UNIVERSITY OF MARYLAND EXTENSION
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# Soil Fertility Guide

Mo Ca Cu P S Fe K Zn Co N B Mg Mn Cl

P-3

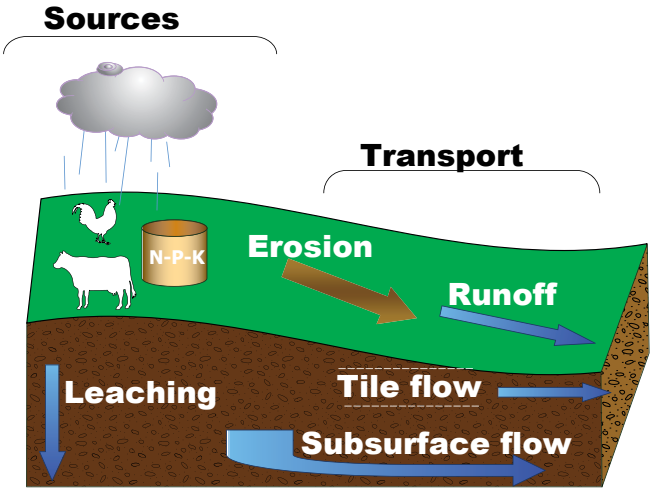
## PHOSPHORUS SITE INDEX

**Introduction**

Phosphorus (P) is an essential nutrient required for healthy plant growth and crop production. However, too much P can be transported to water bodies and may lead to environmental problems such as eutrophication. Eutrophication is a process in which significant amounts of nutrients in a water body, such as the Chesapeake Bay, stimulate excessive algae growth. When these algae die, their decomposition depletes the water of dissolved oxygen, causing other aquatic life such as fish and oysters to die.

Phosphorus from cropland becomes an environmental problem when two conditions exist (see Figure 1 below):

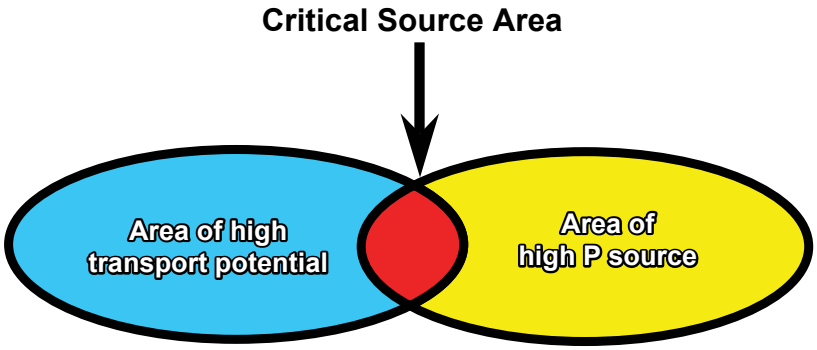
1. a large source of P is present in the soil or in nutrient-bearing material applied to the soil surface and
2. a pathway exists to transport P from the soil to surface water through processes such as erosion, runoff, and/or leaching.




Modified from Sharpley & Gburek, USDA-ARS (used with permission)

Figure 1. Various sources and transport pathways of phosphorus

An area where these two conditions exist simultaneously is known as the critical source area (see Figure 2 below).




**Used with permission from Andrew Sharpley, USDA-ARS**

Figure 2. Critical source area concept

The Phosphorus Site Index (PSI) is a tool that can be used to help identify critical source areas on a farm. During the process, this tool will determine the level of P movement from the site and provide recommendations on management implications to minimize the risk of phosphorus losses. The PSI is broken into two parts:

- **Part A** – Site and Transport Characteristics
- **Part B** – Source and Management Characteristics

## Part A – Site and Transport Characteristics

Part A of the PSI evaluates the phosphorus loss potential due to six site and transport characteristics.

Table 1 on page 3 presents the six site and transport characteristics, the information needed to determine a value for those characteristics and how that value is represented.

Table 1. Site and transport characteristics

| Site/Transport Characteristics | Information Needed | Represented As… |
|---|---|---|
| soil erosion | • precipitation<br>• percent slope and slope length<br>• crop rotation<br>• conservation practices<br>• soil conditions | a value calculated using the Revised Universal Soil Loss Equation (RUSLE) |
| soil runoff class | • percent slope<br>• soil permeability class | a value from 0 – 8* |
| subsurface drainage | • depth to seasonal high water table<br>• soil drainage class | a value from 0 – 8* |
| leaching potential | • depth to seasonal high water table<br>• Maryland NRCS leaching value | a value from 0 – 4* |
| priority of receiving water | • determined by the category in which the watershed is listed as determined in the Maryland Clean Water Action Plan | a value from 0 – 4* |
| distance from edge of field to surface water | • vegetated buffer width<br>• distance from the edge of the cropping area to surface water | a value from 0 – 8* |

* These values can be found using look-up tables in *SFM-7, The Maryland Phosphorus Site Index Technical Users Guide*.

## Calculating Part A

Follow the steps in Table 2 below to calculate Part A of the PSI.

