Virginia Phosphorus Index
Version 2.0

Technical Guide

by

Mary Leigh Wolfe[1]
Jim Pease[2]
Lucian Zelazny[3]
Lee Daniels[3]
Greg Mullins[4]

Virginia Tech
Blacksburg, VA 24061

1Biological Systems Engineering Department (0303), Wolfe (540-231-6092; mlwolfe@vt.edu)
[2]Agricultural and Applied Economics Department (0401), Pease (540-231-4178; peasej@vt.edu)
[3]Crop and Soil Environmental Sciences Department (0404)
[4]New Mexico State University, Las Cruces, NM; formerly Crop and Soil Environmental Sciences Department (0404)

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Virginia Phosphorus Index
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The structure of Version 2.0 of the Virginia Phosphorus Index is identical to that of Version 1.3. Three major changes are included in this version. The changes are based on the results of a recently completed project that included collection and analysis of soil samples from 334 fields in 42 counties across Virginia and application of the P-Index to those fields (Jesiek et al., 2005). First, the scaling factor was changed from 6.3 to 8.5 (Figure 1). Second, the screening criteria for use of the P-Index (Table 2) have been simplified. Second, the equations used to calculate the total soil P factor, the runoff DRP factor, and the subsurface DRP factor have been modified

<u>Reference</u>

Jesiek, J., G. Mullins, M.L. Wolfe, L. Zelazny, and L. Daniels. 2005. Implementing the Phosphorus Index as a Nutrient Management Tool in Virginia to Enhance Water Quality. Final Report, Agreement # 319-02-04-PT. Submitted to Virginia Department of Conservation and Recreation. 60 pp.

Technical Guide Modifications

February 2002
Technical Guide was first distributed.

April 2002
Modifications included the following:

1. Terms “surface water” and “concentrated flow” were replaced with “intermittent and perennial streams”.
2. Term “buffer” was replaced with “stream buffer”.
3. Term “vegetated filter strip” (located at downslope edge of field) was added to differentiate from “stream buffer”.
4. Added adjustment factor (new Table 3) for impact of vegetated filter strip on edge of field soil loss.
5. Adjusted numbers of Tables 3 through 16 to Tables 4 through 17.
6. Required input soil texture is “to” a depth of 18 inches in the soil profile, as opposed to “at 18 inches”.
7. Added Table A.1, Appendix A listing counties/cities with corresponding climatic division and physiographic region.
8. Modified procedure for determining average annual runoff for rotations.
9. Added explanation how to calculate the Applied Fertilizer DRP Factor (AFDRP) when the application rate, fertilizer type, and/or method of application vary during the planning period.
10. Modified procedure for determining average annual percolation for rotations.
11. Corrected Table 14 (now Table 15) average annual percolation for fallow conditions.

August 2002
Modifications included the following:

1. Corrected the curve number for hay and subsequent calculations in the examples on pages 6 and 13.
2. Added Table 6A for curve numbers for row crop/winter small grain cropping system.
3. Updated table of contents to reflect added table.
4. Refined physiographic region listing (Table A.1) for Clarke, Page, and Warren counties.
5. Added definition of “fallow” to Table 6.
6. Added further explanation of “stream” to descriptions of sediment delivery and runoff delivery factors.

November 2002
Modifications included the following:

1. Clarified the rounding process for calculation of the P-Index in Figure 1 and in examples 1 through 4.
2. Added specific soil texture classes to Table 16 in place of ranges of classes.

Technical Guide Modifications (cont.)

July 2003
Modifications in release 1.2 included the following:

1. Updated subsurface risk factor calculation equations and examples to be consistent with the spreadsheet P-Index Version 1.2.

July 2004
Modifications in release 1.3 included the following:

1. The units of the individual factors in Figure 1 were changed to more common units, e.g., tons/acre of sediment rather than million lbs sediment/acre and the unit conversion factor was moved to overall calculation of each of the erosion, runoff, and subsurface risk factors rather than being included in individual subfactors. Appropriate editing in text, tables, and examples was included to fully implement this change.
2. Added description of screening criteria based on phosphorus saturation level to determine when it is appropriate to apply the P-Index.
3. Recommended use of RUSLE2 for estimation of soil loss from the field rather than RUSLE. This recommendation is based on the implementation of RUSLE2 in Virginia by NRCS in 2004.
4. Sediment and runoff delivery factor descriptions clarified with references to NRCS practice standards for evaluating riparian buffers. Ranges and values in Tables 4 and 8 modified.
5. Equations were added to Tables 5 and 8 to account for stratification in pastures and no-till fields.
6. Revised curve number table (Table 6) to be more easily used (values did not change). Table 6A was merged into Table 6.
7. Added crop category table (Table A.3).
8. Changed name of source availability factor to P source coefficient and expanded the table of values (Table 10).
9. Expanded and clarified entries in method of application factor table (Table 11).
10. Added table of soil texture/drainage class factor and hydrologic soil group associated with each soil mapping unit in Virginia (Table A.3).
11. Updated examples to include any modified factor values.

March 2005
Modifications included the following:

1. Changed the "=" signs in Table 2 to the appropriate inequalities.
2. The placement of the "irrigated manure/wastewater" category was corrected by moving it from Table 10 to Table 11.
3. The given soil test P value in example 3 was modified to be within the 20-65% P saturation range. The calculations that are a function of soil test P were also updated.

October 2005
Modifications included the following:

1. Updated the scaling factor from 6.3 to 8.5 (Figure 1).
2. Clarified how curve number method is used to determine runoff from field (Table 1).
3. Screening criteria for use of the P-Index (Table 2) was simplified. Updated values for 20% and 65% P saturation levels were included.
4. Updated equations for determining sediment total P factor (Table 5).
5. Updated equations for determining runoff DRP factor (Table 9).
6. Updated equations for determining subsurface DRP factor (Table 17).
7. Updated example calculations to reflect the new source factor equations.
8. Updated Table A.4 P crop removal to include Mid-Atlantic Phosphorus Group values.

Virginia Phosphorus Index
Version 2.0

Introduction

The Virginia Phosphorus Index (P-Index) is a field level assessment tool that integrates soil, management, environmental, and hydrological (transport) characteristics to determine the relative risk of P losses through surface runoff and subsurface transport to water bodies. This tool separates the main factors influencing P movement into transport, P source, and P management factors. The index accounts for and ranks transport and source factors controlling P loss of sediment-adsorbed P through surface runoff and dissolved forms in surface runoff and through subsurface transport.

Source and transport factors included in the index were determined by reference to the published scientific literature, data collected on selected Virginia soils, and professional judgments of the P-Index development team. A multi-disciplinary research team at Virginia Tech developed the Virginia P-Index. An advisory committee consisting of representatives of the Virginia Department of Conservation and Recreation (DCR), United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), university, and extension personnel was also consulted.

The P-Index is presented in Figure 1 and includes an interpretation of the computed P-Index value. The factors in the P-Index are summarized in Table 1. This guide includes detailed instructions for computing P-Index values, guidelines for using the P-Index as a planning tool, example calculations, and a glossary of terms as they are used relative to the Virginia P-Index.

General Guidelines for Using the Virginia P-Index as a Planning Tool

As a management tool, the P-Index evaluates the relative risk of P losses from a specific field under a given set of soil/landscape conditions and management practices. The P-Index should be calculated using the most current field-specific information that is available from the producer. In addition, the P-Index should be calculated according to how the producer would like to manage the field during the upcoming rotation or nutrient management planning sequence. Based on the P-Index value calculated for the field, the planner and producer can look at the summary interpretations for the Virginia P-Index to determine the relative risk potential for P losses from the field under the current set of management conditions. This evaluation will tell a producer if the current rate of P application is acceptable or whether changes in P management strategy for the field should be considered. If the P-Index is being used as a planning tool for a three year planning period, and there is a major change in cropping system during this period (i.e., change from row-crops to forage system), the P-Index should be calculated for each major cropping system to determine the potential risk of P losses under each system. The interpretation of the Virginia P-Index should not be used to justify a P application rate that is higher than the rate used to calculate the current value of the Virginia P-Index.

The screening criteria given in Table 2, and specified in the NRCS, VA practice standard for nutrient management (590-VA-1), can be applied to determine if it is appropriate to compute the P-Index for a particular field.

Figure 1. Virginia Phosphorus Index

Phosphorus Risk = Erosion Risk Factor + Runoff Risk Factor + Subsurface Risk Factor

P Index[†] = (Erosion Risk Factor X 8.5) + (Runoff Risk Factor X 8.5) + (Subsurface Risk Factor X 8.5)

Erosion Risk Factor = Edge of field soil loss (tons/ac) X Sediment P delivery factor (dimensionless) X Sediment total P factor (ppm) X 0.002[&]

Runoff Risk Factor = Runoff from field (inches) X Runoff P delivery factor (dimensionless) X Runoff DRP[*] factor (ppm) X 0.22651[&] + Applied fertilizer DRP[*] factor (lb/ac)

Subsurface Risk Factor = Percolation (inches) X Soil texture/ drainage factor (dimensionless) X Subsurface DRP[*] factor (ppm) X 0.22651[&]

[†] Before summation of risk factor components into the P-Index, each component is rounded to the nearest whole number. See examples beginning p. 21.
[*] DRP is dissolved reactive orthophosphate.
[&] units conversion factor

Summary Interpretation of Phosphorus Index

P Index Value	Potential Water Quality Impact	Phosphorus Management Guidance Based on Proposed Management Practices
0 – 30	Low	Phosphorus applications according to N-based nutrient management are acceptable.
31 – 60	Medium	Phosphorus applications should not be greater than 1.5 times crop removal.
61 – 100	High	Phosphorus applications should not be greater than crop removal.
> 100	Very High	No phosphorus should be applied.

