Northeast Region Phosphorus Index (NY, CT, MA, ME, RI, NH)

User's Guide

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Executive Summary

- The Northeast Region Phosphorus Index (NE-PI) is a field management tool designed to estimate the relative risk of phosphorus (P) runoff from agricultural fields in New York (NY), Connecticut (CT), Massachusetts (MA), Maine (ME), Rhode Island (RI), and New Hampshire (NH). The NE-PI is derived from NY-PI 2.0, with state specific adjustments for soil test P (STP) cutoffs and P drawdown strategies for farms that have maximized their spreading base and exhausted feasible export options.
- The NE-PI uses a transport × beneficial management practice (BMP) approach, where fields are scored based on factors that drive transport of manure and fertilizer P from agricultural fields, and scores can be lowered by implementation of BMPs that reduce the risk of P transport.
- The NE-PI does not estimate actual P loss, reflecting challenges with accurately predicting loss of P from individual fields. Instead, it rates fields for relative risk of particulate and dissolved P runoff and triggers management changes designed to reduce P runoff risk.
- The NE-PI is used to derive a relative risk score for each nutrient management planning cycle based on information garnered from farm records, soil erosion control plans, manure and fertilization plans, and field visits.
- The first step in development of the NE-PI score for a field is evaluation of soil test P (STP). Fields with a Morgan (NY) or Modified Morgan (CT, ME, MA, and RI) STP exceeding 160 lbs/acre are generally restricted from P application because they are well above the crop response range. Fields with a STP of 100 lbs/acre or lower may receive P at rates either limited by crop nitrogen (N) needs or by annual P-crop removal rates, as long as the NY-PI 2.0 score is less than 100. Fields with a STP from 101 to 160 lbs/acre can receive P up to annual P-crop removal if the NY-PI 2.0 score is < 50. In NH, cutoffs of 11, 23 and 35% P saturation (Mehlich-3 P to Mehlich-3 Al and Fe molar ratios) are used.
- For fields below the STP cutoff of 160 lbs/acre (NY, CT, MA, ME, RI) or 35% P saturation (NH), the NE-PI first assesses risk of runoff (potential for P transport from the field) based on field attributes. The result of the assessment is a "raw score" (prior to BMP selection).
- Farmers and planners can reduce the raw NE-PI score with implementation of BMPs by selecting from options related to: (1) P application method and (2) ground cover/timing.
- Farms with a whole-farm P balance (3-yr running average) at or below 12 lbs P/acre meet the feasible P balance for dairy farms in the region. These farms can apply manure at N-based rates on fields with a Morgan or Modified Morgan STP (NY, CT, ME, MA, RI) up to 100 lbs/acre (or 23% P saturation in NH), even if the NE-PI assessment for these fields limits rates to P-based, as long as the selected BMPs to get to a P-based score are implemented.
- The NE-PI replaces any earlier P runoff estimation tool referenced by the NRCS 590 Nutrient Management Standard and used in Comprehensive Nutrient Management Plans (CNMP) and other conservation planning.

Acknowledgments

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Key in the explorations of use of the NY-PI 2.0 across Connecticut (CT), Massachusetts (MA), Maine (ME), Rhode Island (RI) and New Hampshire (NH) were the evaluations, training and discussion sessions done by Andrew Carpenter and Lauren Souther of Northern Tilth and Mike Contessa of CVA. We want to thank all for their help with evaluations, their feedback, and for assistance with development and implementation of the NE-PI.

Parts of this user guide are taken and/or modified from the manual developed for the NY-PI 2.0, with permission from the original authors.

Acronyms

- BMP: beneficial management practice
- CAFO: concentrated animal feeding operation
- CF: concentrated flow
- CNMP: Comprehensive Nutrient Management Plan
- CPS: Conservation Practice Standard
- E: erosion
- eFOTG: Electronic Field Office Technical Guide
- FD: flow distance to stream
- FF: flooding frequency
- HSG: hydrologic soil group
- NRCS: Natural Resources Conservation Service
- NE-PI: Northeast region phosphorus index
- PI: phosphorus index
- RUSLE2: Revised Universal Soil Loss Equation version 2
- STP: soil test P
- VFD: vegetated flow distance

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1. General Structure and Ranking Site Vulnerability

