists at the USDA-ARS Pasture Systems and Watershed Management Research Unit at University Park, PA and The Pennsylvania State University College of Agricultural Sciences. It is the outcome of a major state and regional effort as part of an international research and development endeavor to produce a management approach that protects water quality from P pollution and enables sustainable and economic animal agricultural production.

#### Where to Get a Copy of the Phosphorus Index

The P Index Factsheet, User Guide, and Excel spreadsheet are electronically available at the Pennsylvania Nutrient Management Program web site under Planning Tools and Resources: <http://panutrientmgmt.cas.psu.edu>

#### Using the Phosphorus Index

A nutrient management plan that addresses both N and P, using the P Index, generally begins with the development of an N-based nutrient management plan required for the previously listed state and federal programs. Manure rates and management recommended in the N-based plan are evaluated by the P Index to determine if they pose a risk of environmental P loss. The P Index evaluation and inputs can then be used to select management alternatives to address identified concerns. For more information, refer to the Example section of this document.

#### **Phosphorus Index information required for each crop management unit**

Table 1 below provides a list of information required to complete a P Index evaluation on a crop management unit (CMU). The N-based plan provides most required information with the remainder coming from existing on-farm sources. Details on these items are given in following sections of this document.

**Table 1. Information required for the PA Phosphorus Index**

Information	Source of information
Field map of the land for the plan	Taken directly from the N-based plan
Mehlich 3 P soil test values (ppm P)	Taken directly from the soil test reports
Distance to water	Estimated from maps or measured in the field
Fertilizer P to be applied (lb P <sub>2</sub> O <sub>5</sub> /A)	Taken directly from the N-based plan
Method of fertilizer P application	Taken directly from the N-based plan
Manure P to be applied (lb P <sub>2</sub> O <sub>5</sub> /A)	Taken directly from the N-based plan
Method of manure P application	Taken directly from the N-based plan
P source coefficient	Water soluble P test results OR User's Guide (Table 1: P Index Factsheet)
Erosion (ton soil loss/A)	Taken from the farm conservation plan or calculated using the Revised Universal Soil Loss Equation (RUSLE)
Runoff Potential	Based on soil type and PA USDA-NRCS tables: "County Runoff Potential Tables: Drainage Class Determination for the P Index" <a href="http://panutrientmgmt.cas.psu.edu/rp_runoff_tables.htm">http://panutrientmgmt.cas.psu.edu/rp_runoff_tables.htm</a>
Subsurface Drainage	Determined from the farmer interview or farm conservation plan
Modified Connectivity	Determined from the farmer interview and/or field inspection

## **Crop management units**

Determining land area to be included in each crop management unit (CMU) is a critical step in developing a nutrient management plan using the P Index because field location and topography are important considerations in the P Index. Factors such as: distance to receiving water, erosion, runoff potential, and modified connectivity may be very different for fields and must be considered in establishing a CMU. If multiple fields are combined into a single CMU, all P Index source and transport factors must be the same for all individual fields in a CMU. **If all P Index factors are not the same for the individual fields in a CMU, then the worst case scenario values must be used for the entire CMU.**

For example, if one field in a CMU is close to receiving water and has a high erosion rate then all fields in that CMU must be considered close to receiving water and to have a high erosion rate in the P Index. This applies regardless of the actual individual field properties. Therefore, collect information on a field-by-field basis and then determine if CMUs can be formed using fields with the same P Index factors.

Often there is considerable variability within fields; therefore, the same approach detailed above is used to address within field variability. Part of a field may be at high risk for P loss while another part of the field may be at low risk. For the P Index, the worst case part of the field must be used to determine its P Index Rating and Value. There may be situations where splitting a field into subfields for P Index evaluation is advantageous. For example, a field may have a relatively small steep sloping area close to a stream. For the P Index, the whole field would be considered to be steep sloping and close to the stream. Splitting off this small, steep sloping area and managing it differently (e.g. applying less manure or applying manure at a different time or in a different way) may remove P-based restrictions on the remainder of the field.

## **Frequency of Phosphorus Index evaluation**

Generally, nutrient management plans are written for multiple years. For example, Act 38 nutrient management plans are written for a three year period. The P Index can be applied to multiple years as long as all P Index factors remain the same for all years in the planning cycle. If management changes occur during the planning cycle, it must be determined if these changes impact the P Index. For example, if the crop changes in a field, the N-based manure rate or method of application may change. These management changes in turn may impact the P Index evaluation of the field. Therefore, several P Index evaluations and differing field management may be required in a planning cycle.

Fortunately, many of the factors in the P Index are constant, i.e. distance to receiving water, runoff potential, subsurface drainage, modified connectivity and erosion unless there are significant BMP changes. Act 38 requires soils tests at the same frequency as planning (every three years); therefore, soil test value changes are generally not needed during a planning cycle. Developing annual P Index evaluations will generally only require changes to the fertilizer and/or manure P management information.

### **Phosphorus Index evaluation for no phosphorus application areas**

In a farm management system where a management decision has been made to not apply manure P, P from other organic nutrient sources, or fertilizer P, including starter fertilizer, to a field or fields for the life of a nutrient management plan, a P Index evaluation is not required for those fields.

**If at anytime there is a change in management and manure P, P from other organic sources, or fertilizer P, including starter fertilizer, will be applied (such as when the field is rotated to a crop that will receive manure), the field or fields must be evaluated with the P Index and the nutrient management plan updated or amended accordingly before this application can occur.**

When the management scenario described above occurs, a P Index evaluation is not required. However, documentation in Appendix 4I that no P will be applied is required. Documentation requires that “No P Applied” be entered into the P Index Part A section of Appendix 4.

### **Phosphorus Index guidance for pastures receiving less than or equal to nitrogen balanced nutrient application rates**

The Act 38 nutrient management regulations have established guidance for pastures receiving less than or equal to N balanced nutrient application rates and a Very High P Index Rating. According to §83.294(j) of the Act 38 regulations, if the following four conditions, taken directly from the regulations, are met these pastures may continue to be grazed.

1. Grazing may not be conducted within 50 feet of a perennial or intermittent stream, a lake or a pond.
2. A prescribed grazing system shall be used to maintain an established stand of forage on the pasture area.
3. The stocking rate shall be limited to ensure that the level of phosphorus deposited by the animals does not exceed the level of phosphorus removal from the soil by vegetation in the pasture.
4. BMPs contained in the Pennsylvania Technical Guide may be used to meet the requirements in paragraphs (1) and (2). Other BMPs shall be approved by the Commission.

For additional information see Pennsylvania’s Field Office Technical Guide at <http://www.nrcs.usda.gov/technical/efotg/index.html>.

### **Phosphorus Index phase-in guidance for crop management units or fields receiving a Very High P Index Rating**

The Act 38 nutrient management regulations have established a phase-in period for CMUs or fields receiving a Very High P Index Rating. This phase-in period applies to operations existing on October 1, 2006 and applies to CAOs, VAOs, and importing operations listed in their nutrient management plan. Specifically, qualifying operations with CMUs or fields with a calculated P Index Value of 80 to 150 may apply P at crop removal rates until December 31, 2010. After December 31, 2010, CMUs or fields with a calculated P Index Value of 80 to 99 may apply P at crop removal rates and CMUs or

fields with a calculated P Index Value of 100 to greater may not apply P (see Table 2). This phase-in period and its requirements are detailed in §83.293(c)(3) of the Act 38 nutrient management regulations.

**Following is a detailed description of each Pennsylvania P Index factor. At the beginning of each section the relevant P Index section is shown in a shaded box.**

**Part A: Screening Tool**

Part A of the P Index is a Screening Tool used to determine if a more detailed analysis using Part B of the P Index is needed. The Part A approach is to evaluate several simple criteria including watershed classification, distance from receiving water and soil test P level. Soil test P level is a key factor in Part A because it reflects P management history. In stable management systems, past and current planned nutrient management practices are similar and soil test P level is a valid indicator of P sources. However, when the current planned practices are not consistent with historical practices soil test level P is not a valid indicator. Therefore when there is a significant management change soil test P is not a good indicator of sources on the farm because of the management change. Typically in these situations, planned manure application rates are significantly higher than historical rates. Management changes resulting in this discrepancy are generally obvious and can include addition of new lands to or expansion of an agricultural operation, manure storage structure installation, a change in P nutrient sources, or a change in animal type. Distance to water is a good general indicator of the potential for P transport to that water. The watershed classification provides an indication of the sensitivity of the receiving waters to potential nutrient pollution. Every CMU or field must be evaluated by P Index Part A using the following criteria.

PART A: SCREENING TOOL	CMU/Field ID	
Is the CMU/field in a Special Protection Watershed?	If the answer is yes to <u>any</u> of these questions, Part B must be used	
Is there a significant farm management change as defined by Act 38?		
Is the Soil Test Mehlich 3 P greater than 200 ppm P? (enter soil test value in ppm P)		
Is the Contributing Distance from this CMU/field to receiving water less than 150 ft.?		

If any Part A questions are answered “Yes:, Part B must be used. More information to assist in answering the Part A questions is given below.

1. Is the CMU/field in a Special Protection Watershed?

County Conservation Districts or The Pennsylvania Department of Environmental Protection (DEP) can provide Special Protection Watershed listings. Part A designations must be consistent with PA Nutrient Management web site guidance and Standard Nutrient Management Plan Appendix 2. Operation Information, Notation of Special Protection Waters.

Information on special protection waters can also be found on the web in an interactive map format called eMapPA at:

<http://www.emappa.dep.state.pa.us/emappa/viewer.htm>

To use this site, turn on the “Streams Designated Use” feature and zoom in on the farm location on the map. For additional information on using this website tool refer to “Using eMap to Identify Special Protection Watersheds”. This reference is posted on the PA Nutrient Management Program website at <http://panutrientmgmt.cas.psu.edu/> under the Planning Tools and Resources section.

2. Is there a significant farm management change defined by the following four Act 38 criteria?
  - net increase of greater than 10% in AEU's per acre
  - change in crop management that results in a farmwide reduction of greater than 20% in nitrogen necessary for realistic expected crop yields
  - alternative organic sources will replace all or some of the nutrient sources listed in the plan
  - additional lands are brought into the operation (purchased or rented)
3. Is the soil test Mehlich 3 P greater than 200 ppm P?  
See the **Soil Test** section under Part B for more details.
4. Is the Contributing Distance from this CMU/field to receiving water less than 150 ft?  
See the **Contributing Distance** section under Part B for more details.

If all Part A questions are answered “No”, the N-based plan for the CMU is acceptable as written and no further P Index analysis, using Part B, is required. Completion of Part A with all “No” answers meets the regulatory requirement for running the P Index on all fields as part of a nutrient management plan.

## Part B: Source Factors

### Soil Test

<b>SOIL TEST</b>	Mehlich 3 Soil Test P (ppm P)
<b>Soil Test Rating = 0.20 * Mehlich 3 Soil Test P (ppm P)</b>	

### Soil Test

The soil test level is Mehlich 3 extractable P in parts per million (ppm). It is taken directly from a soil test report. See the example below from the Penn State soil test report. This is the same soil test value used in P Index Part A.

Penn State Soil Test Report P Results

SOIL NUTRIENT LEVELS	Below Optimum	Optimum	Above Optimum
<sup>1</sup> Soil pH 6.3	██████████		
<sup>2</sup> Phosphorus (P) 20 ppm	██████████		
<sup>2</sup> Potassium (K) 80 ppm	██████████		
<sup>2</sup> Magnesium (Mg) 60 ppm	██████████		

All commercial soil testing labs conducting significant business in Pennsylvania offer the Mehlich 3 soil test as a standard test or as an alternative test upon request. Additionally, these labs report soil test P values in ppm or mg/kg. However, if needed, the following factors convert Mehlich 3 results in units other than ppm P to Mehlich 3 results in ppm P:

$$\begin{aligned} \text{mg P/kg} &= \text{ppm P} \\ \text{lb P/A} \div 2 &= \text{ppm P} \\ \text{lb P}_2\text{O}_5 \text{ /A} \div 4.6 &= \text{ppm P} \end{aligned}$$

Note that these conversions are only unit conversions and require that the test results, regardless of the reporting units, are from the Mehlich 3 soil test. There are no acceptable conversions for converting the soil test result from another extractant to Mehlich 3 P.