Table 1. Transport, source, and management factors for the Virginia P-Index

Factors	Description	How Determined	Source of Values
Transport Factors			
Edge of field (EOF) soil loss	Soil transported to the edge of field by erosion	Revised Universal Soil Loss Equation (as implemented in RUSLE2), including width of EOF vegetated filter strip	RUSLE2 Equation (tons/acre/yr)
Sediment P delivery factor	Proportion of sediment transported from the edge of field to intermittent or perennial stream	Based on stream buffer width and/or the flow distance from edge of field to intermittent or perennial stream	Table 4 (Dimensionless)
Runoff from field	Amount of water (inches) that is lost through surface runoff annually	Crop rotation and hydrologic soil group are used to determine the NRCS runoff curve number. Curve number is used in combination with historic distribution of daily rainfall events in 0.1 in. increments; daily runoff then summed to estimate average annual runoff (based on climatic zone).	Location (County), Crop, Hydrologic Soil Group (Table A.3), Fig. 2, Table 6 and Table 7. (inches)
Runoff delivery factor	Proportion of runoff water delivered to intermittent or perennial stream	Based on stream buffer width and/or distance from edge of field to intermittent or perennial stream	Table 8 (Dimensionless)
Percolation	Potential amount of water that percolates through the root zone (inches)	Determined based on annual rainfall, runoff from field, and evapotranspiration (crop)	Location, Crop, Hydrologic Soil Group, Tables 12 through 15. (inches)
Soil texture/drainage class factor	Effects of soil texture and drainage on the potential for P movement through subsurface transport	Based on the soil drainage class (NRCS) and soil texture to a soil depth of 18 inches	Soil Survey: Soil drainage class and Soil texture to 18 inches Table 16 and Table A.3
Source Factors			
Sediment total P factor	Total P content of the eroded sediment (parts per million)	Estimated based on a Mehlich 1 (Virginia Tech) soil test from the field	Recent soil test results (Convert soil test P from lbs/acre to ppm) and Table 5
Runoff DRP (Dissolved Reactive Orthophosphate) factor	Amount of soil P released in dissolved forms to surface runoff (parts per million)	Estimated based on a Mehlich 1 (Virginia Tech) soil test from the field	Recent soil test results (Convert soil test P from lbs/acre to ppm) and Table 9
Subsurface DRP (Dissolved Reactive Orthophosphate) factor	Amount of soil P released in dissolved forms to percolating water (parts per million)	Determined based on Mehlich 1 (Virginia Tech) soil test from the field	Recent soil test results (Convert soil test P from lbs/acre to ppm) and Table 17
Management Factor			
Applied Fertilizer DRP factor	Amount of P released in surface runoff due to fertilizer P applications	Rate of P[2] application, solubility of P in applied source (P source coefficient, PSC), and method of P fertilizer application (PAF)	Annual P application rate (lb P/ac), Table 10 and Table 11 = (rate of applied P)*(PSC)*(PAF)

[1] Edge of field soil loss is determined using the NRCS Revised Universal Soil Loss Equation 2 (RUSLE2), while the remaining transport, source, and management factors are determined using the figures and tables presented in this technical guide.

[2] Elemental phosphorus, not phosphate (P_2O_5)

Table 2. Screening criteria based on phosphorus saturation level (and corresponding Mehlich I value) for application of the Virginia Phosphorus Index

Region[†]	Mehlich I (ppm)	P Saturation Level	Phosphorus Management Guidance
Ridge and Valley	< 55	< 20%	Phosphorus applications according to N-based nutrient management are acceptable.
	> 525	> 65%	No phosphorus should be applied.
	55 – 525	20% ≤ P ≤ 65%	Phosphorus should be applied based on the computed P-Index value.
Piedmont and Middle and Upper Coastal Plain (above the Surry Scarp)	< 55	< 20%	Phosphorus applications according to N-based nutrient management are acceptable.
	> 375	> 65%	No phosphorus should be applied.
	55 – 375	20% ≤ P ≤ 65%	Phosphorus should be applied based on the computed P-Index value.
Eastern Shore and Lower Coastal Plain (below the Surry Scarp)	< 55	< 20%	Phosphorus applications according to N-based nutrient management are acceptable.
	> 458	> 65%	No phosphorus should be applied.
	55 – 458	20% ≤ P ≤ 65%	Phosphorus should be applied based on the computed P-Index value.

[†] Table A.1 (Appendix A) includes a list of counties/cities and the corresponding physiographic region.
* Adjusted for potential P stratification

Procedures for Estimating Values of Factors in the Virginia Phosphorus Index

Information required for computing the P-Index for a specific field is outlined in Table 3. Information is required from the producer, from the Soil Survey, and from a field visit. The following sections describe how to use the information listed in Table 2 to calculate a P-Index value for a specific field.

Table 3. Information required to calculate the Virginia P-Index

Information from the Producer: ▪ Soil-test P level (may require a site visit) ▪ Analysis data for organic P sources (manure or biosolids) ▪ Rate, timing and method of application for organic P sources ▪ Analysis, rate, timing, and method of application for inorganic P fertilizer applications ▪ Crop rotation sequence ▪ Crop management information
Information from Soil Survey: ▪ County ▪ Predominate soil-mapping unit in the field ▪ Soil drainage class (needed only for fields where detailed soil maps are not available) ▪ Soil textural class to 18 inches (needed only for fields where detailed soil maps are not available) ▪ Hydrologic soil group
Information from a field visit: ▪ Riparian buffer width ▪ Distance from downslope edge of field to stream ▪ Data to calculate soil erosion using RUSLE2 (includes slope and length, etc.)

<u>Erosion Risk Factor</u>

1) Edge of field soil loss

The user must specify the edge of field soil loss in millions lbs sediment/acre. The edge of field soil loss can be calculated in tons/acre using the RUSLE2 model, which is recommended for use with the P Index.

2) Sediment delivery factor

The sediment delivery factor represents the portion of the edge-of-field sediment loss that is transported to an intermittent or perennial stream. Determine the distance from the downslope edge of the field to the nearest intermittent or perennial stream. Determine if there is a functioning riparian herbaceous or forest buffer adjacent to the stream. An existing riparian herbaceous buffer should be evaluated with respect to criteria in NRCS Virginia Conservation Practice Standard 390. An existing riparian forest buffer should be evaluated with respect to criteria in NRCS Virginia Conservation Practice Standard 391. If an existing riparian buffer meets the criteria (Standard 390 or 391, as appropriate), determine the buffer width perpendicular to the stream. Use the narrowest existing width.

Based on the distance from the field to the stream and/or the buffer width, determine the sediment delivery factor from Table 4. Use the lowest applicable sediment delivery factor. For example, if the distance to stream is 350 ft and the buffer width is 55 ft, the sediment delivery factor is equal to 0.6.

Table 4. Sediment delivery factor for the Virginia P Index

Distance from edge of field to nearest stream (intermittent or perennial)/ Riparian buffer width	Sediment Delivery Factor
> 500 ft OR riparian buffer width > 100 ft	0.4
301-500 ft OR riparian buffer width of 76-100 ft	0.6
201-300 ft OR riparian buffer width of 51-75 ft	0.8
101-200 ft OR riparian buffer width of 36-50 ft	0.9
≤100 ft AND riparian buffer width < 36 ft	1.0

3) Sediment total P factor

The equations in Table 5 are used to compute the sediment total P factor for the indicated physiographic regions in Virginia. Table A.1 (Appendix A) includes a list of counties/cities and the corresponding physiographic region. This factor represents the total P content of soil based on a Mehlich I extract soil test. The equations account for P stratification that can occur in those systems.

Table 5. Equations for determining sediment total P factor for the Virginia P Index

Region[1]	Land Use	Equation
Ridge and Valley	Pasture/hayland/ no-till	Sediment total P (ppm) = 465 + 2.655.(Mehlich I in ppm)
	All others	Sediment total P (ppm) = 465 + 2.289 (Mehlich I in ppm)
Piedmont and Middle and Upper Coastal Plain (above the Surry Scarp)	Pasture/hayland/ no-till	Sediment total P (ppm) = 344 + 2.641 (Mehlich I in ppm)
	All others	Sediment total P (ppm) = 344 + 2.277 (Mehlich I in ppm)
Eastern Shore and Lower Coastal Plain (below the Surry Scarp)	Pasture/hayland/ no-till	Sediment total P (ppm) = 156 + 2.727 (Mehlich I in ppm)
	All others	Sediment total P (ppm) = 156 + 2.351 (Mehlich I in ppm)

[1]Table A.1 (Appendix A) includes a list of counties/cities and the corresponding physiographic region.