The NE-PI identifies four *P-loss interpretation categories*: (1) low; (2) medium; (3) high; or (4) very high. Depending on the soil test P (STP) of the field, these four categories translate into one of *three management implications for a field*: (1) N-based (manure and fertilizer application not to exceed annual nitrogen (N) needs for the crop grown based on land grant university nutrient guidelines); (2) P-based (manure and fertilizer P application not to exceed annual P removal with harvest of that crop); and (3) Zero P (no manure or fertilizer P) as shown in Table 1. Annual crop removal of P can be determined by multiplying yield potential for the predominant soil type in the field or measured yield (3-year running average) and its P content. Book values for P content of field crops can be obtained from the NRCS Crop Nutrient Database (https://plants.sc.egov.usda.gov/npk/main). Soil test P (STP) serves as a screening tool and as a tool to determine NE-PI score implications.

Table 1: Overall interpretation and management implication of the NE-PI 2.0.

		Overall interpretation (transport score × BMP score × 10)			
		Management implication for NY, CT, MA, ME and RI			
P-loss risk	PI score	Soil test P (Morgan or Modified Morgan in lbs/acre)[1]			
		< 40	40-100	101-160	> 160
Low	< 50	N-based	N-based	P-based	Zero P
Medium	50-74	N-based	P-based	Zero P	Zero P
High	75-99	P-based	P-based	Zero P	Zero P
Very high	≥ 100	Zero P	Zero P	Zero P	Zero P
		Management implication for NH			
P-loss risk	PI score	Soil test P (P saturation derived from Mehlich 3)[1]			
		< 11	11-22	23-35	> 35
Low	< 50	N-based	N-based	P-based	Zero P
Medium	50-74	N-based	P-based	Zero P	Zero P
High	75-99	P-based	P-based	Zero P	Zero P
Very high	≥ 100	Zero P	Zero P	Zero P	Zero P

[1]When university crop guidelines call for P above the STP or rate limits in this table, P can be added to not exceed land grant guidelines as long as the NE-PI score is <100.

For NY, MA, ME, RI, and CT (Morgan or Modified Morgan STP):

If the STP of a field is less than 40 lbs/acre Morgan or Modified Morgan P, the NE-PI score must be reduced below 100 if manure is to be applied, and below 75 if rates are to be N-based (see Table 1). From 40-100 lbs/acre STP, the NE-PI score must be below 100 if manure is to be applied, application must be P-based or lower if the score is from 50-99 and can be N-based if the score is < 50. From 101-160 lbs/acre STP, P-based management is allowed only if a field has a NE-PI score < 50. Fields with STP levels greater than 160 lbs/acre cannot receive additional P (see section 5 for an exception for "Incidental P Application").

For NH (Mehlich-3 derived P saturation):

If the STP of a field is less than 11% P saturation (Psat), the NE-PI score must be reduced below 100 if manure is to be applied, and below 75 if rates are to be N-based (see Table 1). From 11-

22% Psat, the NE-PI score must be below 100 if manure is to be applied, application must be P-based or lower if the score is from 50-99 and can be N-based if the score is < 50. From 23-35% Psat, P-based management is allowed only if a field has a NE-PI score < 50. Fields with STP levels greater than 35% Psat cannot receive additional P (see section 5 for an exception for "Incidental P Application"). The Psat is derived using the molar ratio of P over aluminum (Al) and iron (Fe). This value is reported on many soil test reports ran by laboratories that supply Mehlich-3 soil test results. It can be calculated as follows:

Psat = 100 * (Melich-3 P/30.974) / (Mehlich-3 Al/26.982+Mehlich-3 Fe/55.845)

The NE-PI score of a field is obtained by multiplying the sum of *transport factor coefficients* by the *beneficial management practice (BMP) coefficients* of selected practices planned for the field.

2. Phosphorus Transport Factors

2.1 General Structure

Two types of P loss are recognized in the NE-PI. Dissolved P (DP) is P in solution (i.e., in runoff or drainage water) and mostly immediately bio-available for algal growth. Particulate P (PP) is organic P or inorganic P sorbed to or incorporated in soil minerals, which must first be broken down into a dissolved P form to be bioavailable. Coefficients for DP and PP differ in the Hydrologic Soil Group (HSG) and Vegetated Flow Distance (VFD) categories. Erosion is only used in the PP score (see Table 2). The sum of the transport factor coefficients multiplied by 10 determines a field's "raw" (pre-BMP) transport score. This score is determined for both DP and PP.