### Soil Test Rating

Soil Test P Rating is calculated by multiplying Mehlich 3 soil test P in ppm P by 0.2. This calculation appropriately weighs soil test P relative to the other source factors.

### **Fertilizer**

<b>FERTILIZER P RATE</b>	<b>Fertilizer P (lb P<sub>2</sub>O<sub>5</sub>/acre)</b>				
<b>FERTILIZER APPLICATION METHOD</b>	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April - October	0.8 Incorporated >1 week or not incorporated following application in November - March	1.0 Surface applied to frozen or snow covered soil
<b>Fertilizer Rating = Fertilizer Rate x Fertilizer Application Method</b>					

### Fertilizer Rate

This factor is the fertilizer P rate, in lb P<sub>2</sub>O<sub>5</sub>/A, that will be applied to the field.) It can be determined directly from the N-based nutrient management plan or by multiplying the fertilizer P<sub>2</sub>O<sub>5</sub> analysis (middle fertilizer analysis value) expressed as a decimal or fraction by the applied amount of fertilizer. (See the note below about handling multiple P fertilizer applications on a CMU.)

For example: If a farmer plans to apply 150 lb/A of 10-20-10 starter fertilizer, calculate the P<sub>2</sub>O<sub>5</sub> fertilizer rate as follows:

Step 1. Divide the fertilizer analysis by 100: (20% P<sub>2</sub>O<sub>5</sub> ÷ 100) = 0.20

Step 2. Calculate P fertilizer rate: 150 lb/A x 0.20 = 30 lb P<sub>2</sub>O<sub>5</sub> /A

For liquid fertilizer applications given as gallons of fertilizer applied per acre, the calculation must also include a volume (gallons) to weight (pounds) conversion. To make this conversion, the weight per gallon of fertilizer must be known. Fertilizer dealers should be able to provide this information. Additionally, P fertilizer application rate information is available in the N-based nutrient management plan.

For example: If a farmer plans to apply 5 gal/A of 10-34-0 liquid starter fertilizer, calculate the P<sub>2</sub>O<sub>5</sub> fertilizer rate as follows:

Step 1. Determine fertilizer weight per gallon: Weight = 11.68 lb/gal

Step 2. Divide the fertilizer analysis by 100: (34% P<sub>2</sub>O<sub>5</sub> ÷ 100) = 0.34

Step 3. Calculate P fertilizer rate: 5 gal/A x 11.68 lb/gal x 0.34 = 20 lb P<sub>2</sub>O<sub>5</sub> /A

### Fertilizer Application Method

Select the Fertilizer Application Method category closest to the planned fertilizer application method (see below). Enter the associated weighting factor into the P Index.

### **FERTILIZER APPLICATION METHOD**

0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April – October	0.8 Incorporated >1 week or not incorporated following application in November - March	1.0 Surface applied to frozen or snow covered soil
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Following is additional information on these categories:

Placed or injected 2" or more deep	– The category applies to starter fertilizer P placed several inches deep in the soil with the planter or to immediate injection. The next category applies to application followed by mechanical incorporation as a separate operation.
Incorporated <1 week following application	– The category applies to <u>mechanical</u> fertilizer incorporation with primary or secondary tillage within 1 week following application. This includes same day incorporation. This <u>does not</u> include incorporation by rainfall.
Incorporated > 1 week or not incorporated following application in April – October	– The category applies to <u>mechanical</u> fertilizer incorporation more than 1 week after application or no fertilizer incorporation from April to October.
Incorporated >1 week or not incorporated following application in Nov. – March	– The category applies to <u>mechanical</u> fertilizer incorporation more than 1 week after application or no fertilizer incorporation from November to March.
Surface applied to frozen or snow covered soil	– The category applies to fertilizer application on frozen or snow covered soil.

### Fertilizer Rating

The Fertilizer Rating is calculated by multiplying the *Fertilizer Rate* by the *Fertilizer Application Method* factor.

### Multiple fertilizer P applications

If more than one fertilizer application is made to a given field, calculate the *Fertilizer Rating* with the rate and application method factor for each individual fertilizer application. Add these *Fertilizer Ratings* together to determine the final *Fertilizer Rating*.

The Multiple P Applications worksheet in the P Index Version 2 spreadsheet can be used to determine a *Fertilizer Rating* for a CMU or field receiving multiple P applications. The P Index spreadsheet is available at the Pennsylvania Nutrient Management Program web site under Planning Tools and Resources: <http://panutrientmgmt.cas.psu.edu>.

## MANURE

***The following section provides instruction for evaluating manure P applications and P applications from other organic nutrient sources in the P Index. The Manure section of the P Index must be used to evaluate all organic P applications to a CMU or field. Fertilizer or inorganic P applications are evaluated in the Fertilizer section of the P Index.***

MANURE P RATE	Manure P (lb P <sub>2</sub> O <sub>5</sub> /acre)				
MANURE APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April - October	0.8 Incorporated >1 week or not incorporated following application in November - March	1.0 Surface applied to frozen or snow covered soil
P SOURCE COEFFICIENT	Refer to: Test results for P Source Coefficient OR Book values from P Index Fact Sheet Table 1				
<b>Manure Rating = Manure Rate x Manure Application Method x P Source Coefficient</b>					

### Manure Rate

This factor is the manure P rate, reported in lb P<sub>2</sub>O<sub>5</sub>/A, that will be applied to the field. This can be determined by multiplying the manure P analysis, directly from the manure analysis report and as recorded in Appendix 3, by the amount of manure that will be applied which is the "Planned Manure Rate" found in Appendix 4. Typically, this will be based on the actual planned manure P rate based on balancing N. (See the note below about handling multiple P fertilizer applications on a CMU.)

Be careful with units, as laboratories report manure analyses in different units. The most common units for manure analysis are lb/1000 gal, lb/100 gal, and lb/ton; all are reported on an as sampled basis.

Example Calculation: If a farmer applies 7000 gal/A of dairy manure with an analysis of 13 lb P<sub>2</sub>O<sub>5</sub> /1000 gal, the calculation is as follows:

$$7000 \text{ gal/A} \times 13 \text{ lb P}_2\text{O}_5 /1000 \text{ gal} = 91 \text{ lb P}_2\text{O}_5 /\text{A}$$

Manure P application rate information should be available directly from the N-based nutrient management plan (Appendix 4, "Planned Manure Rate").

### Manure Application Method

Select the Manure Application Method category closest to the planned manure application method (see below). Enter the associated weighting factor into the P Index.

#### **MANURE APPLICATION METHOD**

0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April - October	0.8 Incorporated >1 week or not incorporated following application in November - March	1.0 Surface applied to frozen or snow covered soil
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Following is additional information on these categories:

Placed or injected 2" or more deep	– The category applies only to <u>directly injected</u> manure such as with a chisel or disk injector. The next category applies to application of manure followed by <u>separate mechanical incorporation</u> .
Incorporated <1 week following application	– The category applies to <u>mechanical</u> manure incorporation with primary or secondary tillage within 1 week following application. This includes same day incorporation. This <u>does not</u> include incorporation by rainfall.
Incorporated > 1 week or not incorporated following application in April – October	– The category applies to <u>mechanical</u> manure incorporation more than 1 week after application or no manure incorporation from April to October.
Incorporated >1 week or not incorporated following application in November – March	– The category applies to <u>mechanical</u> manure incorporation more than 1 week after application or no manure incorporation from November to March.
Surface applied to frozen or snow covered soil	– The category applies to manure application on frozen or snow covered soil.

#### As an interim recommendation, when using:

- a shallow disk injector, select *Placed or injected 2" or more deep* and enter a 0.2 weighting factor into the P Index.
- a spike aerator or a straight disk vertical tillage tool, select *Incorporated <1 week following application* category and enter a 0.4 weighting factor into the P Index.
- a rotary harrow, select either *Incorporated > 1 week or not incorporated following application in April – October* or *November – March* and enter a *either 0.6 or 0.8* weighting factor depending on time of application in the P Index.

### Phosphorus Source Coefficient

The P source coefficient (PSC) accounts for P available for loss directly from organic P sources to surface runoff. It is not related to P crop availability. The appropriate PSC value can be selected two ways. The first option is to have the organic P source analyzed using a now commercially available manure test for water soluble P. This test provides a PSC for a specific organic P source and can be performed at the same time as an standard agronomic manure analysis. The PSC is a calculated value based on the water soluble P manure test. The minimum PSC analytical value is 0.10 and the maximum PSC analytical value is 1.0. Make sure your testing lab is using the correct formula to calculate the PSC. More information about the water soluble P test is

available through the Penn State Agricultural Analytical Services Laboratory (<http://www.aasl.psu.edu/>). The second option is to select a PSC book value from the table below. For all organic P sources not listed, a water soluble P analysis should be conducted. If the analytical results are not available and the organic P source is not listed below, use a default PSC value of 1.0 in the P Index.

Phosphorus source coefficients (PSC) book values<sup>1</sup>

Manure	
Swine manure	1.0
Broiler	0.8
Layer	0.8
Turkey	0.8
Duck	0.8
Dairy – Liquid	0.8
Dairy – Bedded Pack	0.8
Beef	0.8
Horse	0.8
Biosolids	
BPR biosolids	0.8
All biosolids (except BPR)	0.4

<sup>1</sup> Coale, F., T. Basden, D. B. Beegle, R. C. Brandt, H. A. Elliott, D. J. Hansen, P. Kleinman, G. Mullins, and J. T. Sims. 2005. Development of Regionally-Consistent Phosphorus Source Coefficients for Use in Phosphorus Index Evaluations in the Mid-Atlantic Region. USDA-CSREES, The Mid-Atlantic Regional Water Program, MAWQP# 05-04. Available at <http://www.mawaterquality.org/publications/pubs/PSIWhitePaper03-29-05.pdf>

Manure Rating

The Manure Rating is calculated by multiplying the *Manure P Rate* by the *Manure Application Method* factor by the *P Source Coefficient*.

Multiple Manure Applications to a CMU

If more than one manure application is made to a given field, calculate the *Manure Rating* with the rate, method and PSC for each individual manure application. Add these *Manure Ratings* together to arrive at the final *Manure Rating*.

The Multiple P Applications worksheet in the P Index Version 2 spreadsheet can be used to determine a *Manure Rating* for a CMU or field receiving multiple P applications. The P Index spreadsheet is available at the Pennsylvania Nutrient Management Program web site under Planning Tools and Resources: <http://panutrientmgmt.cas.psu.edu>

**Source Factor**

**Source Factor = Soil Test Rating + Fertilizer Rating + Manure Rating**

The overall Source Factor is calculated by adding the *Soil Test Rating* to the *Fertilizer Rating* to the *Manure Rating*. These values are the shaded lines in the P Index.

**Part B: Transport Factors**  
**Erosion**

<b>EROSION</b>	Soil Loss (ton/acre/yr)
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The erosion rate estimates soil loss based on crop management, tillage practices, regional location, and best management practices. The erosion value for the P Index is calculated using the Revised Universal Soil Loss Equation (RUSLE) and is reported in tons/acre/year. This is usually determined by Pennsylvania USDA-NRCS as a part of the conservation plan development process. For the P Index, the actual (A) erosion value should be used and not the tolerable (T) soil loss value. However, if the conservation plan is fully implemented to meet T then the T soil loss value can be used in the P Index. If the actual soil loss is not available, contact your regional nutrient management coordinator (see Contacts for Additional Information).