Runoff Risk Factor

1) Runoff from field

Runoff from a field depends significantly on rainfall, crop, and soil characteristics. Variations of rainfall across the state can be characterized by climatic zone (Figure 2; Table A.1 (Appendix A) is a list of counties/cities with the corresponding climatic zone). Use Figure 2 and/or Table A.1 to select the climatic zone in which the field is located.

The curve number (Table 6) represents the effect of crop and hydrologic soil group on runoff. Determine the crop category for each crop in the field from Table A.2. Determine the soil mapping unit that occurs in the majority of the field. Determine the hydrologic soil group for that soil mapping unit from Table A.3. Determine the curve number for the cropping sequence in the field as follows: If a continuous crop is grown, read the curve number for that crop from Table 6 for the hydrologic soil group that occurs in the majority of the field. For example, if continuous corn (row crop), is grown with no conservation practices on a field on hydrologic soil group B, read a curve number value of 78 from Table 6. Then read the value of average annual runoff from Table 7 for the curve number and climatic zone for the field. For example, if the field is in the Western Piedmont climatic zone and the curve number is 78, the average annual runoff is 3.32 inches. The values in Table 7 were determined using the NRCS Curve Number Method.

If a rotation is implemented on the field, determine the curve number and corresponding annual runoff for each year of the rotation. For example, if the rotation is corn-hay-hay during the three planning years for the field with hydrologic soil group B, read the curve number for corn (78) and the curve number for hay (58). Determine the runoff for each year from Table 7. For example, again in the Western Piedmont zone, year 1 runoff is 3.32 inches; years 2 and 3 are each 0.25 inches. The average annual runoff for the rotation is (3.32+0.25+0.25)/3 = 1.27 inches.

If a field is strip-cropped, compute the average annual runoff for the rotation implemented on the majority of the strips. The order of the crop sequencing on a strip does not affect the calculation of the rotation runoff, so if some strips follow the rotation corn-corn-small grain and other strips starting with the same year are in corn-small grain-corn, the rotation runoff will be the same.

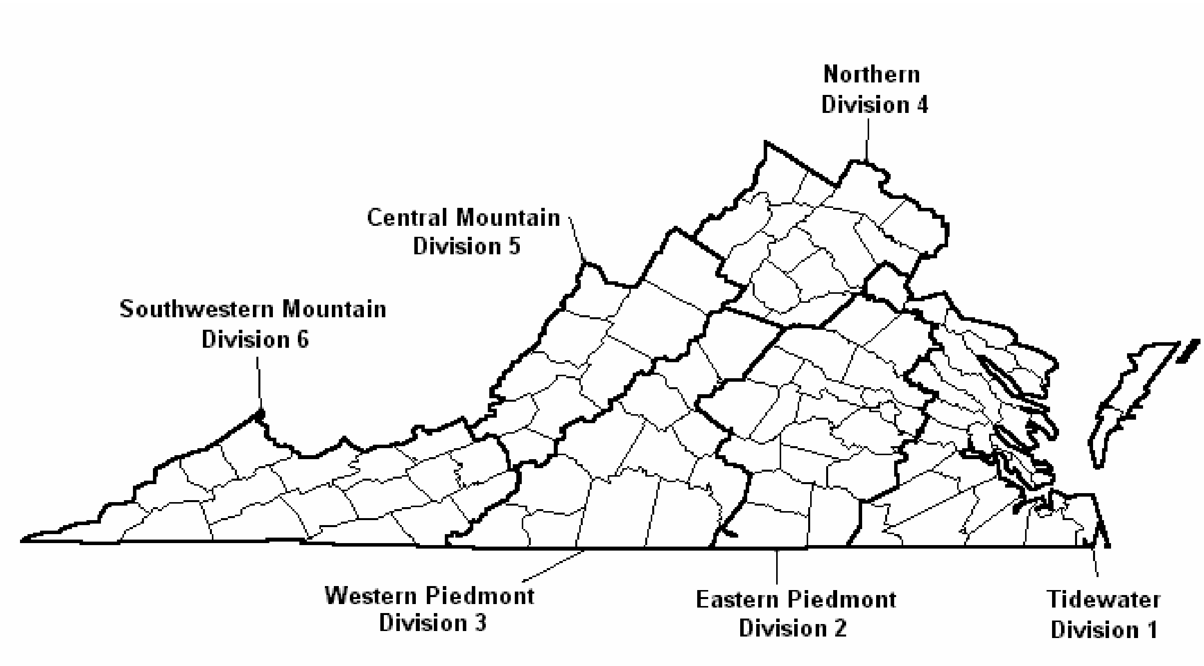

Figure 2. National Climatic Data Center Divisions for Virginia

Table 6. Runoff curve numbers based on crop category, management, and hydrologic soil group (antecedent moisture condition II and Ia = 0.2S) (adapted from Chapter 2 Estimating Runoff, *Urban Hydrology for Small Watersheds*, Technical Release 55, USDA-Natural Resources Conservation Service, 1986)

Crop Category[1]	Conservation Practice (Ground Cover for Pasture)	Hydrologic Soil Group			
		A	B	C	D
Row Crops	None	67	78	85	89
	Contour (<1% grade) or strip or terrace or conservation tillage (>30% residue)	65	75	82	86
	Two or more of contour, strip, terrace, or conservation tillage (>30% residue)	62	71	78	81
Plasticulture	All situations	77	85	90	92
Small Grains	None	63	75	83	87
	Contour (<1% grade) or strip or terrace or conservation tillage (>30% residue)	61	73	81	84
	Two or more of contour, strip, terrace, or conservation tillage (>30% residue)	59	70	78	81
Row Crop/Small Grain Rotation	None	65	77	84	88
	Contour (<1% grade) or strip or terrace or conservation tillage (>30% residue)	63	74	82	85
	Two or more of contour, strip, terrace, or conservation tillage (>30% residue)	61	72	79	83
Pasture, grassland, or range – continuous forage for grazing	<50% ground cover or heavily grazed with no mulch	68	79	86	89
	50-75% ground cover and not heavily grazed	49	69	79	84
	> 75% ground cover and lightly or only occasionally grazed	39	61	74	80
Hayland/Meadow – continuous grass, protected from grazing and generally mowed for hay	All situations	30	58	71	78
Continuous Fallow	All situations	77	86	91	94

[1] Crop categories are identified for various crops in Table A.2.

Table 7. Average annual runoff (inches) in Virginia climatic zones as a function of curve number

Curve Number[1]	Virginia Climatic Zone[2]					
	Tidewater Div 1	Eastern Piedmont Div 2	Western Piedmont Div 3	Northern Div 4	Central Mountain Div 5	Southwestern Mountain Div 6
30	0.00	0.00	0.00	0.00	0.00	0.00
39	0.00	0.00	0.00	0.00	0.00	0.00
49	0.03	0.03	0.03	0.02	0.02	0.02
51	0.06	0.05	0.06	0.04	0.04	0.03
55	0.14	0.13	0.14	0.11	0.09	0.09
58	0.24	0.23	0.25	0.19	0.16	0.15
59	0.29	0.27	0.30	0.22	0.19	0.18
60	0.34	0.32	0.35	0.26	0.23	0.22
61	0.40	0.37	0.41	0.31	0.27	0.25
62	0.47	0.43	0.48	0.36	0.31	0.30
63	0.54	0.50	0.55	0.42	0.36	0.35
64	0.62	0.58	0.64	0.48	0.42	0.40
65	0.71	0.66	0.73	0.56	0.48	0.47
67	0.93	0.86	0.95	0.73	0.64	0.62
68	1.06	0.98	1.08	0.83	0.72	0.70
69	1.20	1.11	1.22	0.94	0.82	0.80
70	1.35	1.25	1.37	1.07	0.94	0.91
71	1.52	1.41	1.54	1.21	1.06	1.03
72	1.71	1.59	1.73	1.37	1.20	1.17
73	1.91	1.78	1.94	1.54	1.35	1.32
74	2.14	2.00	2.16	1.73	1.52	1.49
75	2.39	2.23	2.41	1.94	1.70	1.68
76	2.66	2.49	2.69	2.17	1.91	1.88
77	2.97	2.77	2.99	2.42	2.14	2.11
78	3.30	3.08	3.32	2.71	2.39	2.37
79	3.66	3.43	3.68	3.02	2.67	2.65
80	4.06	3.80	4.07	3.36	2.98	2.97
81	4.50	4.22	4.51	3.74	3.33	3.32
82	4.99	4.68	4.99	4.15	3.71	3.71
83	5.53	5.18	5.51	4.62	4.14	4.14
84	6.12	5.74	6.10	5.13	4.61	4.62
85	6.77	6.36	6.74	5.70	5.14	5.17
86	7.49	7.04	7.45	6.33	5.72	5.77
87	8.30	7.81	8.24	7.03	6.38	6.45
88	9.20	8.66	9.12	7.83	7.13	7.23
89	10.19	9.60	10.10	8.70	7.95	8.09
90	11.31	10.66	11.19	9.70	8.90	9.07
91	12.62	11.91	12.47	10.87	10.01	10.25
94	17.53	16.58	17.28	15.29	14.26	14.74

[1] corresponds to values in Table 6
[2] identified in Figure 2

2) Runoff delivery factor

The runoff delivery factor represents the portion of the field runoff that is delivered to an intermittent or perennial stream. Determine the distance from the downslope edge of the field to the nearest intermittent or perennial stream. Determine if there is a functioning riparian herbaceous or forest buffer adjacent to the stream. An existing herbaceous riparian buffer should be evaluated with respect to criteria in NRCS Virginia Conservation Practice Standard 390. An existing riparian forest buffer should be evaluated with respect to criteria in NRCS Virginia Conservation Practice Standard 391. If an existing riparian buffer meets the criteria (Standard 390 or 391, as appropriate), determine the buffer width perpendicular to the stream. Use the narrowest existing width.