Table 2: Transport factors and coefficients included in the NE-PI. Coefficients are added. Both the dissolved P (DP) and particulate P (PP) sums are multiplied by 10 to obtain a field's raw PI score. The management implication is determined by the greater of the two scores and both scores must be below 100 for manure or fertilizer P to be applied.

Raw Score = Transport Factor Score × 10 (DP score = FD+ VFD_{DP}+FF+ HSG_{DP} + CF; PP score = FD+ VFD_{PP} +FF+ HSG_{PP}+E+ CF)						
Factor	Option	Coefficient	Factor	Option	Coefficient	
Flow distance (FD) to stream in ft	> 500	0	Hydrologic soil group (HSG)	A	DP: 0	PP: 0
	301-500	4		B	DP: 4	PP: 1
	101-300	6		C	DP: 6	PP: 3
	≤ 100	8		D	DP: 8	PP: 5
Vegetated flow distance (VFD)[1]	<35 ft	0	Erosion (E) [2] in ton/acre	≤ 1.0	0	
	≥35 ft	DP: -2	PP: -4	1.1-3.0	1	
Flooding frequency (FF)	Never	0		3.1-5.0	3	
	Occasionally	2		> 5	5	
	Frequent	5	Concentrated flow (CF)	None/treated	0	
				Untreated	4	

[1] Only for fields with FD ≤500 ft. [2] Determined by the RUSLE2 A-value (yearly).

2.2 Flow Distance (FD) from Edge of Field to Stream

Flow distance starts at the edge of the field where the majority of runoff is deemed to leave and follows the path of flow until the first contact with either an intermittent or perennial stream. Wetlands are defined as waters of the state and flow distance ends at the wetland boundary as if it were an intermittent or perennial stream. Though the NE-PI 2.0 does not require distinction between intermittent or perennial streams, awareness of attributes of each may help to best determine where the flow distance ends when evaluating fields:

- Perennial streams (or other perennial waterbodies) generally contain water 365 days per year, though in some dry periods smaller perennial streams may dry up for a short time.
- Intermittent streams or waterbodies contain water on a seasonal basis only during most years. Another way to consider intermittent streams is that in most years water is flowing during those parts of the year when the water table is relatively high.

Be careful when relying on topographic maps for stream determinations. Most topographic maps depict perennial streams with a solid blue line (hence the phrase "blue line" stream) and intermittent streams with a dashed blue line, although some topographic maps depict all streams with a solid blue line. Also, because data for many topographic maps were collected decades ago, the maps do not reflect more recent drainage work. A field visit is necessary to confirm topographic information; existing streams that do not show up on a topographic map still need to be included in NE-PI evaluation. Further, if there is supporting information that a historic stream has been moved, or the determination was incorrect, planners may enter the more realistic determination in the NE-PI and keep documentation notes with the logic behind the decision in case questions arise during an inspection.

The flow distance or distance to a watercourse is the drainage path that runoff water takes when overland flow occurs as it leaves the edge of a field and flows toward an intermittent or perennial stream. The objective for the flow distance is to represent a typical or average distance over which runoff has an opportunity to be filtered through interaction with vegetation and/or soil. For a first assessment, the flow path and distance can be approximated from topographic maps where the flow path runs perpendicular to the contour lines, but this needs to be confirmed by field inspection. There may be more than one flow path leaving a field. Often there are several flow paths heading in the same general direction. Other times, multiple flow paths may head in very different directions. Planners are expected to evaluate these situations using best professional judgment to estimate the general direction and distance of flow for the majority of overland flow that leaves the field being evaluated (planners should consider documenting their rationale in field notes to address questions in case they arise later). For example, road ditches frequently receive some surface runoff from fields, but it may only be a small portion of the total runoff. A road ditch is considered part of the flow path only if it receives the majority of runoff from the field. If a road ditch does not receive the majority of runoff from the field, it is not necessary to apply a label. In well-drained locations, the road ditch may receive the majority of runoff, but runoff occurs infrequently due to the drainage. In cases like this, the road ditch is essentially functioning as a concentrated flow outside of the field, and it is counted as part of the flow distance until it discharges to an intermittent or perennial stream. In other cases, a road ditch may be serving a larger watershed and can be categorized as an intermittent or sometimes a perennial stream.