**Runoff Potential**

<b>RUNOFF POTENTIAL</b>	0 <i>Drainage Class is Excessively</i>	2 <i>Drainage Class is Somewhat Excessively</i>	4 <i>Drainage Class is Well/Moderately Well</i>	6 <i>Drainage Class is Somewhat Poorly</i>	8 <i>Drainage Class is Poorly/Very Poorly</i>
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Surface runoff potential is based on the USDA-NRCS Drainage Class. Based on soil properties, Drainage Class values are classified into Very Poorly, Poorly, Somewhat Poorly, Moderately Well, Well, Somewhat Excessively, and Excessively. To facilitate the incorporation of this factor into the P Index, the Pennsylvania USDA-NRCS has developed tables that list the Drainage Class by soil mapping unit for each Pennsylvania county. These tables are available at the Pennsylvania Nutrient Management Program web site under Planning Tools and Resources: <http://panutrientmgmt.cas.psu.edu>.

Note: In P Index Version 2, a different Runoff Potential indicator is being used than in Version 1. However, the same reference tables are used. The Drainage Class is listed as “Drainage” in the fourth column of the Index Surface Runoff Class tables used with P Index Version 1.

When determining the appropriate Runoff Potential category for a field, first determine the predominate soil type in the field. Then use the “County Runoff Potential Tables: Drainage Class Determination for the P Index” table for the county in which you are working, find the predominate soil type on the table, and select the Drainage Class value. Finally, choose the corresponding P Index category and enter the associated weighting factor into the P Index.

## Subsurface Drainage

<b>SUBSURFACE DRAINAGE</b>	0 None or No direct outlet to receiving water		1 Random – Outlets directly to receiving water		2* Patterned – Outlets directly to receiving water
* OR rapid permeability soil near a stream					

Subsurface drainage accounts for the presence of artificial drainage in a field. There are three options provided in the P Index: *None*, *Random*, and *Patterned*.

None refers to a field that has no artificial drainage. It also refers to a field with subsurface drainage that does not outlet directly to receiving water bodies.

Random applies to fields with one or more drains that address wet conditions in a section(s) of a field. Generally, field drainage qualifying as *Random* will be spaced more than 75 feet apart. Subsurface drainage in this category outlet directly to receiving water bodies.

Patterned applies to fields that have multiple connected drains designed to address wet conditions across an entire field. Patterned drainage is most commonly found in northwestern Pennsylvania, specifically in Crawford, Erie, Lawrence, Mercer, Warren, Butler, and Beaver counties. Generally, these systems have tile drain lines spaced 35 to 50 feet apart. When the tile drain line spacing equals or exceeds 75 feet the system is considered *Random*. Subsurface drainage in this category outlet directly to receiving water bodies.

In assigning the appropriate category, the type of subsurface drainage needs to be determined using farm maps, farm records, or information from the farmer interview. Once it has been determined that a field has *Random* or *Patterned* drainage, the presence of the tile drain and the location of its outlet are not considered as a part of the Modified Connectivity determination. Therefore, tile drains are only considered and accounted for in the *Subsurface Drainage* category.

An additional consideration in the Subsurface Drainage category determination is whether a rapidly permeable soil exists within 100 ft. of a receiving water body. Information for determining whether a soil is rapidly permeable is found in the county soil survey report or by using the USDA-NRCS Web Soil Survey <http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm>. For the P Index, a rapidly permeable soil is defined as having a Permeability greater than 6 in/hr and includes soil types with both Rapid and Very Rapid Soil Permeability Class designations. If a field has soils 1) identified in the soil survey as having a permeability greater than 6 in/hr and 2) within 100 ft. of a receiving stream then the *Patterned Subsurface Drainage* category must be selected and the associated weighting factor entered into the P Index.

## Contributing Distance

<b>CONTRIBUTING DISTANCE</b>	0 > 500 ft.	2 350 to 500 ft.	4 200 to 349 ft.	6 100 to 199 ft. OR <100 ft. with 35 ft. buffer	9 <sup>‡</sup> < 100 ft.
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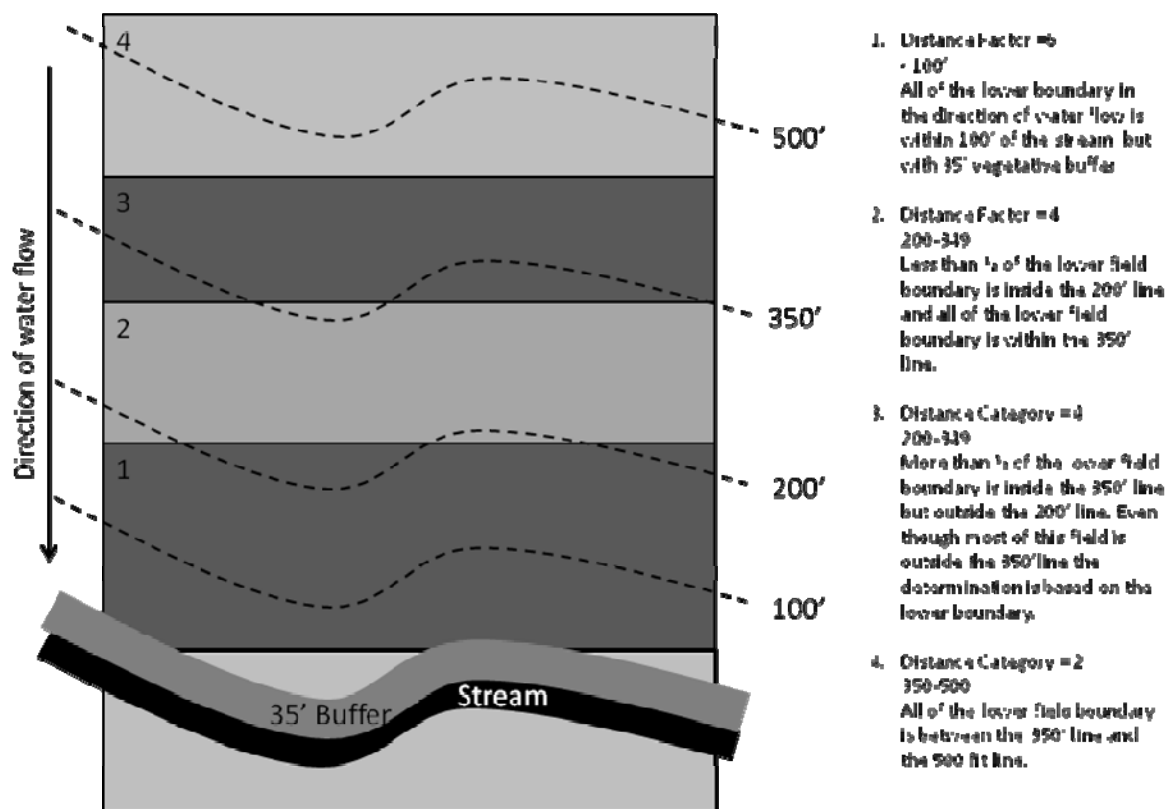
<sup>‡</sup> A “9” Contributing Distance factor does not apply to fields with a 35 ft. buffer receiving manure. For these fields, a “6” Contributing Distance factor must be used. Specific guidance for assigning a Contributing Distance factor for these fields is described in this section under the heading 35 ft. Wide Buffer.

Contributing distance assesses the distance of a field from a receiving body of water. In the Contributing Distance determination, a receiving water body can include: ponds, lakes, and perennial and intermittent streams with channels (bed and bank). Other conveyances such as ditches are accounted for in the Modified Connectivity section of the P Index (see below). The distance categories were developed using landscape properties in combination with the potential occurrence of storms with varying intensities. The closer a field is to a receiving body of water, the more likely it is that P leaving the field will reach the body of water.

To determine the contributing distance for a field, the lower edge or edges of the field in the direction of water flow to the receiving water body must be used. It is necessary to determine how the P Index distance categories correspond with the farm field boundaries. This is most easily done by plotting distance lines at 100, 200, 350, and 500 ft. on a farm map with field boundaries and receiving water bodies delineated. Then determine which Contributing Distance category accounts for a majority (50% or more) of the lower edge or edges of the field in the direction of water flow to the receiving water body. This is method of determining Contributing Distance and the same lower field edge or edges in the direction of water flow to the receiving water body must be used in Part A and Part B. Therefore, all distance determinations and methods must be consistent between P Index Parts A and B.

Depending on the landscape, when determining the lower edge of a field in the direction of water flow, two or more field edges or boundaries may need to be evaluated. In these cases, the total length of all of the field edges or boundaries are considered when determining which Contributing Distance category accounts for 50% or more of the lower edges in the direction of water flow.

The figure below illustrates how to determine the distance category for fields.



### Determining the Contributing Distance Category

Near stream areas require special considerations which must be evaluated and addressed prior to completing the P Index Contributing Distance evaluation. Refer to the NMP Summary section of this Manual for specific requirements.

A category of *9 < 100 ft.* is assigned to a field when the field has been determined to be less than 100 ft of a receiving water body and when either of the two conditions are met:

1. phosphorus is applied to the field only as inorganic fertilizer.
2. animals are grazed in this field and the buffer pasture criteria are not met. Refer to the NMP Summary section of this Manual for the specific buffer pasture criteria.

A category of *6 100 to 199 ft. OR <100 ft. with 35 ft. buffer* is assigned to a field when either of the following conditions are met:

1. the field has been determined to be between 100 and 199 ft. of a receiving water body
2. the field distance has been determined to be less than 100 ft. and the 35 ft. buffer criteria for cropland or pastures have been met. Refer to the NMP Summary

section of this Manual for the specific 35 ft. cropland buffer and 35 ft. pasture buffer criteria.

A category of 4 200 to 349 ft. is assigned to a field when the field has been determined to be between 200 and 349 ft. of a receiving water body.

A category of 2 350 to 500 ft. is assigned to a field when the field has been determined to be between 350 and 500 ft. of a receiving water body.

A category of 0 > 500 ft. is assigned to a field when the field has been determined to be greater than 500 ft. from of a receiving water body.

### Transport Sum

**Transport Sum = Erosion + Runoff Potential + Subsurface Drainage + Contributing Distance**

The Transport Sum is calculated by summing the *Erosion, Surface Runoff Potential, Subsurface Drainage, and Contributing Distance* factors. These values are represented by a shaded line in the P Index.

### Modified Connectivity

<b>MODIFIED CONNECTIVITY</b>	0.85 50 ft. Riparian Buffer APPLIES TO DIST. < 100 FT		1.0 Grassed Waterway or None		1.1 Direct Connection APPLIES TO DIST. > 100 FT
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The previous transport factors account for the landscape or inherent properties of a field that influence P transport and with the exception of erosion cannot be changed. However, the Modified Connectivity factor accounts for management practices that can change, inhibiting or facilitating, how P moves from a field to receiving water.

#### Modified Connections for fields less than 100 ft. from water

In the Modified Connectivity evaluation described below, field distance from receiving water must be determined. There are two possible modified connectivity situations for fields that are within the <100 feet from water category. First, the regulations require that manure cannot be applied within 100 feet of a water body unless there is a 35 foot vegetative buffer established. This buffer or the 100 ft manure application set back modify the connection between a near-stream field and the water. This is accounted for by selecting the “6” distance factor for these situations. No further adjustment for a modified connection is taken in this case. However, a further reduction in the risk of P loss can be obtained if a buffer is designed and managed to meet NRCS standards which includes a minimum width of 50 feet. In this situation, the additional modified connectivity factor is used. This factor is 0.85 which is multiplied times the transport

sum effectively reducing the transport sum reflecting the lower potential for transport of P to water with the designed riparian buffer compared to the simple 35 vegetative buffer. Below is a detailed description of the 50 foot buffer that would meet the NRCS standards.

**50 ft. Wide Buffers:** Fields within 100 ft. of receiving water with 50 ft. wide buffers designed to meet the sediment and dissolved nutrient control criteria of either Pennsylvania USDA-NRCS Practice Standards 390 (Herbaceous Riparian Cover), 391 (Forested Riparian Buffer), or 393 (Filter Strip), should receive BOTH a Contributing Distance factor of 6 and the Modified Connectivity factor of 0.85.