Based on the distance from the field to the stream and/or the buffer width, determine the runoff delivery factor from Table 8. Use the lowest applicable runoff delivery factor. For example, if the distance to stream is 220 ft and the buffer width is 50 ft, the runoff delivery factor is equal to 0.8.

Table 8. Runoff delivery factor for the Virginia P Index

Distance from edge of field to nearest stream (intermittent or perennial)/Riparian buffer width	Runoff Delivery Factor
> 500 ft OR riparian buffer width > 100 ft	0.4
301-500 ft OR riparian buffer width of 76-100 ft	0.6
201-300 ft OR riparian buffer width of 51-75 ft	0.8
101-200 ft OR riparian buffer width of 36-50 ft	0.9
≤100 ft AND riparian buffer width < 36 ft	1.0

3) Runoff DRP (Dissolved Reactive Orthophosphate) factor

The equations in Table 9 are used to compute the runoff DRP factor for the indicated physiographic regions in Virginia. This factor represents the dissolved P potentially available to runoff based on a Mehlich I extract soil test. The equations account for P stratification that can occur in those systems.

Table 9. Equations for determining runoff DRP factor in the Virginia P Index

Region[1]	Land Use	Equation
Ridge and Valley	Pasture/hayland/ no-till	Runoff DRP factor (ppm) = 0.124 + 0.0064 (Mehlich I in ppm)
	All others	Runoff DRP factor (ppm) = 0.124 + 0.0055 (Mehlich I in ppm)
Piedmont and Middle and Upper Coastal Plain (above the Surry Scarp)	Pasture/hayland/ no-till	Runoff DRP factor (ppm) = -0.013 + 0.0068 (Mehlich I in ppm)
	All others	Runoff DRP factor (ppm) = -0.013 + 0.0059 (Mehlich I in ppm)
Eastern Shore and Lower Coastal Plain (below the Surry Scarp)	Pasture/hayland/ no-till	Runoff DRP factor (ppm) = 0.0491 + 0.0059 (Mehlich I in ppm)
	All others	Runoff DRP factor (ppm) = 0.0491 + 0.0051 (Mehlich I in ppm)

[1]Table A.1 (Appendix A) includes a list of counties/cities and the corresponding physiographic region.

4) Applied fertilizer DRP (AFDRP) factor

The applied fertilizer DRP (dissolved reactive orthophosphate) factor represents the amount of DRP in runoff due to phosphorus applications. The factor is calculated using the following equation:

AFDRP factor (lb P/ac) = annual application rate (lb P/ac) * P source coefficient * method of application factor (1)

where: lb P_2O_5 * 0.437 = lb P;
P source coefficient is given in Table 10; and
method of application factor is given in Table 11.

If the application rate, fertilizer type, and/or method of application vary during the planning period, calculate the AFDRP factor for each year. Then average the annual values and use the average annual AFDRP value to compute the P-Index. If fertilizer is applied once in n years, then n years should be the planning period for the P-Index. For example, the planning period should be three years if fertilizer is applied once in three years; the planning period should be two years if fertilizer is applied every other year (once in two years).

Table 10. Phosphorus source coefficient for the Virginia P Index

Fertilizer Type	**P Source Coefficient**
Dairy/Beef Manure	0.20
Poultry Litter	0.20
Alum-treated Poultry Litter	
0.7 < Al:P ratio < 1.0	0.10
0.4 < Al:P ratio < 0.7	0.15
Inorganic	0.25
Biological P Removal (BPR) biosolids	0.20
Biosolids (all non-BPR)	0.10
Others	0.20

Table 11. Method of application factor for the Virginia P Index

Method of Application	**Method of Application Factor**
Injected or incorporated immediately	0.05
Incorporated after 2 days following application	0.10
Incorporated after 4 days following application	0.10
Surface applied, no incorporation or incorporation after 7-days	0.20
Irrigated Manure/Wastewater	0.20

Subsurface Risk Factor

1) Percolation

The amount of water that percolates through the root zone is a function of rainfall, runoff, and evapotranspiration. As indicated previously, the curve number (Table 6) represents the effect of crop and hydrologic soil group on runoff. Variations of rainfall across the state can be characterized by climatic zone (Figure 2; Table A.1). Evapotranspiration depends on the field's vegetation. Select the appropriate table (Tables 12-15 for row crops, pasture, hay, and fallow, respectively) for the crop grown each year. Then, based on the curve number (determined as described under the "Runoff" factor) and climatic zone for the field, read the value of annual percolation from the appropriate table for each year. Determine average annual percolation for use in the P-Index by averaging the annual values.

For example, in the same situation described in the runoff section, a field in continuous corn in the Western Piedmont climatic zone has a curve number of 78. The average annual percolation from Table 12 is 20.31 inches.

If a rotation is implemented on the field, determine the curve number and corresponding annual percolation for each year of the rotation. For example, if the rotation is corn-hay-hay during the three planning years for the field with hydrologic soil group B, read the curve number for corn (78) and the curve number for hay (58). Determine the percolation for year 1 from Table 12 and for years 2 and 3 from Table 14. For example, again in the Western Piedmont zone, year 1 percolation is 20.31 inches; years 2 and 3 are each 23.38 inches. The average annual percolation for the rotation is (20.31+23.38+23.38)/3 = 22.36 inches.

If a field is strip-cropped, compute the average annual percolation for the rotation implemented on the majority of the strips. The order of the crop sequencing on a strip does not affect the calculation of the rotation percolation, so if some strips follow the rotation corn-corn-small grain and other strips starting with the same year are in corn-small grain-corn, the rotation percolation will be the same.

The values in Tables 12-15 were determined by subtracting annual runoff and evapotranspiration from annual rainfall.

Table 12. Average annual percolation (inches) for row crops in Virginia climatic zones as a function of curve number

Curve Number[1]	Virginia Climatic Zone[2]					
	Tidewater Div 1	Eastern Piedmont Div 2	Western Piedmont Div 3	Northern Div 4	Central Mountain Div 5	Southwestern Mountain Div 6
30	21.94	20.66	23.63	20.10	19.39	22.32
39	21.94	20.66	23.63	20.10	19.39	22.32
49	21.91	20.63	23.60	20.08	19.37	22.30
51	21.88	20.61	23.57	20.06	19.35	22.29
55	21.80	20.53	23.49	19.99	19.30	22.23
58	21.70	20.43	23.38	19.91	19.23	22.17
59	21.65	20.39	23.33	19.88	19.20	22.14
60	21.60	20.34	23.28	19.84	19.16	22.10
61	21.54	20.29	23.22	19.79	19.12	22.07
62	21.47	20.23	23.15	19.74	19.08	22.02
63	21.40	20.16	23.08	19.68	19.03	21.97
64	21.32	20.08	22.99	19.62	18.97	21.92
65	21.23	20.00	22.90	19.54	18.91	21.85
67	21.01	19.80	22.68	19.37	18.75	21.70
68	20.88	19.68	22.55	19.27	18.67	21.62
69	20.74	19.55	22.41	19.16	18.57	21.52
70	20.59	19.41	22.26	19.03	18.45	21.41
71	20.42	19.25	22.09	18.89	18.33	21.29
72	20.23	19.07	21.90	18.73	18.19	21.15
73	20.03	18.88	21.69	18.56	18.04	21.00
74	19.80	18.66	21.47	18.37	17.87	20.83
75	19.55	18.43	21.22	18.16	17.69	20.64
76	19.28	18.17	20.94	17.93	17.48	20.44
77	18.97	17.89	20.64	17.68	17.25	20.21
78	18.64	17.58	20.31	17.39	17.00	19.95
79	18.28	17.23	19.95	17.08	16.72	19.67
80	17.88	16.86	19.56	16.74	16.41	19.35
81	17.44	16.44	19.12	16.36	16.06	19.00
82	16.95	15.98	18.64	15.95	15.68	18.61
83	16.41	15.48	18.12	15.48	15.25	18.18
84	15.82	14.92	17.53	14.97	14.78	17.70
85	15.17	14.30	16.89	14.40	14.25	17.15
86	14.45	13.62	16.18	13.77	13.67	16.55
87	13.64	12.85	15.39	13.07	13.01	15.87
88	12.74	12.00	14.51	12.27	12.26	15.09
89	11.75	11.06	13.53	11.40	11.44	14.23
90	10.63	10.00	12.44	10.40	10.49	13.25
91	9.32	8.75	11.16	9.23	9.38	12.07
94	4.41	4.08	6.35	4.81	5.13	7.58