2.3 Vegetated Flow Distance (VFD)

Vegetation in a flow path from the edge of the field to a stream can play an important role in reducing P losses and, for this reason, should be encouraged in appropriate circumstances. A VFD is defined as an area of perennial vegetation that is at least 35 feet long with the ability to intercept flow, slow velocity and treat water leaving the field in a substantially diffuse flow regime. In some cases, a whole field lies in the downgradient flow of an upgradient field. In such a case, if the downgradient field is permanent sod or has a perennial hay crop in the rotation and provides at least 35 feet of flow distance, it may be considered a VFD when the sod is present.

The planner needs to carefully evaluate the potential effectiveness of the vegetation. To intercept, slow, and treat flows, VFDs should be sufficiently vegetated (consider 80% or more vegetated ground cover as a guide). In some cases, most of the water may be leaving through a concentrated flow channel where water is cutting or rapidly moving through the vegetation, thus avoiding any substantial vegetative treatment. In such cases, the vegetation may be ineffective and should not be given credit. Thus, if an upgradient field's flow distance is through a treated concentrated flow in the field, below, the treated concentrated flow would not be considered a VFD for the upgradient field.

While the absence of a VFD is not penalized, the presence of a VFD results in an important transport score reduction for both DP (-2) and PP (-4), reflecting the greater efficiency in reducing PP loss than DP loss. This is only applied for fields with a flow distance ≤500 ft.

2.4 Flooding Frequency (FF)

Each soil type is assigned a flooding frequency classification. The flooding frequency data for can be obtained on the eFOTG website of NRCS (https://efotg.sc.egov.usda.gov/#/). Choose the correct state and click "submit". Click Section II. Click Soil Information. Click on: Flooding Frequency and Ponding Frequency Soil Data. The file is a downloadable excel file. Sometimes this information may be available on flood hazard boundary maps as well. Frequent flooding implies flooding at least once in less than 10 years. Occasional flooding is defined as once every 10 to 100 years. If a field floods once in more than 100 years, it is classified as rare/never.

Dam construction or other factors can alter the flooding frequency upstream and downstream. For example, areas below a dam may flood less often and areas immediately upstream may flood more often. Planners need to be aware of these situations and, with historical information and documented reasoning, adjust the flooding frequency accordingly. The duration of a flooding period is not considered to be very important to the overall transport of dissolved P, so there is no further adjustment or correction for the flooding duration. Although it is apparent that flooding may be an important transport phenomenon, the significance to P loss will depend greatly on the connectivity to water courses and the flow velocities that develop. Flooding may also result in nutrient entrapment and deposition under some circumstances. The risk of actual P loss with flooding frequency is difficult to quantify without a great deal more information.

2.5 Hydrologic Soil Group (HSG)

Using the HSG of the predominant soil type in a field allows the NE-PI to address natural (surface) runoff potential of a soil, as well as a reduction in runoff potential of certain soils when adequate subsurface drainage is installed. Some soils with high permeability are assigned to HSG "D" due to a high natural water table. When adequately drained, the runoff potential of these soils

is reduced, less surface runoff is expected, and they are assigned a dual HSG such as A/D, B/D or C/D, with the first letter representing the adequately drained condition. Adequate drainage is generally defined as seasonal high water-table at least 24 inches below the soil surface. When the planner determines that adequate drainage is installed in a field, the first HSG letter in the pairing can be used in the NE-PI. The most updated data file for HSGs can be obtained from the electronic Field Office Technical Guide (eFOTG of NRCS: https://efotg.sc.egov.usda.gov/#/). Choose your state, submit. Click Section II. Click Soil Information. Click on: Hydrologic Soil Group Data. The file is an excel file that is downloadable.