If a buffer has not been designed by Pennsylvania USDA-NRCS, but appears to be functioning as if it were, it MUST be certified by Pennsylvania USDA-NRCS to receive credit in the P Index.

#### Modified Connections for fields more than 100 ft. from water

If a field is outside of 100 ft. from receiving water, it is necessary to determine if a direct connection conveys surface runoff and erosion leaving a field and discharges into or near receiving water. Direct connections can include: pipe outlets and ditches not meeting the definition of a perennial or intermittent stream (see Act 38 regulations §83.201). Subsurface tile drainage is accounted for in the Subsurface Drainage category and are not direct connections in the P Index.

The location of the direct connection outlet is important. If the outlet discharges into a grassed or vegetated area, it is not a direct connection. However, if the outlet discharges directly into receiving water or an area with no vegetation, it is a direct connection. For fields with a qualifying direct connection and a Contributing Distance greater than 100 ft. from receiving water select a *Modified Connectivity* factor of 1.1.

A grass waterway is considered a special case direct connection. Even though it is a type of direct connection, if properly designed and maintained, a grass waterway should reduce sediment and P transport. Therefore, properly designed and maintained grass waterways do not qualify as direct connections for the P Index.

Tile drains are evaluated and accounted for in the Subsurface Drainage section of the P Index. Therefore, tile drains and their outlets should not be considered direct connections in the Modified Connectivity section. Tile drains can transport P; however, this P loss is properly accounted for in the Subsurface Drainage category.

For fields at any distance from receiving water determined to have a grass waterway or no buffers or direct connections select a Modified Connectivity factor of 1.0.

## Transport Factor

$$\text{Transport Sum} \times \text{Modified Connectivity} \div 24$$

The *Transport Sum* is multiplied by the *Modified Connectivity* value and this product is divided by 24. Twenty-four is the maximum *Transport Sum* value and dividing by this value allows the *Transport Factor* to generally vary between 0 and 1.0. A *Transport Factor* value of 1.0 is the value at which the full (100%) field transport potential is reached. Other *Transport Factor* values represent a percentage of the field's full transport potential. The *Transport Factor* only exceeds 1.0 when erosion losses are exceptionally high.

## Phosphorus Index calculation and interpretation

$$\text{P Index Value} = 2 \times \text{Source} \times \text{Transport}$$

The final P Index Value for a field is calculated by multiplying the *Source Factor* x *Transport Factor* x 2. The factor of "2" allows P Index Values over 100 to receive a Very High P Index Rating consistent with other Mid-Atlantic states. The P Index Rating is a relative description of the vulnerability or risk of P loss to surface water bodies. The nutrient management recommendation for the calculated P Index Value and associated P Index Rating can be interpreted using Pennsylvania P Index Table 2 (see below).

In addition to providing an indication of the relative risk of P loss, the P Index Ratings determine recommendations for nutrient application. At Low or Medium P Index Ratings, the maximum nutrient applications are based on N balance. The amount of available N from all nutrient sources cannot exceed the N crop requirement. For Low and Medium P Index Ratings, standard best management practices for manure management should be followed. Although the nutrient application recommendation is the same for Low and Medium Ratings, the Medium range indicates a higher risk of adverse impact on surface water and warns to evaluate management practices to ensure P loss risk does not increase. Practices to consider include the manure application rate, timing and method of manure application and the adequacy and function of conservation practices.

For the High P Index Rating, nutrient applications are limited to the lower of the N or P balanced rate. The total of all P applications must be reduced so that no more P is applied than will be removed by the current crop. This will significantly reduce the amount of P applied compared to an N balanced rate and should not result in further buildup of soil P. Other management practices such as timing and method of manure application and conservation practices should also be considered. In some cases, changes in other management may lower the risk of P loss, and thus the P Index Value and Rating, so that the nutrient application rate is not restricted to crop P removal. As nutrient application rates based on P balance can be very low and sometimes not practical for manure application equipment, up to three years of crop P removal may be applied in one application with no manure or P applied in the following 2 years.

However, there are several important limitations. First, the multi-year manure rate cannot exceed N balance for the current crop. Second, the multi-year manure rate must be evaluated in the P Index. If the multi-year rate results in a Very High P Index Rating for the current year, this rate cannot be applied. In this case, the maximum multi-year rate must be the manure rate receiving a P Index Value below 100.

A Very High P Index Rating indicates a very high risk of P loss and no P from any source can be applied. Even if P is not applied, management practices, such as soil conservation practices, should be evaluated to ensure P is not lost from the field. As with the High category, changing management practices such as manure rate, timing or method of application may reduce the P Index Value allowing some P application.

At a High or Very High P Index Rating, the planner should go back to the individual P Index factors to determine why the field received a High or Very High Rating. This information can be used to guide management changes that may reduce P loss risk to surface water. For example, a High Manure Rating may be reduced by changing the time or method of manure application. A high erosion factor may be reduced by implementing conservation practices. Thus, the final plan for a field with a High or Very High P Index Rating will likely result from an iterative process of changing planned management and re-evaluating the field with P Index to ensure final planned management is within limitations specified in Table 2.

**Table 2. Phosphorus index management guidance.**

Value	Rating	Management Guidance
0 to 59	Low	<b>Nutrients can be applied to meet the Nitrogen crop requirement.</b> <i>Low</i> potential for P loss. Maintenance of current farming practices is recommended to minimize the risk of adverse impacts on surface waters.
60 to 79	Medium	<b>Nutrients can be applied to meet the Nitrogen crop requirement.</b> <i>Medium</i> potential for P loss. The chance for adverse impacts on surface waters exists. An assessment of current farm nutrient management and conservation practices is recommended to minimize the risk of future P losses.
80 to 99	High	<b>Nutrients can be applied to meet the Phosphorus crop removal.</b> <i>High</i> potential for P loss and adverse impacts on surface waters. Soil and water conservation measures and P-balanced management plans are needed to minimize the risk of P loss.
100 or greater*	Very High	<ul style="list-style-type: none"> <li>• <b>No Phosphorus can be applied.</b> <i>Very high</i> potential for P loss and adverse impacts on surface waters. Conservation measures and management plan not allowing any phosphorus to be applied on these fields must be implemented to minimize the P loss.</li> <li>• <b>For pastures - Nutrients can be applied to meet the Phosphorus crop removal.</b> To allow this application to occur specific BMPs must be installed and other criteria must be met under the Act 38 regulations. See the Pasture Guidance section at the beginning this document and §83.294(j) of the Act 38 regulations.</li> </ul>

\* Refer to the section **Phosphorus Index transition guidance for crop management units or fields receiving a Very High P Index Rating** of this document to review phase-in nutrient management guidance for CMUs or fields receiving a Very High P Index Rating. This phase-in guidance was established through the Act 38 regulations and is effective until December 31, 2010.

To meet Pennsylvania nutrient management plan requirements, the P Index calculation for the final planned management on a CMU/field must be included as a part of the submitted nutrient management plan. The management reported in the plan must be consistent with the final P Index Value, associated P Index Rating and nutrient management recommendations. For example, if the final P Index Value has a High P Index Rating, the P applied in the plan must not exceed crop P removal. The initial and interim P Index calculations performed as part of the planning process are not required for plan submission and should not be included with the submitted nutrient management plan, as they may cause confusion for the farmer or the plan reviewer.

## **Example: Integrating the Phosphorus Index into a nutrient management plan using Pennsylvania's standard plan format**

For the following examples and associated scenarios, Pennsylvania's Standard Nutrient Management Plan Version 2.0 format is used. This Standard Plan format is available at <http://panutrientmgmt.cas.psu.edu> under Planning Tools and Resources.

Following is a step by step summary of the process for using the *Phosphorus Index* with the *Pennsylvania Standard Nutrient Management Plan format*. This is followed by three examples illustrating the process. When using the Nutrient Management Plan Spreadsheet Version 2.0 many of the calculations are automatically completed.

### Step 1: Appendix 4. Field Information and P Index Part A

Using Standard Plan Format Appendix 4, the first step of the planning process is to determine which fields will need to be evaluated using P Index Part B. This determination is made using Part A or the screening tool of the P Index and Appendix 4. Part A requires the user to determine if the field is in a special protection watershed, if there have been significant farm management changes, if the soil test P level for the field is greater than 200 ppm Mehlich 3 P or if the field is within 150 ft. from receiving water. If any of these criteria are met, the field may be a risk for P loss and may require management changes. Therefore, the field must be evaluated using P Index Part B. For additional information on P Index Part A, see the Part A: Screening Tool section of this document. In the following scenarios, the results of the Part A evaluation are included as "P Index Part A" in Appendix 4. Once the Part A evaluation is complete, begin N-based manure allocation.

### Step 2: Appendix 4. Determining Other Nutrient Contributions and Appendix 4. Calculating N-Balanced Manure Rate

During N-based manure allocation, fields identified as requiring P Index Part B evaluation must be carefully considered. Typically, a preliminary N-based manure allocation is made and this proposed allocation is evaluated by completing P Index Part B using the associated field information. If the Part B evaluation, results in a P Index Rating of Low or Medium, no changes are required and the proposed N-based management can be used on this field. However, if the P Index Rating is High or Very High the manure allocation, application rate, and/or application management must be modified according to P Index management guidance. All P Index Part B evaluations required by Part A, including all inputs, must be submitted as Appendix 5.

### Step 3: Appendix 4. Calculating P-Based Manure Rate for Fields Requiring Part B of the P Index

Before conducting the P Index Part B evaluation, the proposed manure application rate is entered into Appendix 4 and the associated amount of P applied in that manure application needs to be calculated in lb P<sub>2</sub>O<sub>5</sub>/A.

### Step 4: Pennsylvania P Index Version 2, Part B evaluation

After determining the proposed amount of P applied (lb P<sub>2</sub>O<sub>5</sub>/A), the lb P<sub>2</sub>O<sub>5</sub>/A and the associated field information are evaluated using P Index Part B.

### Step 5: Completing Appendix 4. Calculating P-Based Manure Rate for Fields Requiring Part B of the P Index

After determining the P Index Value and Rating and nutrient management recommendation for a field, Appendix 4 needs be completed for fields with High or Very High P Index Rating. For fields receiving a Low or Medium P Index Rating, Appendix 4 is complete with the information entered in Step 3 and no further calculations are needed in Appendix 4. Any field receiving a High P Index Rating is limited to nutrient applications from all sources based on crop P removal. On these fields, additional calculations must be performed to complete Appendix 4 because a P-based manure rate needs to be determined to satisfy the P Index recommendation and to determine the planned manure rate for the field.

#### Step 6: Appendix 4. Nutrients Applied in Manure and Balance and Supplemental Fertilizer and Final Nutrient Balance

This section of Appendix 4 summarizes the planned manure rates, additional fertilizer requirements and final nutrient balances. Note that in Appendix 4, there is a P Index Value category for each field requiring a P Index Part B evaluation. In addition to reporting the P Index Value in this category, the full Part B evaluation with all inputs must be submitted as Appendix 5.

#### Step 7: Appendix 5. Phosphorus Index

All P Index Part B evaluations must be included as Appendix 5. All source and transport factors as well as the final P Index Value must be reported.

### **Examples**

The following examples illustrate how to integrate the P Index into nutrient management plan development. The example, consisting of three scenarios and a summary section, will work through the Standard Plan Format: Appendix 4 and Appendix 5. In the three scenarios, information required for Appendix 4 and P Index Part B evaluations is provided. The appendices provided in the scenario section are viewed as “working” versions as there is information included that would not be submitted with the final nutrient management plan. In the scenario summary section, a final or “submitted” version of Appendix 4 and Appendix 5 is provided. The summary scenario information would be submitted as part of a nutrient management plan developed using the Standard Plan Format.

In *Scenario 1*, the Part B evaluation will show that the N-based plan is acceptable and only proper documentation is required. In *Scenario 2*, the Part B evaluation using an N-based rate results in a High P Index Rating. However, modifying the manure management by changing the timing of application lowers the P Index Value and Rating allowing for the application of nutrients at an N-based rate. Finally in *Scenario 3*, the Part B evaluation using an N-based rate results in a Very High P Index Rating. In this case, the only practical management option is to reduce the planned manure rate.

