High Risk:

Soils are sufficiently saturated with P to have an increased risk for P loss. Nutrient management plans should incorporate best management practices (e.g., fertilizer and manure management, soil conservation plans) that directly address the need to minimize the environmental impacts of soil P on water quality.

***Very High Risk*:**

Soils are highly saturated with P and significant P losses can be expected by leaching, runoff, and erosion. These fields may pose a serious environmental concern to nearby surface waters and shallow groundwaters and should be given the highest priority for nutrient management and conservation practices to prevent P loss. Application of P to these soils should be avoided to prevent further saturation of the soil and protect water quality.

REFERENCES:

Sims, J. T., R. O. Maguire, A. B. Leytem, K. L. Gartley, and M. C. Pautler. 2002. Evaluation of Mehlich 3 as an Agri-environmental Soil Phosphorus Test for the Mid-atlantic United States . Soil Sci. Soc. Am. J. *In press.*

UD Soil Test Fact Sheet ST-05

UD Nutrient Management Fact Sheet NM-04

ADDITIONAL INFORMATION

Additional information may be obtained from University of Delaware Cooperative Extension Service offices in Newark, Dover, and Georgetown.

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SOIL TEST NOTES

NOTE 18: *Phosphorus Management and The Phosphorus Saturation Ratio*

PHOSPHORUS, AGRICULTURE AND ENVIRONMENTAL QUALITY

Agricultural P Management: Phosphorus (P) is one of the most important nutrients required for crop production. Phosphorus is essential for most physiological processes in plants, including photosynthesis, cell functions, and flower and seed production. When soils are deficient in P, plant growth suffers and yields may be reduced. To prevent crop P deficiencies, soils should be regularly evaluated with an agronomic soil P test, such as the Mehlich 3 soil test used by the University of Delaware. If soil P is inadequate for crop production, commercial fertilizers, animal manures, municipal biosolids and other soil amendments can be used to build soil P into the optimum range for crop production.

Environmental P Management: Environmental concerns with soil P focus on the role it plays in *eutrophication* which is defined as ***"the enrichment of or increase in the fertility status of natural waters that causes accelerated growth of algae and other aquatic plants"***. In many fresh water and some estuarine water bodies, algal and plant growth is limited by inadequate levels of P in the water. The introduction of P into sensitive surface waters through runoff, runoff, erosion or subsurface flow from high P soils can enrich these waters with P, resulting in eutrophication. Undesirable effects of eutrophication include algal blooms, surface scums, foul odors, accelerated growth of aquatic weeds, impeded water flow, fish kills due to lack of oxygen and the disappearance of desirable aquatic communities. To prevent eutrophication, it is important to develop environmentally sound P-based nutrient management plans.

PHOSPHORUS-BASED NUTRIENT MANAGEMENT PLANNING:

- ***What is P-based Nutrient management planning?***
  In recent years, because of increasing concerns about the effects of nonpoint source pollution of surface and shallow ground waters by agricultural sources of P, there has been interest in identifying fields where "P-based" nutrient management practices should be implemented. Phosphorus-based nutrient management emphasizes farm and field-scale practices that prevent the build-up of soil P to "excessive" levels and soil and water conservation measures that minimize P losses by erosion, runoff, and leaching. In Delaware, the Nutrient Management Act of 1999 stated that, for soils considered as "high" in P, the application of P from any source (e.g., manures, fertilizers) cannot exceed a three-year crop P removal rate.

- ***How should "high P" soils be identified in Delaware?*** The University of Delaware recommends that the "***Phosphorus Site Index***" be used to identify "high P soils". Agronomic soil tests (e.g., Mehlich 3) were developed to predict the likelihood of profitable crop response to inputs of P in fertilizers, manures, and other soil amendments, not to directly predict nonpoint source pollution (see *Fact Sheet NM-04*, **"*Interpreting Soil Phosphorus Tests*"** for more details). The ***Phosphorus Site Index*** integrates site characteristics (topography, drainage, leaching potential, proximity to water) with P source management (soil test P, application method, rate, and timing of fertilizer and manure P) to identify fields where the risk of P losses to water will be of most concern (see Fact Sheet ST-05, **"*The Phosphorus Site Index: A Phosphorus Management Strategy for Delaware's Agricultural Soils*"** for more details). *Phosphorus Site Index* assessments should be conducted on all fields, not just those fields with high soil test P values. This is because P losses by soil erosion can sometimes contribute significantly to nonpoint P pollution even if soil test P values are low. When interpreting the ***Phosphorus Site Index***, it is also important to consider how "saturated" a soil is with P, by evaluating the soil ***Phosphorus Saturation Ratio.***

- ***What is the soil "Phosphorus Saturation Ratio"?***
  The ***Phosphorus Saturation Ratio*** (PSR) is defined as the ratio between the amount of P present in the soil and the total capacity of that soil to retain P. As a soil becomes increasingly "saturated" with P two things will occur. First, the quantity of soluble P that can be lost from soils by surface runoff and by leaching into shallow groundwaters increases. Second, eroding soil particles are increasingly enriched in biologically available P and thus more likely to release P into waters when they are deposited as sediments in streams, ponds, lakes, and estuaries.

- ***How is the soil "Phosphorus Saturation Ratio" determined in Delaware?*** Research conducted in Delaware has shown that soil P saturation can be reliably estimated from the ratio of soil P to soil aluminum and iron [Al+Fe] (Sims et al., 2002). This is because Al and Fe are the soil components that contribute the most to soil P retention in Delaware soils. Effective December 15, 2001 the University of Delaware began reporting soil P saturation on all "routine" soil tests to aid in the development of P-based management plans.

- ***How is the soil "Phosphorus Saturation Ratio" interpreted in Delaware?*** The PSR should be used to supplement the information determined during a ***Phosphorus Site Index*** evaluation of a field. It provides additional information on the potential of soil P to contribute to P losses by runoff, erosion, and leaching. The University of Delaware separates soils into three P Saturation categories. Interpretations and management recommendations for these categories are given below:

P Saturation Ratio	Risk of P Loss
< 25	Low-Medium Risk
25 - 50	High Risk
> 50	Very High Risk

Low-Medium Risk :

Soils have a low to medium risk of losing environmentally significant amounts of P ***if soil erosion is controlled***. Phosphorus management practices should focus on controlling soil erosion and preventing the future buildup of soil P by over-application of manure or fertilizer P.