Some bedrock-controlled soils may have an HSG rating of D as bedrock is generally considered a limiting feature to the downward movement of water and thus these soils are considered more prone to runoff. However, the site-specific nature of the underlying bedrock may allow more water infiltration (thus less runoff potential) than what a D HSG rating indicates. Planners can input an HSG of C or B into the NE-PI for these D soils when all the following conditions from the Web Soil Survey map unit descriptions apply: (1) soils are less than 40 inches to bedrock; (2) natural drainage is well drained or better; (3) there is a soil rating of no ponding or flooding; and (4) seasonal high-water table remains below 23 inches.

In addition to documentation of the above soil properties, planners need to justify the input switch in the CNMP and confirm that normal agronomic crop management is not affected by seasonal wetness (i.e. normal planting times, average or above yields, soil is conducive to intensive crops management of crops such as corn, alfalfa, or other crops that are not impacted by wetness).

2.6 Erosion (E)

The soil erosion rate for a field site must first be estimated using the Revised Universal Soil Loss Equation Version 2 (RUSLE2). RUSLE2 was developed to evaluate sheet and rill erosion for different types of agricultural cropping systems, mineral soils exposed to raindrop impact and field locations where overland flow is produced by rainfall intensities exceeding infiltration capacity. RUSLE2 is used to inventory existing erosion rates of a defined planning unit or field, guide conservation planning for alternatives to keep soil erosion within acceptable rates on the planning unit, and to estimate if sediment loss from erosion is likely to reach downslope lands, nearby streams, and/or waterbodies. RUSLE2 estimates soil loss, sediment yield, and sediment characteristics from rill and inter-rill (sheet and rill) erosion caused by rainfall and associated overland flow on a field-determined critical dominant hillslope profile within a defined field boundary. RUSLE2 uses factors that represent the effects of climatic erosivity, soil erodibility, topography, cover-management, and soil conservation practices to compute erosion. The user enters the location, soil type, slope topography, and field management (crop rotation, tillage system, etc.). The RUSLE2 program predicts and reports yearly soil loss in tons/acre. The predicted soil loss for the crop year being planned (RUSLE2 A factor) is used to select the erosion coefficient for the transport factor score in the NY-PI 2.0. The RUSLE2 software is available from http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm.

2.7 Concentrated Flow (CF) Within a Field

Concentrated flows (CFs) are areas of gully erosion where water flows over the surface for a short time after a significant rainfall event and flow is sufficient to initiate ephemeral gully or gully erosion. These areas of visually observable channelized erosion tend to recur after tillage operations and tend to deepen and widen over time within the same areas of the field. Untreated

CFs often leave the field and eventually connect to intermittent or perennial streams beyond the field boundary. Untreated, these areas can transition to classic gullies that cannot be farmed and take on an intermittent stream characteristic within the former field boundary. Concentrated flow areas of this magnitude within field boundaries need to be treated with a BMP(s) under the NRCS 590 Nutrient Management Standard. Common treatment options may include grassed waterways, water and sediment control basins, diversions, other structural soil conservation practices, and/or cultural practices to address the erosion. Until such areas within fields are adequately treated, they are considered an "untreated CF". If a CF is present in a field under evaluation, the transport factor coefficient in the NE-PI for the field is "4" while if the concentrated flow is treated, the coefficient is "0" (Table 2). Some fields may have CFs that end within a field or that are stable (i.e. no observable ephemeral gully or gully erosion occurring due to soil, topography, surface cover, or hydrology). In these situations, the field can receive a score of "0" for CF for the NE-PI assessment. Most concentrated flows are not specifically depicted on topographic maps (though they may show up through contour lines), but they may be marked on soil conservation plan maps. As water flow patterns, rainfall, and field features continue to change, planners and farmers need to remain vigilant for newly developing concentrated flows in fields. It is a good practice to evaluate fields for concentrated flows each time soil samples are collected.

3. Beneficial Management Practice Factors

Beneficial management practices are practices considered likely to contribute to reductions in P loss. Practices selected can vary significantly depending on many factors, including crop rotation, farm resources and goals, and are often implemented in various combinations where some individual and combinations of practices have greater potential effects than others. The NE-PI employs two groups of practices (select one from each category) that interact to reduce the raw PI score: (1) method of P application, and (2) ground cover/timing (Table 3).

Table 3: Beneficial management practices (BMPs) of the NE-PI. Select one from each category (method and ground cover/timing) to determine the final PI score after BMPs.