Table 2. Calculating the Total Site and Transport Value

| Step | Action |
|---|---|
| 1 | Add together all six numerical values from Part A. |
| 2 | Multiply the sum of the six values by a scaling factor of 0.02.<br><br>***Result:*** This number equals the Total Site and Transport Value. |

**Part B – Management and Source Characteristics**

Part B of the PSI evaluates the phosphorus loss potential due to five farm management practices and P source characteristics.

Table 3 below presents the five management and source characteristics, the information needed to determine a value for those characteristics and how that value is represented.

Table 3. Management and source characteristics

| Management and Source Characteristics | Information Needed | Represented As… |
|---|---|---|
| soil test P level | • the soil test P level which has been converted to the University of Maryland's Fertility Index Value (FIV) | a calculated value obtained by multiplying the FIV-P number by a factor of 0.2 |
| P fertilizer application rate | • planned P fertilizer application rate (expressed as lbs $P_2O_5$/acre) | a calculated value obtained by multiplying the P fertilizer application rate by a factor of 0.6 |
| P fertilizer application method and timing | • application method used (e.g., banded, injected, surface applied)<br>• timing of application | a value from 0 – 60* |
| organic P application rate | • planned rate of P application from manure or other organic sources (expressed as lbs $P_2O_5$/acre) | a calculated value obtained by multiplying the organic source P application rate by the Phosphorus Source Coefficient (PSC) |
| organic P application method and timing | • application method used (e.g., injected, surface applied)<br>• timing of application | a value from 0 – 60* |

* These values can be found using look-up tables in *SFM-7, The Maryland Phosphorus Site Index Technical Users Guide*.

**Calculating Part B**

Follow the step in Table 4 below to calculate Part B of the PSI.

Table 4. Calculating the Total Management and Source Value

| Step | Action |
|---|---|
| 1 | Add together all five numerical values from Part B.<br><br>***Result:*** This number equals the Total Management and Source Value. |

**Tying It All Together – Calculating the P Loss Rating**

The P Loss Rating indicates the potential risk of phosphorus movement from a particular field.

Follow the step in Table 5 below to calculate the P Loss Rating.

Table 5. Calculating the P Loss Rating

| Step | Action |
|---|---|
| 1 | Multiply the Total Site and Transport Value (from Part A) by the Total Management and Source Value (from Part B).<br><br>***Result:*** This number equals the P Loss Rating. (It does not represent actual pounds of P loss.) |

**Interpreting the P Loss Rating**

The P Loss Rating indicates if the field in question is a critical source area. The P Loss Rating falls into one of four interpretive categories: LOW, MEDIUM, HIGH and VERY HIGH.

Table 6 on page 6 presents the four ranges of P Loss Ratings, the interpretive category for each range and the management implications for each range.

Table 6. Interpreting the P Loss Rating

| P Loss Rating | Category | Management Implication |
|---|---|---|
| **0 – 50** | **LOW** potential for P movement from this site given current management practices and site characteristics. | • N-based nutrient recommendations are acceptable for this site.<br>• Soil P levels and P loss potential may increase in the future due to continued N-based recommendations. |
| **51 – 75** | **MEDIUM** potential for P movement from this site given current management practices and site characteristics. | • N-based nutrient recommendations 1 year in 3.<br>• P-based nutrient recommendations 2 years in 3.<br>• P applications limited to amount expected to be removed from field by crop harvest or soil test-based P application recommendations, whichever is greater. |
| **76 – 100** | **HIGH** potential for P movement from this site given current management practices and site characteristics. | • P-based nutrient recommendations for this site.<br>• P applications limited to amount expected to be removed from field by crop harvest or soil test-based P application recommendations.<br>• All BMPs for reducing P losses by erosion, runoff or leaching should be implemented. |
| **> 100** | **VERY HIGH** potential for P movement from this site given current management practices and site characteristics. | • No P should be applied to this site.<br>• Active remediation techniques should be implemented in an effort to reduce the P loss potential from this site. |

**PSI Scenarios** The following scenarios are based on actual data from fields with a LOW, MEDIUM, HIGH and VERY HIGH Phosphorus Site Index.

Scenario 1: **LOW** PSI field

**Part A (Site and Transport Characteristics)**

| | | Value |
|---|---|---|
| **location** | Piedmont Plateau | |
| **soil mapping unit** | Combs fine sandy loam | |
| **crop** | no-till corn silage | |
| **conservation practices** | contour planting | |
| **slope** | gently sloping (2%) | |
| **soil loss (tons/acre/year)** | 1 | 2 |
| **runoff class** | low | 2 |
| **subsurface drainage** | low | 2 |
| **leaching potential** | low | 0 |
| **distance to water / buffer** | <100ft / >50ft | 2 |
| **priority of receiving water** | Antietam Creek Watershed | 2 |
| | Sum of Site and Transport Characteristics | 10 |
| | Scaling factor | 0.02 |
| | **Total Site and Transport Value** | 0.20 |

**Part B (Management and Source Characteristics)**

| | | Value |
|---|---|---|
| **FIV-P** | 275 | 55 |
| **P fertilizer application rate** | 0 | 0 |
| **P fertilizer application method** | 0 | 0 |
| **organic P application rate** | 210 | 126 |
| **organic P application method** | surface applied in March | 45 |
| | **Total Management and Source Value** | 226 |
| | **P Loss Rating** | 45 |

**Interpretation:** Very favorable soil characteristics (low runoff class, low leaching potential and low subsurface drainage) and low soil erosion counteract the effects of a high soil test value and manure left on the surface.