[1] corresponds to values in Table 6
[2] identified in Figure 2

Table 13. Average annual percolation (inches) for pasture in Virginia climatic zones as a function of curve number

Curve Number[1]	Virginia Climatic Zone[2]					
	Tidewater Div 1	Eastern Piedmont Div 2	Western Piedmont Div 3	Northern Div 4	Central Mountain Div 5	Southwestern Mountain Div 6
30	18.12	16.92	19.94	16.76	15.79	18.73
39	18.12	16.92	19.94	16.76	15.79	18.73
49	18.09	16.89	19.91	16.74	15.77	18.71
51	18.06	16.87	19.88	16.72	15.75	18.70
55	17.98	16.79	19.80	16.65	15.70	18.64
58	17.88	16.69	19.69	16.57	15.63	18.58
59	17.83	16.65	19.64	16.54	15.60	18.55
60	17.78	16.60	19.59	16.50	15.56	18.51
61	17.72	16.55	19.53	16.45	15.52	18.48
62	17.65	16.49	19.46	16.40	15.48	18.43
63	17.58	16.42	19.39	16.34	15.43	18.38
64	17.50	16.34	19.30	16.28	15.37	18.33
65	17.41	16.26	19.21	16.20	15.31	18.26
67	17.19	16.06	18.99	16.03	15.15	18.11
68	17.06	15.94	18.86	15.93	15.07	18.03
69	16.92	15.81	18.72	15.82	14.97	17.93
70	16.77	15.67	18.57	15.69	14.85	17.82
71	16.60	15.51	18.40	15.55	14.73	17.70
72	16.41	15.33	18.21	15.39	14.59	17.56
73	16.21	15.14	18.00	15.22	14.44	17.41
74	15.98	14.92	17.78	15.03	14.27	17.24
75	15.73	14.69	17.53	14.82	14.09	17.05
76	15.46	14.43	17.25	14.59	13.88	16.85
77	15.15	14.15	16.95	14.34	13.65	16.62
78	14.82	13.84	16.62	14.05	13.40	16.36
79	14.46	13.49	16.26	13.74	13.12	16.08
80	14.06	13.12	15.87	13.40	12.81	15.76
81	13.62	12.70	15.43	13.02	12.46	15.41
82	13.13	12.24	14.95	12.61	12.08	15.02
83	12.59	11.74	14.43	12.14	11.65	14.59
84	12.00	11.18	13.84	11.63	11.18	14.11
85	11.35	10.56	13.20	11.06	10.65	13.56
86	10.63	9.88	12.49	10.43	10.07	12.96
87	9.82	9.11	11.70	9.73	9.41	12.28
88	8.92	8.26	10.82	8.93	8.66	11.50
89	7.93	7.32	9.84	8.06	7.84	10.64
90	6.81	6.26	8.75	7.06	6.89	9.66
91	5.50	5.01	7.47	5.89	5.78	8.48
94	0.59	0.34	2.66	1.47	1.53	3.99

[1] corresponds to values in Table 6
[2] identified in Figure 2

Table 14. Average annual percolation (inches) for hay in Virginia climatic zones as a function of curve number

Curve Number[1]	Virginia Climatic Zone[2]					
	Tidewater Div 1	Eastern Piedmont Div 2	Western Piedmont Div 3	Northern Div 4	Central Mountain Div 5	Southwestern Mountain Div 6
30	15.84	14.70	17.79	14.68	13.74	16.76
39	15.84	14.70	17.79	14.68	13.74	16.76
49	15.81	14.67	17.76	14.66	13.72	16.74
51	15.78	14.65	17.73	14.64	13.70	16.73
55	15.70	14.57	17.65	14.57	13.65	16.67
58	15.60	14.47	17.54	14.49	13.58	16.61
59	15.55	14.43	17.49	14.46	13.55	16.58
60	15.50	14.38	17.44	14.42	13.51	16.54
61	15.44	14.33	17.38	14.37	13.47	16.51
62	15.37	14.27	17.31	14.32	13.43	16.46
63	15.30	14.20	17.24	14.26	13.38	16.41
64	15.22	14.12	17.15	14.20	13.32	16.36
65	15.13	14.04	17.06	14.12	13.26	16.29
67	14.91	13.84	16.84	13.95	13.10	16.14
68	14.78	13.72	16.71	13.85	13.02	16.06
69	14.64	13.59	16.57	13.74	12.92	15.96
70	14.49	13.45	16.42	13.61	12.80	15.85
71	14.32	13.29	16.25	13.47	12.68	15.73
72	14.13	13.11	16.06	13.31	12.54	15.59
73	13.93	12.92	15.85	13.14	12.39	15.44
74	13.70	12.70	15.63	12.95	12.22	15.27
75	13.45	12.47	15.38	12.74	12.04	15.08
76	13.18	12.21	15.10	12.51	11.83	14.88
77	12.87	11.93	14.80	12.26	11.60	14.65
78	12.54	11.62	14.47	11.97	11.35	14.39
79	12.18	11.27	14.11	11.66	11.07	14.11
80	11.78	10.90	13.72	11.32	10.76	13.79
81	11.34	10.48	13.28	10.94	10.41	13.44
82	10.85	10.02	12.80	10.53	10.03	13.05
83	10.31	9.52	12.28	10.06	9.60	12.62
84	9.72	8.96	11.69	9.55	9.13	12.14
85	9.07	8.34	11.05	8.98	8.60	11.59
86	8.35	7.66	10.34	8.35	8.02	10.99
87	7.54	6.89	9.55	7.65	7.36	10.31
88	6.64	6.04	8.67	6.85	6.61	9.53
89	5.65	5.10	7.69	5.98	5.79	8.67
90	4.53	4.04	6.60	4.98	4.84	7.69
91	3.22	2.79	5.32	3.81	3.73	6.51
94	0	0	0.51	0	0	2.02

[1] corresponds to values in Table 6
[2] identified in Figure 2

Table 15. Average annual percolation (inches) for fallow conditions in Virginia climatic zones as a function of curve number

Curve Number[1]	Virginia Climatic Zone[2]					
	Tidewater Div 1	Eastern Piedmont Div 2	Western Piedmont Div 3	Northern Div 4	Central Mountain Div 5	Southwestern Mountain Div 6
30	44.67	42.82	44.83	41.13	39.59	41.61
39	44.67	42.82	44.83	41.13	39.59	41.61
49	44.64	42.79	44.80	41.11	39.57	41.59
51	44.61	42.77	44.77	41.09	39.55	41.58
55	44.53	42.69	44.69	41.02	39.50	41.52
58	44.43	42.59	44.58	40.94	39.43	41.46
59	44.38	42.55	44.53	40.91	39.40	41.43
60	44.67	42.50	44.48	40.87	39.36	41.39
61	44.27	42.45	44.42	40.82	39.32	41.36
62	44.20	42.39	44.35	40.77	39.28	41.31
63	44.13	42.32	44.28	40.71	39.23	41.26
64	44.05	42.24	44.19	40.65	39.17	41.21
65	43.96	42.16	44.10	40.57	39.11	41.14
67	43.74	41.96	43.88	40.40	38.95	40.99
68	43.61	41.84	43.75	40.30	38.87	40.91
69	43.47	41.71	43.61	40.19	38.77	40.81
70	43.32	41.57	43.46	40.06	38.65	40.70
71	43.15	41.41	43.29	39.92	38.53	40.58
72	42.96	41.23	43.10	39.76	38.39	40.44
73	42.76	41.04	42.89	39.59	38.24	40.29
74	42.53	40.82	42.67	39.40	38.07	40.12
75	42.28	40.59	42.42	39.19	37.89	39.93
76	42.01	40.33	42.14	38.96	37.68	39.73
77	41.70	40.05	41.84	38.71	37.45	39.50
78	41.37	39.74	41.51	38.42	37.20	39.24
79	41.01	39.39	41.15	38.11	36.92	38.96
80	40.61	39.02	40.76	37.77	36.61	38.64
81	40.17	38.60	40.32	37.39	36.26	38.29
82	39.68	38.14	39.84	36.98	35.88	37.90
83	39.14	37.64	39.32	36.51	35.45	37.47
84	38.55	37.08	38.73	36.00	34.98	36.99
85	37.90	36.46	38.09	35.43	34.45	36.44
86	37.18	35.78	37.38	34.80	33.87	35.84
87	36.37	35.01	36.59	34.10	33.21	35.16
88	35.47	34.16	35.71	33.30	32.46	34.38
89	34.48	33.22	34.73	32.43	31.64	33.52
90	33.36	32.16	33.64	31.43	30.69	32.54
91	32.05	30.91	32.36	30.26	29.58	31.36
94	27.14	26.24	27.55	25.84	25.33	26.87

[1] corresponds to values in Table 6
[2] identified in Figure 2

2) Soil texture/drainage class factor

The soil texture/drainage class factor values indicated in Table 16 assume that very poorly, poorly, and somewhat poorly drained soils will have artificial drainage if they are being farmed. Values for the soil texture/drainage class factor are given in Table 16 and should be used whether or not the field has artificial drainage. For fields where detailed soil maps are not available, determine the nature and variation in soil texture to a depth of 18 inches and the soil drainage class via on-site investigation of several representative profiles. For fields where adequately detailed soil survey coverage is available, look up the predominant soil type for the field in question in the mapping legend, and then use Table A.3 to determine the appropriate factor.