Best/beneficial management practices (BMP score = method × ground cover and timing score)	
Method of applications	Coefficient
Surface spread without setback	1.0
Surface spread with ≥100-ft setback from the field boundary (start of the predominant flow path)[1]	0.8
Surface spread with ≥35-ft managed vegetated (sod/harvested) setback from the field boundary (start of the predominant flow path)[1]	0.7
Incorporation within 24 hours with ≥15-ft setback from down-gradient surface waters	0.7
Injection with ≥15-ft setback from down-gradient surface waters	0.5
Ground cover/timing	
Bare ground and more than 2 weeks before planting	1.0
Bare ground and within 2 weeks of planting (in season)	0.8
Winter-hardy cover crop (fall/winter)	0.8
Whole-plant crop residue (~80% or more ground cover, e.g. corn grain)	0.7
Sod after last cutting (fall/winter)	0.6
Growing sod or row crop/planting green	0.5

[1] Only for fields with FD ≤ 500 ft. Setbacks are within field boundaries.

There are five practices listed in the method of application section and six practices in the ground cover/timing section. A practice such as surface application of manure (method of application score of 1.0) on bare ground more than 2 weeks before spring planting (ground cover and timing score of 1.0) does not reduce the NE-PI score for a field because this combination of method of application and timing related to ground coverage and crop growth is considered most risky in terms of P loss potential. All other options serve to reduce the overall P loss risk (and thus the PI score). For example, surface spread manure with a 100-ft setback (method of application score of 0.8) on a winter hardy cover crop (ground cover and timing score of 0.8), will reduce the raw NY-PI 2.0 score to 64% of the original score (0.8 × 0.8 = 0.64). Additional practices can be added in future years as knowledge about effectiveness of BMPs grows and technologies evolve over time.

3.1 Method of Application

Method of application refers to the way that manure or fertilizer P is applied to fields, and includes four BMP options:

- *Setback from the field boundary (start of the predominant flow path):* A manure spreading setback creates an area within a field boundary that does not get manure, implemented along the down-gradient edge of the field. When the setback is 100 feet or more, credit may be taken in the BMP section of the NE-PI. This option is not available when a field has more than 500 ft of flow distance from the field edge to down-gradient surface water.
- *Vegetated setback from the field boundary (start of the predominant flow path):* This is a vegetated strip of perennial grass within the field boundary, implemented along the down-gradient edge of the field, that does not receive manure but gets harvested at least once annually. When the vegetated strip is 35 feet or more, credit may be taken in the BMP section of the NE-PI. This option is not available when a field has more than 500 ft of flow distance from the field edge to down-gradient surface water.
- *Incorporation:* The use of an aeration tool or other tillage implement to mix manure and soil to improve interface between soil and manure.
- *Injection:* Direct sub-surface placement of manure into the soil leaving little or no manure on the soil surface.

3.2 Ground Cover and Timing

Ground cover and timing relates to field surface residue coverage and timing of P application relative to crop growth. Risk of loss of P is reduced when fields have ground coverage and manure is applied close to crop uptake of nutrients. Additional definitions include:

- *Winter-hardy cover crop:*
  Cereal rye, triticale, wheat, or other cereal crop that is likely to overwinter in most circumstances and have adequate biomass to reduce runoff. While oats may overwinter on some fields in some years, they are too cold-sensitive to meet this requirement.
- *Planting green:*
  The practice of planting into a living crop that is terminated around the time of planting.

4. Adaptive Management Option

Farms with a whole-farm mass balance (NMB, 3-yr running average) for P at or below 12 lbs P/acre are permitted to apply manure at N-based rates on fields with STP < 100 lbs/acre, even if the initial NE-PI assessments for these fields limits rates to P-based, as long as the selected BMPs to get to the P-based score are implemented. This changes the interpretation table from what is shown in Table 1 to Table 4 (changes are noted in shaded, italicized text).

The adaptive management option is designed to help improve whole-farm P management on a medium- to long-term time scale by rewarding good P management across all farm operations, including precision feeding. For more information, data input sheets, and software, see: http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/MassBalances.html.

Table 4: Overall interpretation and management implication of the NE-PI for farms with a 3-year running average whole farm P balance below 12 lbs P/acre.