Scenario 2: **MEDIUM** PSI field

**Part A (Site and Transport Characteristics)**

| | | Value |
|---|---|---|
| **location** | Eastern Shore | |
| **soil mapping unit** | Muck | |
| **crop** | corn-bean rotation, moldboard plowed | |
| **conservation practices** | none | |
| **slope** | gently sloping (1%) | |
| **soil loss (tons/acre/year)** | 0.65 | 1.3 |
| **runoff class** | low | 2 |
| **subsurface drainage** | high | 6 |
| **leaching potential** | medium | 2 |
| **distance to water / buffer** | <100ft / <25ft; >25ft No P application zone | 6 |
| **priority of receiving water** | Dividing Creek Watershed | 1 |
| | Sum of Site and Transport Characteristics | 18.3 |
| | Scaling factor | 0.02 |
| | **Total Site and Transport Value** | 0.37 |

**Part B (Management and Source Characteristics)**

| | | Value |
|---|---|---|
| **FIV-P** | 372 | 74 |
| **P fertilizer application rate** | 0 | 0 |
| **P fertilizer application method** | 0 | 0 |
| **organic P application rate** | 135 | 81 |
| **organic P application method** | incorporated more than 5 days after application | 45 |
| | **Total Management and Source Value** | 200 |
| | **P Loss Rating** | 74 |

**Interpretation:** A high soil test value and delay in incorporation of manure lead to a MEDIUM P Loss Rating.

Scenario 3: **HIGH** PSI field

**Part A (Site and Transport Characteristics)**

| | | Value |
|---|---|---|
| **location** | Southern Maryland | |
| **soil mapping unit** | Caroline silt loam | |
| **crop** | vegetable with rye cover crop | |
| **conservation practices** | none | |
| **slope** | 5% | |
| **soil loss (tons/acre/year)** | 24 | 48 |
| **runoff class** | low | 2 |
| **subsurface drainage** | medium | 4 |
| **leaching potential** | low | 0 |
| **distance to water / buffer** | >100ft | 0 |
| **priority of receiving water** | Breton Bay Watershed | 4 |
| | Sum of Site and Transport Characteristics | 58 |
| | Scaling factor | 0.02 |
| | **Total Site and Transport Value** | 1.16 |

**Part B (Management and Source Characteristics)**

| | | Value |
|---|---|---|
| **FIV-P** | 171 | 34 |
| **P fertilizer application rate** | 20 | 12 |
| **P fertilizer application method** | starter | 30 |
| **organic P application rate** | 0 | 0 |
| **organic P application method** | 0 | 0 |
| | **Total Management and Source Value** | 76 |

| | |
|---|---|
| **P Loss Rating** | 88 |

**Interpretation:** When the Total Site and Transport Value is so high, in this case due to excessive soil loss, the P Loss Rating will be negatively impacted even when the Total Management and Source Value is modest.

Scenario 4: **VERY HIGH** PSI field

**Part A (Site and Transport Characteristics)**

| | | Value |
|---|---|---|
| **location** | Eastern Shore | |
| **soil mapping unit** | Fallsington sandy loam | |
| **crop** | no-till corn with cover crop | |
| **conservation practices** | none | |
| **slope** | very gently sloping (0.5%) | |
| **soil loss (tons/acre/year)** | 0.1 | 0.20 |
| **runoff class** | negligible | 0 |
| **subsurface drainage** | very high | 8 |
| **leaching potential** | high | 4 |
| **distance to water / buffer** | <100ft / none | 8 |
| **priority of receiving water** | Nanticoke River Watershed | 2 |
| | Sum of Site and Transport Characteristics | 22.2 |
| | Scaling factor | 0.02 |
| | **Total Site and Transport Value** | 0.44 |

**Part B (Management and Source Characteristics)**

| | | Value |
|---|---|---|
| **FIV-P** | 1132 | 226 |
| **P fertilizer application rate** | 0 | 0 |
| **P fertilizer application method** | 0 | 0 |
| **organic P application rate** | 70 | 42 |
| **organic P application method** | surface applied March | 45 |
| | **Total Management and Source Value** | 313 |
| | **P Loss Rating** | 138 |

**Interpretation:** When soil test levels are extremely high, the P Loss Rating will be negatively impacted.

**References**

Coale, F. 2005. *The Maryland Phosphorus Site Index Technical Users Guide.* SFM-7. University of Maryland, Department of Natural Resource Sciences and Landscape Architecture, College Park, MD, 20742.

Sharpley, A. N., T. Daniels, T. Sims, J. Lemunyon, R. Stevens and R. Perry. 1999. *Agricultural Phosphorus and Eutrophication*. ARS-149. US Department of Agriculture, Agricultural Research Service, Beltsville, MD, 20705.

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