**Scenario 1: Field 13- Appendix 4. N Based Rate Acceptable (See step by step instructions below)**

<b>Crop Year(s)</b>	2009	<b>CMU/Field ID</b>	13		
<b>Acres</b>	2.9				
<b>Soil Test Report Date</b>	5/1/2008				
<b>Laboratory Name</b>	AASL				
<b>Soil Test Levels (Mehlich-3 P &amp; K)</b> (If soil test results are not in ppm show conversions in Appendix 10)	<b>ppm P</b>	<b>ppm K</b>	<b>pH</b>		
	256	100	6.2		
<b>P Index Part A</b> <ul style="list-style-type: none"> <li>No P Applied</li> <li>N-Based ("No" to all Part A Questions)</li> <li>Part B ("Yes" to any Part A Question)</li> </ul>	Part B				
<b>Crop</b>	Corn Silage				
<b>Planned Yield</b>	21 ton/A				
<b>Soil Test Recommendation (lb/A)</b>	<b>N</b>	<b>P<sub>2</sub>O<sub>5</sub></b>	<b>K<sub>2</sub>O</b>		
	150	0	0		
<b>Other Nutrients Applied (lb/A)</b> (Nutrients applied regardless of manure)	10	20	10		
<b>Manure History Description</b>	Manure applied 3 out last 5 years				
<b>Residual Manure N (lb/A)</b>	20				
<b>Legume History Description</b>	None				
<b>Residual Legume N (lb/A)</b>	0				
<b>Net Nutrients Required (lb/A)</b>	120	(20)	(10)		
<b>Manure Group &amp; Application Season</b>	Spring Dairy		Spring		
<b>Application Management</b> (Incorporation, cover crops, etc.)	None; Rain 5 to 7 days				
<b>Availability Factors</b> (Total N or NH <sub>4</sub> -N & Organic N)	<b>Total N</b>	<b>NH<sub>4</sub>-N</b>	<b>Org. N</b>		
	0.30	N/A	N/A		
<b>Available N (lb/ton or lb/1000 gal)</b>	8.4				
<b>N Balanced Manure Rate (ton or gal/A)</b>	14,286 gal/A				
<b>P Removal Balanced Manure Rate (ton or gal/A)</b> (If required by P Index)	<b>Net Crop P Removal (lb/A)</b>	<b>P Removal Balanced Manure Rate</b>			
	N/A	N/A			
<b>Planned Manure Rate (ton or gal/A)</b>	9000 gal/A				
<b>Manure Nutrients Applied at Planned Rate</b>	76	117	225		
<b>Nutrient Balance After Manure (lb/A)</b>	44	(137)	(235)		
<b>Supplemental Fertilizer (lb/A)</b>	40	0	0		
<b>Final Nutrient Balance (lb/A)</b>	4	(137)	(235)		
<b>Manure Utilized on CMU (tons or gallons)</b>	26,100 gallons				
<b>Notes</b>					

← STEP 1

← STEP 2

← STEP 3  
← STEP 4

## **Step by Step instructions for completing Appendix 4 for fields requiring Part B of the P Index**

Labels in the example above refer to the following steps.

### **Step 1: Appendix 4. Field Information and P Index Part A of the Standard Nutrient Management Plan format**

The Part A evaluation of Field 13, shown below in the Standard Nutrient Management Plan format, directed the planner to complete a Part B evaluation because the Mehlich 3 soil test exceeded 200 ppm P.

### **Step 2: Appendix 4. Determining Other Nutrient Contributions and Calculating N-Balanced Manure Rate of the Standard Nutrient Management Plan format**

Proposed N-based manure allocation information for Field 13 is shown in Appendix 4 below. Completion of this Appendix follows the standard procedure for determining a maximum N-based manure application rate for a field in a nutrient management plan. This is consistent with the information and reference materials provided in the Nutrient Plan Writing workshop and the Nutrient Management Program Technical Manual.

### **Step 3: Appendix 4. Determining a proposed planned manure rate**

The next step is to select a proposed manure rate based on the N calculations in Appendix 4. In this example, 9000 gal/A is selected. A higher rate could be selected, but the nutrient management regulations require split manure applications above 9000 gal/A.

### **Step 4: Appendix 4. Calculating P applied at the proposed application rate**

The proposed manure application rate of 9000 gal/A is then entered into Appendix 4 as shown above. Using the proposed manure application rate and the manure analysis value in lb P<sub>2</sub>O<sub>5</sub>/1000 gal., a proposed rate of P applied is calculated. For Field 13, based on the proposed manure rate of 9000 gal/A and a manure analysis of 13 lb P<sub>2</sub>O<sub>5</sub>/1000 gal., 117 lb P<sub>2</sub>O<sub>5</sub>/A will be applied. For more information on calculating P manure application rates, refer to the Manure Rate section

All of the information calculated up to this point is found in a typical N-based nutrient management plan. However, because Part A of the P Index directed the completion of a Part B evaluation, the proposed manure application rate must be evaluated using Part B of the Pennsylvania P Index.

**Pennsylvania P Index Version 2, Part B evaluation. Reported in Appendix 5 of the Standard Nutrient Management Plan Format**

PART B: SOURCE FACTORS						CMU/Field ID	13
SOIL TEST	Mehlich 3 Soil Test P (ppm P)						256
<b>Soil Test Rating = 0.20 * Mehlich 3 Soil Test P (ppm P)</b>							51
FERTILIZER P RATE	Fertilizer P (lb P <sub>2</sub> O <sub>5</sub> /acre)						20
FERTILIZER APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April to October	0.8 Incorporated >1 week or not incorporated following application in November to March	1.0 Surface applied to frozen or snow covered soil		0.2
<b>Fertilizer Rating = Fertilizer Rate x Fertilizer Application Method</b>							4
MANURE P RATE	Manure P (lb P <sub>2</sub> O <sub>5</sub> /acre)						117
MANURE APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April to October	0.8 Incorporated >1 week or not incorporated following application in November to March	1.0 Surface applied to frozen or snow covered soil		0.6
P SOURCE COEFFICIENT	Refer to: Test results for P Source Coefficient OR Book values from P Index Fact Sheet Table 1						0.8
<b>Manure Rating = Manure Rate x Manure Application Method x P Source Coefficient</b>							56
<b>Source Factor = Soil Test Rating + Fertilizer Rating + Manure Rating</b>							111
PART B: TRANSPORT FACTORS						CMU/Field ID	13
EROSION	Soil Loss (ton/acre/yr)						2
RUNOFF POTENTIAL	0 <i>Drainage Class is Excessively</i>	2 <i>Drainage Class is Somewhat Excessively</i>	4 <i>Drainage Class is Well/Moderately Well</i>	6 <i>Drainage Class is Somewhat Poorly</i>	8 <i>Drainage Class is Poorly/Very Poorly</i>		2
SUBSURFACE DRAINAGE	0 None		1 Random		2* Patterned		0
CONTRIBUTING DISTANCE	0 > 500 ft.	2 350 to 500 ft.	4 200 to 349 ft.	6 100 to 199 ft. OR <100 ft. with 35 ft. buffer	9 <sup>‡</sup> < 100 ft.		2
<b>Transport Sum = Erosion + Runoff Potential + Subsurface Drainage + Contributing Distance</b>							6
MODIFIED CONNECTIVITY	0.85 50 ft. Riparian Buffer APPLIES TO DIST < 100 FT		1.0 Grassed Waterway OR None		1.1 Direct Connection APPLIES TO DIST > 100 FT		1.0
<b>Transport Sum x Modified Connectivity/24</b>							0.25
<b>P Index Value = 2 x Source x Transport</b>							56

**Step 5**  
From Appendix 4  
"Other Nutrients Applied"

**Step 6**  
← From Appendix 4  
"Manure Nutrients Applied at Planned"  
← From Appendix 4  
"Application Mgmt." &  
"Manure Group"

**Step 7**  
Enter the Transport factors and calculate the final P Index value

\* OR rapid permeability soil near a stream

‡ "9" factor does not apply to fields receiving manure with a qualifying 35 ft. buffer.

### Step 5

Fertilizer information from the N-based plan is entered into the P Index. Any planned P fertilizer from the “Other Nutrients Applied” line in Appendix 4 is entered in the “Fertilizer P rate” line in the P Index. The method of application, which in this example is a starter fertilizer is selected from the choices in the “Fertilizer Application Method” line in the P Index. In this example this would be a “2”

### Step 6

Manure information from the N-based plan is entered into the P Index. Any planned P Manure from the “P applied at the planned rate” line in Appendix 4 is entered in the “Manure P rate” line in the P Index. The method of application, which in this example is a late spring application that is not incorporated is selected from the choices in the “Manure Application Method” line in the P Index. In this example this would be a “6”. The P source coefficient is also entered for the manure type.

### Step 7

The transport factors for the field are entered into the P Index and the final P Index value is calculated.

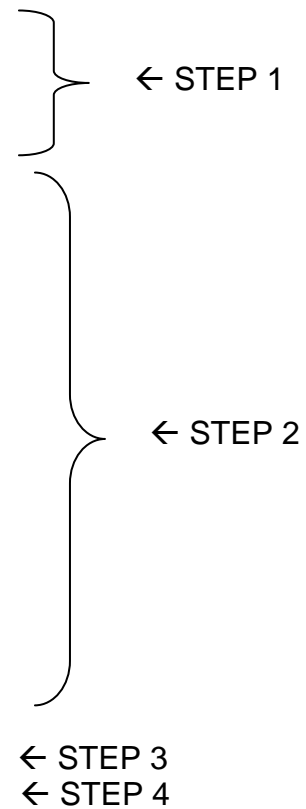
In this example, the evaluation resulted in a P Index Value of 56 which is a Low P Index Rating. The associated nutrient management guidance is “Nutrients can be applied to meet the Nitrogen crop requirement”. No change in the proposed manure rate for Field 13 is required; however, this determination must be properly documented. Proper documentation requires that the P Index Part B on the previous page with all inputs and final P Index Value be included as Appendix 5 of the Standard Nutrient Management Plan format.

The P Index Rating for Field 13 is Low and nutrients can be applied to the field using N-based rates. Therefore, it is not necessary to calculate a P-based manure application rate. For Field 13 and any other field receiving a Low or Medium P Index Rating, Appendix 4 is complete once the Manure Nutrients Applied at Planned Rate calculation is complete. Scenario 3 will provide an example of completing Appendix 4 when P-based rates need to be calculated.

After the planned manure rate has been selected and evaluated as needed in P Index Part B, Appendix 4 can be completed. This information is used to determine additional fertilizer need and calculate final nutrient balances. Note: Although the final planned manure application rate for Field 13 is N-based, a Part B evaluation was required. Therefore, P Index Part A and Part B inputs and the final P Index value must be submitted with Appendix 5.