		Overall interpretation (transport score × BMP score × 10)			
		Management implication for NY, CT, ME, and MA			
P-loss risk	PI score	Soil test P (Morgan or Modified Morgan in lbs/acre) [1]			
		< 40	40-100	101-160	> 160
Low	< 50	N-based	N-based	P-based	Zero P
Medium	50-74	N-based	*N-based*	Zero P	Zero P
High	75-99	*N-based*	*N-based*	Zero P	Zero P
Very high	≥ 100	Zero P	Zero P	Zero P	Zero P
		Management implication for NH			
P-loss risk	PI score	Soil test P (P saturation) [1]			
		< 11	11-22	23-35	> 35
Low	< 50	N-based	N-based	P-based	Zero P
Medium	50-74	N-based	*N-based*	Zero P	Zero P
High	75-99	*N-based*	*N-based*	Zero P	Zero P
Very high	≥ 100	Zero P	Zero P	Zero P	Zero P

[1]When Cornell crop guidelines call for P above the STP or rate limits in this table, P can be added to not exceed land grant guidelines as long as the NE-PI score <100.

5. Incidental P Application

When a farm has maximized their spreading base and exhausted feasible export options, i.e. adding hay land or more distant crop fields that were not previously spread, land application of manure to fields with STP over 100 lbs P/acre Morgan (NY) or Modified Morgan (ME, MA, RI and CT), and 23% Psat (NH) is permitted given the NE-PI score for the field is <100; crops are harvested from the field; and the following conditions apply:

For NY:

- The farm does not import any manure from off-farm sources.
- The manure source is treated effluent (P_2O_5 equivalent is less than 1 pound per thousand gallons) or a very dilute source (full collection of high flow bunk runoff).

- Applied material must have attributes that provide other benefits to crop yield and therefore increase P removal, such as supplying irrigation water and/or N.
- A P drawdown plan is implemented by farm management and their AEM certified planner in accordance with the following:
    - Phosphorus application rates are limited to the lesser of 20 lbs P_2O_5/acre or 25% of crop removal.
    - This plan includes annual soil testing to monitor P levels and, over time, demonstrate a decreasing trend in soil test P
- Track the whole-farm nutrient mass balance (NMB) to ensure that P is being managed optimally across the farm (at or below 12 lbs P/acre).

For ME, MA, and NH:

- The farm does not import any manure from off-farm sources.
- Applied material must have attributes that provide other benefits to crop yield and therefore increase P removal, such as supplying irrigation water and/or N.
- A P drawdown plan is implemented by farm management in accordance with the following:
    - Phosphorus application rates are limited to:
        - ≤ 50% of crop removal for STP >160 lbs/acre (35% Psat for NH).
        - ≤ 75% of crop removal for STP 101-160 lbs/acre (23-35% Psat for NH).
    - The plan includes soil testing every other year to monitor P levels and, over time, demonstrate that P levels are decreasing over time.

For CT:

- The farm does not import manure or other P containing materials such as biosolids or compost from off-farm, sources *and* does not apply P fertilizer
- Applied material must have attributes that provide other benefits to crop yield and therefore increase P removal, such as supplying irrigation water and/or N.
- A P drawdown plan is implemented by farm management in accordance with the following:
    - ≤ 50% of crop removal for STP >160 lbs/acre.
    - ≤ 75% of crop removal for STP 101-160 lbs/acre.
    - ≤ 90% of crop removal for up to three years if 50 or 75% of crop removal does not allow the farm to allocate all on-farm generated manure, while other options are implemented including one or more of the following:
        - Reduce animal numbers on the farm.
        - Increase exports of manure or nutrient products off the farm.
        - Use Cornell's NMB software and manage the farm's annual P balance (3-year average) at or below 12 lbs P/acre.
    - The plan includes soil sampling every 3 growing seasons or less and keeping at least three consecutive results (3-9 years) at all times to show STP trend over time. If STP results for fields under incidental P application are static or increase over time, a nutrient management planner should be contacted to justify or adjust the drawdown plan.

For RI:

- Seek guidance from the NRCS-RI Nutrient Management Specialist.