Table 16. Soil texture/drainage class factor

Soil drainage class[1]	**Soil texture to depth of 18"**		
	Coarse sand Sand Fine sand Very fine sand Loamy coarse sand Loamy sand	**Loamy fine sand Loamy very fine sand Sandy loam Coarse sandy loam Fine sandy loam Very fine sandy loam Loam Silt loam Silt Sandy clay loam**	**Clay loam Silty clay loam Sandy clay Silty clay Clay**
Very poorly and poorly drained	1.0	0.75	0.50
Somewhat poorly drained	0.25	0.25	0.0
Moderately-well and well-drained	0.0	0.0	0.0
Somewhat excessively and excessively drained	See footnote 2	See footnote 2	See footnote 2

[1] **Very Poorly Drained**: Free water remains at or very near the ground surface during much of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. The soils are commonly level or depressed and frequently ponded.

Poorly Drained: Free water is commonly at or near the surface long enough during the growing season so that most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously wet directly below the plow depth.

Somewhat Poorly Drained: Wetness markedly restricts the growth of mesophytic crops, unless artificial drainage is provided.

Moderately Well Drained: The soils are wet for only a short time within the rooting depth during the growing season, but long enough that most mesophytic crops are affected.

Well Drained: Wetness does not inhibit the growth of roots for significant periods during most growing seasons. The soils are mainly free of the mottling that is related to wetness.

Excessively drained and somewhat excessively drained: Water is removed very rapidly. The free water table is deep. Soils are commonly very coarse textured.

[2] Within these drainage classes (somewhat excessively and excessively drained), soils that classify as Psamments are assigned a factor of 1.0, and Udepts or Orthents with coarse-loamy or sandy skeletal particle size classes are assigned a factor of 0.50. All other soils in these drainage classes are assigned a factor of 0.0.

3) Subsurface DRP (Dissolved Reactive Orthophosphate) factor

The equations in Table 17 are used to compute the subsurface DRP factor for the indicated physiographic regions in Virginia. This factor represents the dissolved P potentially available for subsurface loss based on a Mehlich I extract soil test.

Table 17. Equations for determining subsurface DRP factor for the Virginia P Index

Region[1]	Equation
Ridge and Valley	Subsurface DRP factor (ppm) = -0.0077 + 0.0096 (Mehlich I in ppm)
Piedmont and Middle and Upper Coastal Plain (above the Surry Scarp)	Subsurface DRP factor (ppm) = -0.1579 + 0.0109 (Mehlich I in ppm)
Eastern Shore and Lower Coastal Plain (counties below the Surry Scarp)	Subsurface DRP factor (ppm) = 0.2045 + 0.0059 (Mehlich I in ppm)

[1]Table A.1 (Appendix A) includes a list of counties/cities and the corresponding physiographic region.

Example Calculations of the Virginia P-Index

Example 1: An agricultural field in Rockingham County

Field and Site Information: The soil type is a Frederick-Lodi silt loam, a well-drained soil with a texture of silt loam to clay to a depth of 18 inches. Hydrologic soil group = B (Table A.3). The distance from the edge of the field to a stream averages 150 feet. Soil loss from the field as determined using RUSLE2 = 4 tons/acre. There is no riparian buffer.

Phosphorus Source and Field Management: The crop rotation is corn for silage (plus crop residue – planted no-till) followed by rye for silage (no crop residue – conventional tillage), both planted in straight rows. The soil test P value based on the Virginia Tech Soil Testing Laboratory (Mehlich 1 Extract) is 340 lbs P/acre or 170 ppm P, which is in the "Very High" category based on the Virginia Tech Soil Testing Laboratory. Poultry litter (PAN = 35 lbs/ton; P_2O_5 = 62 lbs/ton) is applied without incorporation at a rate of 4.3 tons/acre. This rate is based on the nitrogen needs of the corn grown for silage (PAN = 150 lbs/acre). The resulting P application is 265 lbs P_2O_5/acre or 116 lbs P/acre.

<u>Erosion Risk Factor (ERF)</u>

- Edge of Field Soil Loss (EFSL)= 4 tons/acre (RUSLE2)
- Sediment Delivery Ratio (SDR) = 0.9 (Table 4)
- Sediment Total P Factor (STPF) = 854 ppm (Table 5)
- **ERF = [Edge of field soil loss] X [Sediment Delivery Ratio] X [Sediment Total P Factor] X 0.002**
- **Erosion Risk Factor or ERF = 4 X 0.9 X 854 X 0.002 = 6.15**

<u>Runoff Risk Factor (RRF)</u>

- Runoff From Field (RFF) = 1.52 inches (Fig. 2, Tables 6 and 7) (Curve Number = 74)
- Runoff Delivery Factor (RDF) = 0.9 (Table 8)
- Runoff DRP Factor (RDRPF) = 1.06 ppm (Table 9)
- Applied DRP Factor (ADRPF) = 116 lbs/acre X 0.20 X 0.20 = 4.64 lbs/acre (Tables 10 and 11)
- **Runoff Risk Factor = [RFF X RDF X RDRPF X 0.22651] + ADRPF**
- **Runoff Risk Factor = [1.52 X 0.9 X 1.06 X 0.22651] + 4.64 = 4.97**

<u>Subsurface Risk Factor (SRF)</u>

- Percolation = 17.87 inches (Fig. 2, Tables 6 and 12)
- Soil texture/drainage factor = 0 (Table 16, A.3)
- Subsurface DRP Factor = 1.62 ppm (Table 17)
- **SRF = [Percolation]X [Soil texture/drainage factor] X [Subsurface DRP factor] X 0.22651**
- **Subsurface Risk Factor = 17.87 X 0 X 1.62 X 0.22651 = 0**

<u>Phosphorus Risk & Phosphorus Index Calculation:</u>

- **Phosphorus Risk = Erosion Risk Factor + Runoff Risk Factor + Subsurface Risk Factor**
- **P-Index = (ERF X 8.5) + (RRF X 8.5) + (SRF X 8.5)**
- **P-Index = (6.15 X 8.5) + (4.97 X 8.5) + 0 = 52 + 42 + 0**
- **P-Index = 94**

The overall P-Index rating for the field is 94 and corresponds to a “High” P-Index rating (Fig. 1). Based on the interpretation of the Virginia P-Index ratings, the producer should apply poultry litter at a rate no higher than the estimated crop P removal needs for the corn and rye silage rotation. Crop P removal can be estimated as illustrated in the following table, based on crop P removal rates presented in Table A.4 and yield potential of the soil. As seen in the following table, the crop P removal for this rotation is 100 lbs P_2O_5/acre. The proposed rate of application (265 lbs P_2O_5/acre) exceeds the estimated crop removal. The producer should apply no more than 100 lbs P_2O_5/acre under the proposed crop and management scenario.

Credit given in Virginia for phosphorus removal by harvested crops

Crop	**Yield Potential[1]**	**Crop P Removal[2]**	**Proposed P Applied as Poultry Litter**
Corn Silage	18 tons/acre	72 lbs P_2O_5	265 lbs P_2O_5
Rye Silage	5 tons/acre	28 lbs P_2O_5	
Total		100 lbs P_2O_5	265 lbs P_2O_5

Soil = Frederick-Lodi Silt Loam. Soil Productivity Group: Corn = IIb; Small Grains = I; Tall Grass Hay = II.
[1] Donohue, S.J. and S.E. Heckendorn. 1994. Soil Test Recommendations for Virginia. Virginia Tech and Virginia Cooperative Extension.
[2] Determined using potential yield and P removal presented in Table A.4.

Example 2: An agricultural field in Accomack County

Field & Site Information: The soil type is a Nimmo sandy loam, a poorly-drained soil with a loam to sandy loam texture to a depth of 18 inches. Hydrologic soil group = D (Table A.3). The distance from the edge of the field to a stream averages 150 feet. Soil loss from the field as determined using RUSLE2 = 2 tons/acre. The riparian buffer is less than 30 ft wide.

Phosphorus Source and Field Management: The crop is corn for grain planted using conventional tillage in straight rows. The soil test P value based on the Virginia Tech Soil Testing Laboratory (Mehlich 1 Extract) is 700 lbs P/acre or 350 ppm P, which is in the "Very High" category based on the Virginia Tech Soil Testing Laboratory. Poultry litter (PAN = 35 lbs/ton; P_2O_5 = 62 lbs/ton) is applied without incorporation at a rate of 4 tons/acre. This rate is based on the nitrogen needs of the corn grown for grain (PAN = 140 lbs/acre). The resulting P application is 248 lbs P_2O_5/acre or 108 lbs P/acre.