**Scenario 2: Field 17- Appendix 4. Modifying management based on P Index outcome. (See step by step instructions below)**  
**- Proposed Management**

<b>Crop Year(s)</b>	2009	<b>CMU/Field ID</b>	17 (Proposed)		
<b>Acres</b>	6.8				
<b>Soil Test Report Date</b>	5/1/2008				
<b>Laboratory Name</b>	AASL				
<b>Soil Test Levels (Mehlich-3 P &amp; K)</b> (If soil test results are not in ppm show conversions in Appendix 10)	<b>ppm P</b>	<b>ppm K</b>	<b>pH</b>		
	211	95	6.1		
<b>P Index Part A</b> <ul style="list-style-type: none"> <li>No P Applied</li> <li>N-Based ("No" to all Part A Questions)</li> <li>Part B ("Yes" to any Part A Question)</li> </ul>	Part B				
<b>Crop</b>	Corn				
<b>Planned Yield</b>	125 bu/A				
<b>Soil Test Recommendation (lb/A)</b>	<b>N</b>	<b>P<sub>2</sub>O<sub>5</sub></b>	<b>K<sub>2</sub>O</b>		
	130	0	0		
<b>Other Nutrients Applied (lb/A)</b> (Nutrients applied regardless of manure)	10	20	10		
<b>Manure History Description</b>	Manure applied 3 out last 5 years				
<b>Residual Manure N (lb/A)</b>	20				
<b>Legume History Description</b>	None				
<b>Residual Legume N (lb/A)</b>	0				
<b>Net Nutrients Required (lb/A)</b>	120	(20)	(10)		
<b>Manure Group &amp; Application Season</b>	Fall Dairy	Late Fall			
<b>Application Management</b> (Incorporation, cover crops, etc.)	None; Rain 5 to 7 days				
<b>Availability Factors</b> (Total N or NH <sub>4</sub> -N & Organic N)	<b>Total N</b>	<b>NH<sub>4</sub>-N</b>	<b>Org. N</b>		
	0.20	N/A	N/A		
<b>Available N (lb/ton or lb/1000 gal)</b>	5.6				
<b>N Balanced Manure Rate (ton or gal/A)</b>	21,429				
<b>P Removal Balanced Manure Rate (ton or gal/A)</b> (If required by P Index)	<b>Net Crop P Removal (lb/A)</b>	<b>P Removal Manure Rate</b>			
	N/A	N/A			
<b>Planned Manure Rate (ton or gal/A)</b>	9000 gal/A				
<b>Manure Nutrients Applied at Planned Rate</b>	76	117	225		
<b>Nutrient Balance After Manure (lb/A)</b>					
<b>Supplemental Fertilizer (lb/A)</b>					
<b>Final Nutrient Balance (lb/A)</b>					
<b>Manure Utilized on CMU (tons or gallons)</b>					
<b>Notes</b>	Proposed Management				



## **Step by Step instructions for completing Appendix 4 for fields requiring Part B of the P Index**

Labels in the example above refer to the following steps.

### **Step 1: Appendix 4. Field Information and P Index Part A of the Standard Nutrient Management Plan format**

The Part A evaluation of Field 17, shown below in the Standard Nutrient Management Plan format, directed the planner to complete a Part B evaluation because the Mehlich 3 soil test exceeded 200 ppm P.

### **Step 2: Appendix 4. Determining Other Nutrient Contributions and Calculating N-Balanced Manure Rate of the Standard Nutrient Management Plan format**

Proposed N-based manure allocation information for Field 17 is shown in Appendix 4. Completion of this Appendix follows the standard procedure for determining a maximum N-based manure application rate for a field in a nutrient management plan. This is consistent with the information and reference materials provided in the Nutrient Plan Writing workshop and the Nutrient Management Program Technical Manual.

### **Step 3: Appendix 4. Determining a proposed planned manure rate**

The next step is to select a proposed manure rate based on the N calculations in Appendix 4. In this example, 9000 gal/A is selected. A higher rate could be selected, but the nutrient management regulations require split manure applications above 9000 gal/A.

### **Step 4: Appendix 4. Calculating P applied at the proposed application rate**

The proposed manure application rate of 9000 gal/A is then entered into Appendix 4 as shown above. Using the proposed manure application rate and the manure analysis value in lb P<sub>2</sub>O<sub>5</sub>/1000 gal., a proposed rate of P applied is calculated. For Field 17, based on the proposed manure rate of 9000 gal/A and a manure analysis of 13 lb P<sub>2</sub>O<sub>5</sub>/1000 gal., 117 lb P<sub>2</sub>O<sub>5</sub>/A will be applied. For more information on calculating P manure application rates, refer to the Manure Rate section of this document.

All of the information calculated up to this point is found in a typical N-based nutrient management plan. However, because Part A of the P Index directed the completion of a Part B evaluation, the proposed manure application rate must be evaluated using Part B of the Pennsylvania P Index.

**Pennsylvania P Index Version 2, Part B evaluation. Reported in Appendix 5 of the Standard Nutrient Management Plan Format**

PART B: SOURCE FACTORS						CMU/Field ID	17 Proposed <sup>†</sup>	17 Final
SOIL TEST	Mehlich 3 Soil Test P (ppm P)						211	211
<b>Soil Test Rating = 0.20 * Mehlich 3 Soil Test P (ppm P)</b>							42	42
FERTILIZER P RATE	Fertilizer P (lb P <sub>2</sub> O <sub>5</sub> /acre)						20	20
FERTILIZER APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April to October	0.8 Incorporated >1 week or not incorporated following application in November to March	1.0 Surface applied to frozen or snow covered soil		0.2	0.2
<b>Fertilizer Rating = Fertilizer Rate x Fertilizer Application Method</b>							4	4
MANURE P RATE	Manure P (lb P <sub>2</sub> O <sub>5</sub> /acre)						117	117
MANURE APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April to October	0.8 Incorporated >1 week or not incorporated following application in November to March	1.0 Surface applied to frozen or snow covered soil		0.8	<b>0.6</b>
P SOURCE COEFFICIENT	Refer to: Test results for P Source Coefficient OR Book values from P Index Fact Sheet Table 1						0.8	0.8
<b>Manure Rating = Manure Rate x Manure Application Method x P Source Coefficient</b>							75	56
<b>Source Factor = Soil Test Rating + Fertilizer Rating + Manure Rating</b>							121	102
PART B: TRANSPORT FACTORS						CMU/Field ID	17 – Prop.	17
EROSION	Soil Loss (ton/acre/yr)						3	3
RUNOFF POTENTIAL	0 <i>Drainage Class is Excessively</i>	2 <i>Drainage Class is Somewhat Excessively</i>	4 <i>Drainage Class is Well/Moderately Well</i>	6 <i>Drainage Class is Somewhat Poorly</i>	8 <i>Drainage Class is Poorly/Very Poorly</i>		4	4
SUBSURFACE DRAINAGE	0 None		1 Random		2* Patterned		0	0
CONTRIBUTING DISTANCE	0 > 500 ft.	2 350 to 500 ft.	4 200 to 349 ft.	6 100 to 199 ft. OR <100 ft. with 35 ft. buffer	9 <sup>‡</sup> < 100 ft.		2	2
<b>Transport Sum = Erosion + Runoff Potential + Subsurface Drainage + Contributing Distance</b>							9	9
MODIFIED CONNECTIVITY	0.85 50 ft. Riparian Buffer APPLIES TO DIST < 100 FT		1.0 Grassed Waterway OR None		1.1 Direct Connection APPLIES TO DIST > 100 FT		1.0	1.0
<b>Transport Sum x Modified Connectivity/24</b>							0.38	0.38
<b>P Index Value = 2 x Source x Transport</b>							92	78

<sup>†</sup> This column would not appear in the final plan.

\* OR rapid permeability soil near a stream

<sup>‡</sup> "9" factor does not apply to fields receiving manure with a qualifying 35 ft. buffer.

In this example, the original plan information is entered in the column labeled “17 Proposed” above.

#### Step 5

Fertilizer information from the N-based plan is entered into the P Index. Any planned P fertilizer from the “Other Nutrients Applied line in Appendix 4 is entered in the “Fertilizer P rate” line in the P Index. The method of application, which in this example is a starter fertilizer is selected from the choices in the “Fertilizer Application Method” line in the P Index. In this example this would be a “2”

#### Step 6

Manure information from the proposed N-based plan is entered into the P Index. Any planned P Manure from the “P applied at the planned rate” line in Appendix 4 is entered in the “Manure P rate” line in the P Index. The method of application, which in this example is a Late Fall application that is not incorporated is selected from the choices in the “Manure Application Method” line in the P Index. In this example this would be a “8”. The P source coefficient is also entered for the manure type.

#### Step 7

The transport factors for the field are entered into the P Index and the final P Index value is calculated.

In this example, the evaluation resulted in a P Index Value of 92 which is a High P Index Rating. The associated nutrient management guidance is “Nutrients can be applied to meet the Phosphorus crop removal.”. Therefore, the N based rate cannot be use as planned and a management change is required for this field.

#### Modifying the plan based on the P Index outcome

In this example, the modified plan is shown in the column labeled “17 (Final)” above. In a real plan only the final modified plan information would be shown in Appendix 4 and Appendix 5.

The planner noted a planned late fall application of liquid dairy manure. A possible management option is to change the season of application and apply the manure in the spring. The second column in the Part B evaluation on the previous page, labeled Field 17 (Final), reflects this change. By changing the manure application to the spring, the factor for *Manure Application Method* is reduced from 0.8 to 0.6. Subsequently, the P Index Value is reduced to 78 (from the initial P Index Value of 92). A P Index Value of 78 has an associated Medium P Index Rating and allows for nutrient application at an N-based rate.

This management change would be need to be included in all appropriate appendices of the Standard Plan format including Appendix 4 as the season of manure application has changed. In this case, because of the change in spreading season, the Available N and the N Balanced Manure Rate have changed. Changes are shown in **bold** below. In making changes to manure

application method and timing, the Incorporation Factors and associated calculations may change and should be reviewed before finalizing the plan. In the submitted plan, only the final version of Appendix 4 for “Field 17 (Final)” below is included. In the submitted plan, do not include the proposed version of Appendix 4 shown earlier or any other interim calculations. Several approaches may be evaluated until a workable and practical option is found. Once finalized, the planned management must match the nutrient management plan, P Index inputs, calculated P Index Value, and P Index guidance provided for the field.

**Scenario 2: Field 17- Appendix 4. Modifying management based on P Index outcome.  
- Final Management**

Crop Year(s)	2009	CMU/Field ID	17 (Proposed)			17 (final)		
Acres	6.8			6.8				
Soil Test Report Date	5/1/2008			5/1/2008				
Laboratory Name	AASL			AASL				
Soil Test Levels (Mehlich-3 P & K) (If soil test results are not in ppm show conversions in Appendix 10)	ppm P	ppm K	pH	ppm P	ppm K	pH		
	211	95	6.1	211	95	6.1		
<b>P Index Part A</b> <ul style="list-style-type: none"> <li>No P Applied</li> <li>N-Based ("No" to all Part A Questions)</li> <li>Part B ("Yes" to any Part A Question)</li> </ul>	Part B			Part B				
Crop	Corn			Corn				
Planned Yield	125 bu/A			125 bu/A				
Soil Test Recommendation (lb/A)	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O		
	130	0	0	130	0	0		
Other Nutrients Applied (lb/A) (Nutrients applied regardless of manure)	10	20	10	10	20	10		
Manure History Description	Manure applied 3 out last 5 years			Manure applied 3 out last 5 years				
Residual Manure N (lb/A)	20			20				
Legume History Description	None			None				
Residual Legume N (lb/A)	0			0				
Net Nutrients Required (lb/A)	120	(20)	(10)	120	(20)	(10)		
Manure Group & Application Season	Fall Dairy	Late Fall		Spring Dairy	Spring			
Application Management (Incorporation, cover crops, etc.)	None; Rain 5 to 7 days			None; Rain 5 to 7 days				
Availability Factors (Total N or NH <sub>4</sub> -N & Organic N)	Total N	NH <sub>4</sub> -N	Org. N	Total N	NH <sub>4</sub> -N	Org. N		
	0.20	N/A	N/A	0.30	N/A	N/A		
Available N (lb/ton or lb/1000 gal)	5.6			8.4				
N Balanced Manure Rate (ton or gal/A)	21,429 gal/A			14,286 gal/A				
P Removal Balanced Manure Rate (ton or gal/A) (If required by P Index)	Net Crop P Removal (lb/A)	P Removal Balanced Manure Rate		Net Crop P Removal (lb/A)	P Removal Manure Rate			
	N/A	N/A		N/A	N/A			
Planned Manure Rate (ton or gal/A)	9000 gal/A			9000 gal/A				
Manure Nutrients Applied at Planned Rate	76	117	225	76	117	225		
Nutrient Balance After Manure (lb/A)				24	(137)	(235)		
Supplemental Fertilizer (lb/A)				20	0	0		
Final Nutrient Balance (lb/A)				4	(137)	(235)		
Manure Utilized on CMU (tons or gallons)				61,200 gallons				
Notes	This was the proposed management. Not shown in final plan.			PI Value near 80. Future NMP may need P-based rates.				