Summary

The NE-PI is a qualitative risk-based assessment tool designed to enhance nutrient management planning for agricultural operations across the region. The purpose of NE-PI is to assess vulnerability of agricultural fields to P loss (transport risk) and incentivize adoption of BMPs to reduce the risk of P loss from high-risk fields. This tool uses a transport × BMP approach, where fields are scored based on factors that drive transport of manure and fertilizer P from agricultural fields, and scores can be lowered by implementation of BMPs that reduce the risk of P transport. The NE-PI does not estimate actual P loss, reflecting challenges with accurately predicting loss of P from individual fields across landscapes. Instead, it rates fields for relative risk of particulate and dissolved P runoff and triggers management changes designed to reduce P loss risk and enhance whole farm P use efficiency.

Appendix: Northeast Region Phosphorus Index

The NE-PI uses a transport × best/beneficial management practice (BMP) approach. A field transport score for dissolved P (DP) and particulate P (PP) is calculated based on transport factors and reduced by applying BMPs. The adjusted score and soil test P (STP) result in a management implication (the greater of the DP and PP scores; both scores must be ≤100 for P to be applied).

Overall interpretation (transport factor score × BMP score × 10)					
		Management implication[1]			
P-loss risk	PI score	Soil test P (Morgan or Modified Morgan in lbs/acre or Psat in NH)			
		< 40 (<11%)	40-100 (11-22%)	101-160 (23-35%)	> 160 (>35%)
Low	< 50	N-based	N-based	P-based	Zero P
Medium	50-74	N-based	P-based	Zero P	Zero P
High	75-99	P-based	P-based	Zero P	Zero P
Very high	≥ 100	Zero P	Zero P	Zero P	Zero P

Transport Score (Sum of Transport Factor Scores × 10) (DP score = FD+ VFD_{DP}+FF+ HSG_{DP} + CF; PP score = FD+ VFD_{PP} +FF+ HSG_{PP}+E+ CF)					
Factor	Option	Coefficient	Factor	Option	Coefficient
Flow distance (FD) to stream in ft	> 500	0	Hydrologic soil group (HSG)	A	DP: 0 PP: 0
	301-500	4		B	DP: 4 PP: 1
	101-300	6		C	DP: 6 PP: 3
	≤ 100	8		D	DP: 8 PP: 5
Vegetated flow distance (VFD)[2]	<35 ft	0	Erosion (E)[3] in ton/acre	≤ 1.0	0
	≥35 ft	DP: -2 PP: -4		1.1-3.0	1
Flooding frequency (FF)	Never	0		3.1-5.0	3
	Occasionally	2		> 5.0	5
	Frequent	5	Concentrated flow (CF)	None/treated	0
				Present	4

Best/beneficial management practices (BMP score = method × ground cover and timing score)	
Method of applications	Coefficient
Surface spread without setback	1.0
Surface spread with ≥100-ft setback from the field boundary (start of the predominant flow path)[2]	0.8
Surface spread with ≥35-ft managed vegetated (sod/harvested) setback from the field boundary (start of the predominant flow path)[2]	0.7
Incorporation within 24 hours with ≥15-ft setback from down-gradient surface waters	0.7
Injection with ≥15-ft setback from down-gradient surface waters	0.5
Ground cover and timing	
Bare ground and more than 2 weeks before planting	1.0
Bare ground and within 2 weeks of planting (in season)	0.8
Winter-hardy cover crop (fall/winter)	0.8
Whole-plant crop residue (~80% or more ground cover, e.g. corn grain)	0.7
Sod after last cutting (fall/winter)	0.6
Growing sod or row crop/planting green	0.5

[1] Implications: 'N-based' can receive manure based on the crop's N needs; 'P-based' restricts manure applications to annual crop P removal equivalence; 'Zero P' means no P from any source. When land grant university crop guidelines call for P above the STP or rate limits in this table, P can be added to not exceed land grant guidelines as long as the NE-PI score is <100. Farms with a whole-farm P mass balance (3-yr running average) at or below 12 lbs P/acre can apply manure at N based rates on fields with STP ≤ 100 lbs/acre, even if the initial NE-PI score limits rates to P-based, as long as the selected BMPs to get to a P-based score are implemented. [2]Only for fields with FD ≤ 500 ft. Setbacks are within field boundaries. [3]Determined by the RUSLE2 A-value (yearly).