Erosion Risk Factor (ERF)
- Edge of Field Soil Loss (EFSL)= 2 tons/acre (RUSLE2)
- Sediment Delivery Ratio (SDR) = 0.9 (Table 4)
- Sediment Total P Factor (STPF) = 979 ppm (Table 5)
- **ERF = [Edge of field soil loss] X [Sediment Delivery Ratio] X [Sediment Total P Factor] X 0.002**
- **Erosion Risk Factor or ERF = 2 X 0.9 X 979 X 0.002 = 3.52**

Runoff Risk Factor (RRF)
- Runoff From Field (RFF) = 10.19 inches (Fig. 2, Tables 6 and 7) (Curve number = 89)
- Runoff Delivery Factor (RDF) = 0.9 (Table 8)
- Runoff DRP Factor (RDRPF) = 1.83 ppm (Table 9)
- Applied DRP Factor (ADRPF) = 108 lbs/acre X 0.20 X 0.20 = 4.32 lbs/acre (Table 10 & 11)
- **Runoff Risk Factor = [RFF X RDF X RDRPF X 0.22651] + ADRPF**
- **Runoff Risk Factor = [10.19 X 0.9 X 1.83 X 0.22651] + 4.32 = 8.12**

Subsurface Risk Factor (SRF)
- Percolation = 11.75 inches (Fig. 1, Tables 6 and 12)
- Soil texture/drainage factor = 0.75 (Table 16, A.3)
- Subsurface DRP Factor = 1.15 ppm (Table 17)
- **SRF = [Percolation]X [Soil texture/drainage factor] X [Subsurface DRP factor] X 0.22651**
- **Subsurface Risk Factor = 11.75 X 0.75 X 2.27 X 0.22651 = 4.51**

Phosphorus Risk & Phosphorus Index Calculation:
- **Phosphorus Risk = Erosion Risk Factor + Runoff Risk Factor + Subsurface Risk Factor**
- **P-Index = (ERF X 8.5) + (RRF X 8.5) + (SRF X 8.5)**
- **P-Index = (3.52 X 8.5) + (8.12 X 8.5) + (4.53 X 8.5) = 30 + 69 + 39**
- **P-Index = 138**

The overall P-Index rating for the field is 138 and corresponds to a "Very High" P-Index rating (Figure 1). Based on the interpretation of the Virginia P Index rating, the producer should not apply any additional P to this field.

Example 3: An agricultural field in Isle of Wight County

Field & Site Information: The soil type is a Emporia fine sandy loam, a deep, well-drained soil with a sandy loam to sandy clay loam texture to a depth of 18 inches. Hydrologic soil group = C (Table A.3). The distance from the edge of the field to a stream averages 75 feet. Soil loss from the field as determined using RUSLE2 = 1 tons/acre. The minimum riparian buffer width is 25 ft.

Phosphorus Source and Field Management: The crop rotation is bermudagrass cut for hay with rye inter seeded in the fall and cut for silage. The soil test P value based on the Virginia Tech Soil Testing Laboratory (Mehlich 1 Extract) is 480 lbs P/acre or 240 ppm P, which is in the "Very High" category based on the Virginia Tech Soil Testing Laboratory. Secondary lagoon waste from a farrow-finish swine operation (1.5 lbs PAN/1000 gal, 0.68 lbs P_2O_5/1000 gal) is applied based on the nitrogen needs of the burmudagrass/rye for hay rotation (Plant Available Nitrogen applied/year = 370 lbs/acre). The resulting P application is 168 lbs P_2O_5/acre or 73.4 lbs P/acre. The field has been in the bermudagrass, interseeded rye for 7 years.

Erosion Risk Factor (ERF)

- Edge of Field Soil Loss (EFSL)= 1 tons/acre (RUSLE2)
- Sediment Delivery Ratio (SDR) = 1.0 (Table 4)
- Sediment Total P Factor (STPF) = 810 ppm (Table 5)
- **ERF = [Edge of field soil loss] X [Sediment Delivery Ratio] X [Sediment Total P Factor] X 0.002**
- **Erosion Risk Factor or ERF = 1 X 1.0 X 810 x 0.002 = 1.62**

Runoff Risk Factor (RRF)

- Runoff From Field (RFF) = 1.52 inches (Fig. 2, Tables 6 and 7) (Curve number = 71)
- Runoff Delivery Factor (RDF) = 1.0 (Table 8)
- Runoff DRP Factor (RDRPF) = 1.47 ppm (Table 9)
- Applied DRP Factor (ADRPF) = 73.4 lbs/acre X 0.20 X 0.20 = 2.94 lbs/acre (Table 10 & 11)
- **Runoff Risk Factor = [RFF X RDF X RDRPF X 0.22651] + ADRPF**
- **Runoff Risk Factor = [1.52 X 1.0 X 1.47 X 0.22651] + 2.94 = 3.45**

Subsurface Risk Factor (SRF)

- Percolation = 14.32 inches (Fig. 2, Tables 6 and 14)
- Soil texture/drainage factor = 0 (Table 16, A.3)
- Subsurface DRP Factor = 1.62 ppm (Table 17)
- **SRF = [Percolation]X [Soil texture/drainage factor] X [Subsurface DRP factor] X 0.22651**
- **Subsurface Risk Factor = 3.24 X 0 X 1.62 X 0.22651 = 0**

Phosphorus Risk & Phosphorus Index Calculation:

- **Phosphorus Risk = Erosion Risk Factor + Runoff Risk Factor + Subsurface Risk Factor**
- **P-Index = (ERF X 8.5) + (RRF X 8.5) + (SRF X 8.5)**
- **P-Index = (1.62 X 8.5) + (3.45 X 8.5) + 0 = 14 + 29 + 0**
- **P-Index = 43**

The overall P-Index rating for the field is 43 and corresponds to a "Medium" P-Index rating (Fig. 1). Based on the interpretation of the Virginia P Index ratings, the producer should apply the secondary swine lagoon waste at a rate not to exceed 1.5 times the estimated crop P removal needs for the bermudagrass/rye for hay rotation. Crop P removal can be estimated as illustrated in the following table, based on crop P removal rates presented in Table A.4 and yield potential of the soil. As seen in the following table, 1.5 times the crop P removal for this rotation is 120 lbs P_2O_5/acre. The proposed rate of application (168 lbs P_2O_5/acre) exceeds the estimated crop removal. The producer should apply no more than 120 lbs P_2O_5/acre under the proposed crop and management scenario.

Credit given in Virginia for phosphorus removal by harvested crops

Crop	**Yield Potential[1]**	**Crop P Removal[2]**	**Proposed P Applied as Secondary Swine Lagoon Waste**
Bermudagrass	5 tons/acre	52 lbs P_2O_5	168 lbs P_2O_5
Rye	5 tons/acre	28 lbs P_2O_5	
Total		80 lbs P_2O_5	168 lbs P_2O_5

Soil = Emporia fine sandy loam. Soil Productivity Group: Small Grains = II; Tall Grass Hay = II.

[1] Donohue, S.J. and S.E. Heckendorn. 1994. Soil Test Recommendations for Virginia. Virginia Tech and Virginia Cooperative Extension.

[2] Determined using potential yield and P removal presented in Table A.4.

Example 4 - Three Year Crop Rotation

An agricultural field on a dairy operation in Rockingham County

Field & Site Information:

Soil: Frederick-Lodi silt loam; **Drainage Class** = well-drained; **Textural class**: silt loam to clay; **Hydrologic soil group** = B (Table A.3); **Soil Erosion based on RUSLE2** = 3 tons/acre; **Distance from edge of field to intermittent stream** = 80 feet; **Riparian Buffer** = 0 feet

Phosphorus Source and Field Management: The crop rotation is two years of corn planted no-till for silage followed by rye for silage planted using conventional tillage. Both crops are planted in straight rows. Following corn, the field is established in orchardgrass hay for four years. The three-year planning period (i.e., the nutrient management plan is revised) begins with the first year of corn silage. The soil test P value based on the Virginia Tech Soil Testing Laboratory (Mehlich 1 Extract) is 350 lbs P/acre or 175 ppm P, which is in the "Very High" category based on the Virginia Tech Soil Testing Laboratory. Liquid dairy manure is the primary source of P applied to this field according to the schedule given below.