Scenario 3: Field 21- Appendix 4. Modifying manure rate based on P Index outcome. (See step by step instructions below)

<b>Crop Year(s)</b>	2009	<b>CMU/Field ID</b>	21 (Proposed)		
<b>Acres</b>	8				
<b>Soil Test Report Date</b>	5/1/2008				
<b>Laboratory Name</b>	AASL				
<b>Soil Test Levels (Mehlich-3 P &amp; K)</b> (If soil test results are not in ppm show conversions in Appendix 10)	<b>ppm P</b>	<b>ppm K</b>	<b>pH</b>		
	195	105	6.0		
<b>P Index Part A</b> <ul style="list-style-type: none"> <li>No P Applied</li> <li>N-Based ("No" to all Part A Questions)</li> <li>Part B ("Yes" to any Part A Question)</li> </ul>	Part B				
<b>Crop</b>	Corn				
<b>Planned Yield</b>	125 bu/A				
<b>Soil Test Recommendation (lb/A)</b>	<b>N</b>	<b>P<sub>2</sub>O<sub>5</sub></b>	<b>K<sub>2</sub>O</b>		
	130	0	0		
<b>Other Nutrients Applied (lb/A)</b> (Nutrients applied regardless of manure)	10	20	10		
<b>Manure History Description</b>	Manure applied 3 out last 5 years				
<b>Residual Manure N (lb/A)</b>	20				
<b>Legume History Description</b>	None				
<b>Residual Legume N (lb/A)</b>	0				
<b>Net Nutrients Required (lb/A)</b>	100	(20)	(10)		
<b>Manure Group &amp; Application Season</b>	Spring Dairy	Spring			
<b>Application Management</b> (Incorporation, cover crops, etc.)	None; Rain 5 to 7 days				
<b>Availability Factors</b> (Total N or NH <sub>4</sub> -N & Organic N)	<b>Total N</b>	<b>NH<sub>4</sub>-N</b>	<b>Org. N</b>		
	0.30	N/A	N/A		
<b>Available N (lb/ton or lb/1000 gal)</b>	8.4				
<b>N Balanced Manure Rate (ton or gal/A)</b>	11,905				
<b>P Removal Balanced Manure Rate (ton or gal/A)</b> (If required by P Index)	<b>Net Crop P Removal (lb/A)</b>	<b>P Removal Manure Rate</b>			
	N/A	N/A			
<b>Planned Manure Rate (ton or gal/A)</b>	9000 gal/A				
<b>Manure Nutrients Applied at Planned Rate</b>	76	117	225		
<b>Nutrient Balance After Manure (lb/A)</b>					
<b>Supplemental Fertilizer (lb/A)</b>					
<b>Final Nutrient Balance (lb/A)</b>					
<b>Manure Utilized on CMU (tons or gallons)</b>					
<b>Notes</b>	Proposed Management				

← STEP 1

← STEP 2

← STEP 3

← STEP 4

## **Step by Step instructions for completing Appendix 4 for fields requiring Part B of the P Index**

Labels in the example above refer to the following steps.

### **Step 1: Appendix 4. Field Information and P Index Part A of the Standard Nutrient Management Plan format**

The Part A evaluation of Field 21, shown below in the Standard Nutrient Management Plan format, directed the planner to complete a Part B evaluation because the Mehlich 3 soil test exceeded 200 ppm P.

### **Step 2: Appendix 4. Determining Other Nutrient Contributions and Calculating N-Balanced Manure Rate of the Standard Nutrient Management Plan format**

Proposed N-based manure allocation information for Field 21 is shown in Appendix 4. Completion of this Appendix follows the standard procedure for determining a maximum N-based manure application rate for a field in a nutrient management plan. This is consistent with the information and reference materials provided in the Nutrient Plan Writing workshop and the Nutrient Management Program Technical Manual.

### **Step 3: Appendix 4. Determining a proposed planned manure rate**

The next step is to select a proposed manure rate based on the N calculations in Appendix 4. In this example, 9000 gal/A is selected. A higher rate could be selected, but the nutrient management regulations require split manure applications above 9000 gal/A.

### **Step 4: Appendix 4. Calculating P applied at the proposed application rate**

The proposed manure application rate of 9000 gal/A is then entered into Appendix 4 as shown above. Using the proposed manure application rate and the manure analysis value in lb P<sub>2</sub>O<sub>5</sub>/1000 gal., a proposed rate of P applied is calculated. For Field 21, based on the proposed manure rate of 9000 gal/A and a manure analysis of 13 lb P<sub>2</sub>O<sub>5</sub>/1000 gal., 117 lb P<sub>2</sub>O<sub>5</sub>/A will be applied. For more information on calculating P manure application rates, refer to the Manure Rate section of this document.

All of the information calculated up to this point is found in a typical N-based nutrient management plan. However, because Part A of the P Index directed the completion of a Part B evaluation, the proposed manure application rate must be evaluated using Part B of the Pennsylvania P Index.

**Pennsylvania P Index Version 2, Part B evaluation. Reported in Appendix 5 of the Standard Nutrient Management Plan Format**

PART B: SOURCE FACTORS						CMU/Field ID	21-1 <sup>†</sup>	21-2 <sup>†</sup>	21-3
SOIL TEST	Mehlich 3 Soil Test P (ppm P)						195	195	195
<b>Soil Test Rating = 0.20 * Mehlich 3 Soil Test P (ppm P)</b>							39	39	39
FERTILIZER P RATE	Fertilizer P (lb P <sub>2</sub> O <sub>5</sub> /acre)						20	20	0
FERTILIZER APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April to October	0.8 Incorporated >1 week or not incorporated following application in November to March	1.0 Surface applied to frozen or snow covered soil		0.2	0.2	0
<b>Fertilizer Rating = Fertilizer Rate x Fertilizer Application Method</b>							4	4	0
MANURE P RATE	Manure P (lb P <sub>2</sub> O <sub>5</sub> /acre)						117	26	46
MANURE APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April to October	0.8 Incorporated >1 week or not incorporated following application in November to March	1.0 Surface applied to frozen or snow covered soil		0.6	0.6	0.6
P SOURCE COEFFICIENT	Refer to: Test results for P Source Coefficient OR Book values from P Index Fact Sheet Table 1						0.8	0.8	0.8
<b>Manure Rating = Manure Rate x Manure Application Method x P Source Coefficient</b>							56	13	22
<b>Source Factor = Soil Test Rating + Fertilizer Rating + Manure Rating</b>							99	56	61
PART B: TRANSPORT FACTORS						CMU/Field ID	21-1 <sup>†</sup>	21-2 <sup>†</sup>	21-3
EROSION	Soil Loss (ton/acre/yr)						4	4	4
RUNOFF POTENTIAL	0 <i>Drainage Class is Excessively</i>	2 <i>Drainage Class is Somewhat Excessively</i>	4 <i>Drainage Class is Well/Moderately Well</i>	6 <i>Drainage Class is Somewhat Poorly</i>	8 <i>Drainage Class is Poorly/Very Poorly</i>		6	6	6
SUBSURFACE DRAINAGE	0 None		1 Random		2* Patterned		0	0	0
CONTRIBUTING DISTANCE	0 > 500 ft.	2 350 to 500 ft.	4 200 to 349 ft.	6 100 to 199 ft. OR <100 ft. with 35 ft. buffer	9 <sup>‡</sup> < 100 ft.		6	6	6
<b>Transport Sum = Erosion + Runoff Potential + Subsurface Drainage + Contributing Distance</b>							16	16	16
MODIFIED CONNECTIVITY	0.85 50 ft. Riparian Buffer APPLIES TO DIST < 100 FT		1.0 Grassed Waterway OR None		1.1 Direct Connection APPLIES TO DIST > 100 FT		1.0	1.0	1.0
<b>Transport Sum x Modified Connectivity/24</b>							0.67	0.67	0.67
<b>P Index Value = 2 x Source x Transport</b>							133	75	82

<sup>†</sup> This column would not appear in the final plan

\* OR rapid permeability soil near a stream

<sup>‡</sup> "9" factor does not apply to fields receiving manure with a qualifying 35 ft. buffer.

In this example, the original plan information is entered in the column labeled “2-1” above.

#### Step 5

Fertilizer information from the N-based plan is entered into the P Index. Any planned P fertilizer from the “Other Nutrients Applied” line in Appendix 4 is entered in the “Fertilizer P rate” line in the P Index. The method of application, which in this example is a starter fertilizer is selected from the choices in the “Fertilizer Application Method” line in the P Index. In this example this would be a “2”

#### Step 6

Manure information from the proposed N-based plan is entered into the P Index. Any planned P Manure from the “P applied at the planned rate” line in Appendix 4 is entered in the “Manure P rate” line in the P Index. The method of application, which in this example is a Spring application that is not incorporated is selected from the choices in the “Manure Application Method” line in the P Index. In this example this would be a “6”. The P source coefficient is also entered for the manure type.

#### Step 7

The transport factors for the field are entered into the P Index and the final P Index value is calculated.

In this example, the evaluation resulted in a P Index Value of 133 which is a Very High P Index Rating. The associated nutrient management guidance is “No Phosphorus can be applied.”. Therefore, the N based rate cannot be used as planned and a management change is required for this field. In this case, the only practical management option is a reduction in the manure application rate. Other possible management changes that may have lowered the P Index Value and corresponding P Index Rating such as injecting or immediately incorporating the manure were not practical for this farmer.

### **Modifying the plan based on the P Index outcome**

All P must be included in the calculation of the crop P removal rate. This includes the manure P and any fertilizer P that is applied. The crop P removal is determined by multiplying the expected crop yield (125 bu/A in this example) and the removal per unit of yield (0.4 lb P<sub>2</sub>O<sub>5</sub>/bu from the Agronomy Guide Table 1.2-9 in this example). The total crop P removal in this example is 50 lb P<sub>2</sub>O<sub>5</sub>/A (125 bu/A x 0.4 lb P<sub>2</sub>O<sub>5</sub>/bu).

Starter Fertilizer In Appendix 4 the line labeled “Other Nutrients Applied” indicates that a starter fertilizer application containing 20 lb P<sub>2</sub>O<sub>5</sub>/A is planned for this field. This starter fertilizer P must be deducted from the total crop P removal (50 lb P<sub>2</sub>O<sub>5</sub>/A). This results in a net crop P removal of 30 lb P<sub>2</sub>O<sub>5</sub>/A (50 lb P<sub>2</sub>O<sub>5</sub>/A - 20 lb P<sub>2</sub>O<sub>5</sub>/A) that can be supplied by manure.

### P Removal Manure Rate

The manure analysis is 13 lb P<sub>2</sub>O<sub>5</sub>/1000 gal and the P balanced manure rate is 2308 gal/A (30 lb P<sub>2</sub>O<sub>5</sub>/A ÷ 13 lb P<sub>2</sub>O<sub>5</sub>/1000 gal = 2308 gal/A). Based on this calculation a new planned rate is selected. In this example, 2000 gal/A is selected as the planned rate. At this rate of manure application, 26 lb P<sub>2</sub>O<sub>5</sub>/A (2000 gal/A x 13 lb P<sub>2</sub>O<sub>5</sub>/1000 gal) is supplied by the manure.

### Rerun the P Index with the change in management

The amount of manure P calculated above (26 lb P<sub>2</sub>O<sub>5</sub>/A) must now be entered into the P Index for a new evaluation. This is the column labeled 21-2 in the P Index above. The new P Index Value calculated using this P-based rate is 75 which corresponds to a Medium P Index Rating. This would be an acceptable management plan.

A concern is that the 2000 gal/A rate is very low and may not be practical. An alternative may be eliminating the starter fertilizer P. This would increase the amount of manure applied at the crop P removal rate. Appendix 4 below was revised to reflect this change. Now the P Removal Manure rate is 3846 gal/A. The planner chose a planned manure rate of 3500 gal/A which will apply 46 lb P<sub>2</sub>O<sub>5</sub>/A.

This change must now be made in the P Index. The starter P needs to be eliminated and the Manure P Rate changed to 46 lb P<sub>2</sub>O<sub>5</sub>/A. This is the column labeled 21-3 in the P Index above. The resulting P Index Value is 82 which corresponds to a High P Index Rating. However, because the planned rate of 3500 gal/A is less than the crop P removal rate without starter of 3846 gal/A, this is acceptable management and is more practical than the 2000 gal/A rate. The soil test level is very high; therefore, there is minimal agronomic risk associated with the elimination of the starter fertilizer P application.

**Scenario 3: Field 21- Appendix 4. Modifying management based on P Index outcome. (See step by step instructions below)**

Crop Year(s)	2009	CMU/Field ID	21-2			21-3		
Acres	8			6.8				
Soil Test Report Date	5/1/2008			5/1/2008				
Laboratory Name	AASL			AASL				
Soil Test Levels (Mehlich-3 P & K) (If soil test results are not in ppm show conversions in Appendix 10)	ppm P	ppm K	pH	ppm P	ppm K	pH		
	195	105	6.0	211	95	6.1		
P Index Part A • No P Applied • N-Based ("No" to all Part A Questions) • Part B ("Yes" to any Part A Question)	Part B			Part B				
Crop	Corn			Corn				
Planned Yield	125 bu/A			125 bu/A				
Soil Test Recommendation (lb/A)	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O		
	130	0	0	130	0	0		
Other Nutrients Applied (lb/A) (Nutrients applied regardless of manure)	10	20	10					
Manure History Description	Manure applied 3 out last 5 years			Manure applied 3 out last 5 years				
Residual Manure N (lb/A)	20			20				
Legume History Description	None			None				
Residual Legume N (lb/A)	0			0				
Net Nutrients Required (lb/A)	100	(20)	(10)	110	(20)	(10)		
Manure Group & Application Season	Spring Dairy	Spring		Spring Dairy	Spring			
Application Management (Incorporation, cover crops, etc.)	None; Rain 5 to 7 days			None; Rain 5 to 7 days				
Availability Factors (Total N or NH <sub>4</sub> -N & Organic N)	Total N	NH <sub>4</sub> -N	Org. N	Total N	NH <sub>4</sub> -N	Org. N		
	0.30	N/A	N/A	0.30	N/A	N/A		
Available N (lb/ton or lb/1000 gal)	8.4			8.4				
N Balanced Manure Rate (ton or gal/A)	11,905 gal/A			13,095 gal/A				
P Removal Balanced Manure Rate (ton or gal/A) (If required by P Index)	Net Crop P Removal (lb/A)	P Removal Balanced Manure Rate		Net Crop P Removal (lb/A)	P Removal Manure Rate			
	30	2,308 gal/A		50	3,846 gal/A			
Planned Manure Rate (ton or gal/A)	2000 gal/A			3500 gal/A				
Manure Nutrients Applied at Planned Rate	17	26	50	29	46	88		
Nutrient Balance After Manure (lb/A)				81	(46)	(88)		
Supplemental Fertilizer (lb/A)				80	0	0		
Final Nutrient Balance (lb/A)				1	(46)	(88)		
Manure Utilized on CMU (tons or gallons)				28,000 gallons				
Notes	This was rejected because the rate of 2000 gal/A was not practical			With the starter removed a more practical rate of 3500 gal/A was planned.				

Modifying the Plan  
← Remove Starter P

Modifying the Plan  
← P Removal Rate Calculation  
Modifying the Plan  
← Revised P based planned rate

### **Calculating Maximum P-Based Manure Rate for Fields Requiring Part B of the P Index**

If the farmer did not want to eliminate starter fertilizer, there is an option that may allow a higher manure application rate than 2308 gal/A (the maximum crop P removal manure rate with starter fertilizer application). Since the P Index Value at the planned rate of 2000 gal/A was 75, this would indicate that a manure rate greater than crop P removal could be applied as long as the resulting P Index Value did not equal or exceed 80. Once the P Index Value equals or exceeds 80, the manure rate is limited to crop P removal. To determine this manure rate, calculate a manure rate resulting in a P Index Value of 79. This manure rate would be greater than the crop P removal manure rate, but would be acceptable management. In the P Index spreadsheet version, this calculation is provided. In this example with the starter fertilizer application, the manure rate that would result in a P Index Value of 79 is 2604 gal/A. This is not a large increase over the crop P removal manure rate, but it does allow a slightly higher manure rate to be used with a starter fertilizer application. The manure rate increase using this approach will vary and can be much greater than in this example.

The final management decisions need to be included in all appropriate appendices of the Standard Plan format including Appendices 6 II and 6 III. In this example, changing the manure rate would require adding the P removal rate calculation and changing the planned rate accordingly. If the starter fertilizer application was eliminated, Appendix 4 would need to be revised to reflect the change in net nutrients required and the N balanced rate. Even though the N based rate is not used for this field the correct N balanced rate for the scenario must be calculated and included in Appendix 4 to document that there would be no excess N applied. In the submitted plan, only include the version of Appendix 4 that matches the final planned management. Both final and interim versions of Appendix 4 are included here to illustrate the impact of management changes.

### **Scenario Summary: Fields 13, 17, and 21**

Based on the three scenarios and the final management decisions, the following represents Appendix 4 and Appendix 5 submitted with the nutrient management plan using the Standard Plan format.

Appendix 4. Fields 13, 17, and 21 Final Appendix 4 as would be submitted

Crop Year(s)	2009	CMU/Field ID	13			17			21		
Acres			2.9			6.8			8		
Soil Test Report Date			5/1/2008			5/1/2008			5/1/2008		
Laboratory Name			AASL			AASL			AASL		
Soil Test Levels (Mehlich-3 P & K) (If soil test results are not in ppm show conversions in Appendix 10)	ppm P	ppm K	pH	ppm P	ppm K	pH	ppm P	ppm K	pH		
	256	100	6.2	211	95	6.1	195	105	6.0		
P Index Part A • No P Applied • N-Based ("No" to all Part A Questions) • Part B ("Yes" to any Part A Question)	Part B			Part B			Part B				
Crop	Corn Silage			Corn			Corn				
Planned Yield	21 ton/A			125 bu/A			125 bu/A				
Soil Test Recommendation (lb/A)	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O		
	150	0	0	130	0	0	130	0	0		
Other Nutrients Applied (lb/A) (Nutrients applied regardless of manure)	10	20	10	10	20	10	0	0	0		
Manure History Description	Manure applied 3 out last 5 years			Manure applied 3 out last 5 years			Manure applied 3 out last 5 years				
Residual Manure N (lb/A)	20			20			20				
Legume History Description	None			None			None				
Residual Legume N (lb/A)	0			0			0				
Net Nutrients Required (lb/A)	120	(20)	(10)	120	(20)	(10)	110	0	0		
Manure Group & Application Season	Spring Dairy	Spring		Spring Dairy	Spring		Spring Dairy	Spring			
Application Management (Incorporation, cover crops, etc.)	None; Rain 5 to 7 days			None; Rain 5 to 7 days			None; Rain 5 to 7 days				
Availability Factors (Total N or NH <sub>4</sub> -N & Organic N)	Total N	NH <sub>4</sub> -N	Org. N	Total N	NH <sub>4</sub> -N	Org. N	Total N	NH <sub>4</sub> -N	Org. N		
	0.30	N/A	N/A	0.30	N/A	N/A	0.30	N/A	N/A		
Available N (lb/ton or lb/1000 gal)	8.4			8.4			8.4				
N Balanced Manure Rate (ton or gal/A)	14,286 gal/A			17,857 gal/A			13,095 gal/A				
P Removal Balanced Manure Rate (ton or gal/A) (If required by P Index)	Net Crop P Removal (lb/A)	P Removal Balanced Manure Rate		Net Crop P Removal (lb/A)	P Removal Manure Rate		Net Crop P Removal (lb/A)	P Removal Manure Rate			
	N/A	N/A		N/A	N/A		N/A	N/A			
Planned Manure Rate (ton or gal/A)	9000 gal/A			9000 gal/A			3500 gal/A				
Manure Nutrients Applied at Planned Rate	76	117	225	76	117	225	29	46	88		
Nutrient Balance After Manure (lb/A)	44	(137)	(235)	24	(137)	(235)	81	(46)	(88)		
Supplemental Fertilizer (lb/A)	40	0	0	20	0	0	80	0	0		
Final Nutrient Balance (lb/A)	4	(137)	(235)	4	(137)	(235)	1	(46)	(88)		
Manure Utilized on CMU (tons or gallons)	26,100 gallons			61,200 gallons			28,000 gal				
Notes				PI Value near 80. Future NMP may need P-based rates.			Manure rate restricted due to P concerns.				

**Appendix 5. Fields 13, 17, and 21 Final P Index as would be submitted**

PART B: SOURCE FACTORS						CMU/Field ID	13	17	21
SOIL TEST	Mehlich 3 Soil Test P (ppm P)						256	211	195
<b>Soil Test Rating = 0.20 * Mehlich 3 Soil Test P (ppm P)</b>							51	42	39
FERTILIZER P RATE	Fertilizer P (lb P <sub>2</sub> O <sub>5</sub> /acre)						20	20	0
FERTILIZER APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April to October	0.8 Incorporated >1 week or not incorporated following application in November to March	1.0 Surface applied to frozen or snow covered soil		0.2	0.2	0
<b>Fertilizer Rating = Fertilizer Rate x Fertilizer Application Method</b>							4	4	0
MANURE P RATE	Manure P (lb P <sub>2</sub> O <sub>5</sub> /acre)						117	117	46
MANURE APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated <1 week following application	0.6 Incorporated > 1 week or not incorporated following application in April to October	0.8 Incorporated >1 week or not incorporated following application in November to March	1.0 Surface applied to frozen or snow covered soil		0.6	0.6	0.6
P SOURCE COEFFICIENT	Refer to: Test results for P Source Coefficient OR Book values from P Index Fact Sheet Table 1						0.8	0.8	0.8
<b>Manure Rating = Manure Rate x Manure Application Method x P Source Coefficient</b>							56	56	22
<b>Source Factor = Soil Test Rating + Fertilizer Rating + Manure Rating</b>							111	102	61
PART B: TRANSPORT FACTORS						CMU/Field ID	13	17	21
EROSION	Soil Loss (ton/acre/yr)						2	3	4
RUNOFF POTENTIAL	0 <i>Drainage Class is Excessively</i>	2 <i>Drainage Class is Somewhat Excessively</i>	4 <i>Drainage Class is Well/Moderately Well</i>	6 <i>Drainage Class is Somewhat Poorly</i>	8 <i>Drainage Class is Poorly/Very Poorly</i>		2	4	6
SUBSURFACE DRAINAGE	0 None		1 Random		2* Patterned		0	0	0
CONTRIBUTING DISTANCE	0 > 500 ft.	2 350 to 500 ft.	4 200 to 349 ft.	6 100 to 199 ft. OR <100 ft. with 35 ft. buffer	9 <sup>‡</sup> < 100 ft.		2	2	6
<b>Transport Sum = Erosion + Runoff Potential + Subsurface Drainage + Contributing Distance</b>							6	9	16
MODIFIED CONNECTIVITY	0.85 50 ft. Riparian Buffer APPLIES TO DIST < 100 FT		1.0 Grassed Waterway OR None		1.1 Direct Connection APPLIES TO DIST > 100 FT		1.0	1.0	1.0
<b>Transport Sum x Modified Connectivity/24</b>							0.25	0.38	0.67
<b>P Index Value = 2 x Source x Transport</b>							56	78	82

\* OR rapid permeability soil near a stream

‡ "9" factor does not apply to fields receiving manure with a qualifying 35 ft. buffer.

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