Phosphorus	Year 1	Year 2	Year 3
	Spring - summer: Corn Silage	**Spring - Summer: Corn Silage**	**Orchardgrass - Hay**
	Fall-Winter: Rye Silage	**Fall: Orchardgrass Establishment**	
Phosphorus Source	Spring - Corn: Liquid Dairy Manure (6000 gal/acre)	Spring - Liquid Dairy Manure (6000 gal/acre)	Spring/Summer - Liquid Dairy Manure (6000 gal/acre)
Phosphorus Rate	72 lbs P_2O_5/acre	72 lbs P_2O_5/acre	72 lbs P_2O_5/acre
Phosphorus Source	Fall - Rye: Liquid Dairy Manure (6000 gal/acre)	None	None
Phosphorus Rate	72 lbs P_2O_5/acre		

Erosion Risk Factor (ERF)

- Edge of Field Soil Loss (EFSL)= 3 tons/acre (RUSLE2)
- Sediment Delivery Ratio (SDR) = 1.0 (Table 4)
- Sediment Total P Factor (STPF) = 866 ppm (Table 5)
- **ERF = [EFSL] X [Sediment Delivery Ratio] X [Sediment Total P Factor] X 0.002**
- **Erosion Risk Factor or ERF = 3 X 1.0 X 866 x 0.002 = 5.20**

Runoff Risk Factor (RRF):

- Runoff From Field (RFF) for ***Rotation***: **(Runoff from Field is calculated for each year and averaged for the number of years in the rotation)**
  - Runoff Year 1: Runoff From Field (RFF) = 1.52 inches (Fig. 2, Table 6 & Table 7) (Curve Number = 74)

- Runoff Year 2: Runoff From Field (RFF) = 1.52 inches (Fig. 2, Table 6 & Table 7) (Curve Number = 74)
- Runoff Year 3: Runoff From Field (RFF) = 0.16 inches (Fig. 2, Table 6 & Table 7) (Curve Number = 58)
- **Average Runoff for Rotation = (Runoff Year 1 + Runoff Year 2 + Runoff Year 3)/3**
- **Average Runoff From Field for Rotation = (1.52 + 1.52 + 0.16)/3 = 1.07 inches**

- Runoff Delivery Factor (RDF) = 1.0 (Table 8)
- Runoff DRP Factor (RDRPF) = 1.09 ppm (Table 9)
- Applied DRP Factor (AFDRP) for Rotation: **(AFDRP is calculated for each year and averaged for the number of years in the rotation)**
  - AFDRP Year 1: Applied DRP Factor (AFDRP) = 63 lbs/acre X 0.20 X 0.20 = 2.52 lbs/acre (Table 10 & Table 11)
  - AFDRP Year 1: Applied DRP Factor (AFDRP) = 31.5 lbs/acre X 0.20 X 0.20 = 1.26 lbs/acre (Table 10 & Table 11)
  - AFDRP Year 1: Applied DRP Factor (AFDRP) = 31.5 lbs/acre X 0.20 X 0.20 = 1.26 lbs/acre (Table 10 & Table 11)
  - **Average AFDRP for Rotation = (AFDRP Year 1 + AFDRP Year 2 + AFDRP Year 3)/3**
  - **Average AFDRP for Rotation = (2.52 + 1.26 + 1.26)/3 = 1.68**
- **Runoff Risk Factor = [RFF X RDF X RDRPF X 0.22651] + ADRPF**
- **Runoff Risk Factor = [1.07 X 1.0 X 1.09 X 0.22651] + 1.68 = 1.94**

Subsurface Risk Factor (SRF)

- Percolation: **(Potential Percolation is calculated for each year and averaged for the number of years in the rotation)**
  - Percolation Year 1: Percolation = 17.87 inches (Fig 2 ; Table 6; Table 12)
  - Percolation Year 2: Percolation = 17.87 inches (Fig. 2; Table 6; Tables 12)
  - Percolation Year 3: Percolation = 13.58 inches (Fig. 2; Table 6; Tables 14)
  - **Average Percolation for Rotation = (Runoff Year 1 + Runoff Year 2 + Runoff Year 3)/3**
  - **Average Percolation for Rotation = (17.87 + 17.87 + 13.58)/3 = 16.44 inches**
  - Soil texture/drainage factor = 0 (Table 16, A.3)
  - Subsurface DRP Factor = 1.67 ppm (Table 17)
  - **SRF = [Percolation]X [Soil texture/drainage factor] X [Subsurface DRP factor] X 0.22651**
  - **Subsurface Risk Factor = 16.44 X 0 X 1.67 X 0.22651 = 0**

<u>Phosphorus Risk & Phosphorus Index Calculation for the Three Year Rotation:</u>

- **Phosphorus Risk = Erosion Risk Factor + Runoff Risk Factor + Subsurface Risk Factor**
- **P-Index = (ERF X 8.5) + (RRF X 8.5) + (SRF X 8.5)**
- **Phosphorus Risk = (5.20 X 8.5) + (1.94 X 8.5) + 0 = 44 + 16 + 0**
- **P-Index = 60**

The overall P-Index rating for the field is 60 and corresponds to a "Medium" P-Index interpretative rating (Fig. 1). Based on the interpretation of the Virginia P Index ratings, the producer should apply the liquid dairy manure at a rate not to exceed 1.5 times the estimated crop P removal needs for the corn silage/orchardgrass rotation. Crop P removal can be estimated as illustrated in the following table, based on crop P removal rates presented in Table A.4 and yield potential of the soil. As seen in the following table, 1.5 times the crop P removal for this three-year rotation is 354 lbs P_2O_5/acre. The proposed rate of application (288 lbs P_2O_5/acre) for the three-year planning period is lower than the estimated 1.5 times crop removal, so no adjustment is needed to the proposed rate.

Credit given in Virginia for phosphorus removal by harvested crops during the rotation

Year	Crop	Yield Potential[1]	Crop P Removal[2]	P applied as Dairy Manure
Year 1	Corn Silage	18 tons/acre	72 lbs P_2O_5	72 lbs P_2O_5
	Rye Silage	5 tons/acre	28 lbs P_2O_5	72 lbs P_2O_5
Year 2	Corn Silage	18 tons/acre	72 lbs P_2O_5	72 lbs P_2O_5
	Orchardgrass Hay Est.	0 tons/acre	0 lbs P_2O_5	0 lbs P_2O_5
Year 3	Orchardgrass Hay	4 tons/acre	64 lbs P_2O_5	72 lbs P_2O_5
Three Year Total			236 lbs P_2O_5	288 lbs P_2O_5
1.5 Times The Three Year Total Crop Removal			354 lbs P_2O_5	

Soil = Frederick-Lodi Silt Loam. Soil Productivity Group: Corn = IIb; Small Grains = I; Tall Grass Hay = II.

[1] Donohue, S.J. and S.E. Heckendorn. 1994. Soil Test Recommendations for Virginia. Virginia Tech and Virginia Cooperative Extension.

[2] Determined using potential yield and P removal presented in Table A.4.

Glossary of Terms: Virginia P-Index

Applied Fertilizer DRP factor – amount of phosphorus released in surface runoff due to P applications, based on the rate of applied phosphorus, the P source coefficient, and the method of fertilizer application factor

Buffer width – minimum width of the riparian buffer perpendicular to the stream

Climatic division – Virginia is divided into six regions based on climatic homogeneity

Curve number – value that is a function of antecedent soil moisture, hydrologic soil group, and vegetal cover/cultural practices; used in the NRCS Curve Number Method to compute runoff volume

Dissolved Reactive Orthophosphate (DRP) – The concentration of dissolved inorganic orthophosphate in solution (i.e., $H_2PO_4^-$ and HPO_4^{2-}). DRP is the form of P that is most readily available to aquatic plants.

Distance from edge of field – the straight-line distance from the edge of the field to the nearest stream (intermittent or perennial)

Edge of field – downslope end of the field

Filter strip – a strip or area of vegetation for removing sediment, organic matter, nutrients, and other pollutants from runoff (definition from NRCS Virginia Conservation Practice Standard 393). Filter strips may be grass, shrubs, trees, or other perennial vegetation. Nutrient applications in strip should not exceed soil test recommendations.

Flow distance from field – the length of the flow path from the edge of the field to an intermittent or perennial stream

Hydrologic soil group – Refers to soils grouped by runoff-producing characteristics. Soils are assigned to four groups (A, B, C, D). Soils in group A have a high infiltration rate when thoroughly wet and a corresponding low runoff potential. At the other extreme, soils in group D have a very low infiltration rate and a corresponding high runoff potential.

Intermittent stream – in the context of the P-Index, this term refers to a stream, or reach of stream (or ditch or similar conveyance), that carries water during and for a short time after precipitation (often termed “ephemeral”) as well as a stream that flows only during wet periods of the year (30 to 90% of the year) and is fed by seepage from perched water tables, saturated areas including lateral subsurface flow, or other groundwater sources in addition to snow melt or runoff from rainfall events.

Method of fertilizer application factor – The portion (fraction) of the applied phosphorus source released to surface runoff as affected by the method of application.

NRCS Curve Number Method - The Curve Number (CN) method computes runoff as a function of

$$RO = \frac{(P - 0.2\,S\,)^2}{P + 0.8\,S} \quad with\ P > 0.2\,S$$

where:

$$S = \frac{1000}{CN} - 10$$

rainfall, antecedent soil moisture, soil type, and vegetal cover/cultural practices and is expressed as:

RO	=	runoff volume (inches);
P	=	rainfall depth (inches); and
CN	=	runoff curve number; a function of antecedent soil moisture, hydrologic soil group, and cover/cultural practices; values are available in tables in a number of sources

Percolation – amount of water that infiltrates the soil and is not lost from the soil profile through evapotranspiration. This water may flow below the root zone and recharge groundwater flows or aquifers.

P source coefficient – The portion (fraction) of phosphorus in any applied fertilizer source that is released to surface runoff.

Riparian forest buffer – an area of predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies (definition from NRCS Virginia Conservation Practice Standard 391). Nutrient applications in strip should not exceed soil test recommendations.

Riparian herbaceous buffer (cover) – an area of predominantly grass, forb and herbaceous vegetation located adjacent to and up-gradient from watercourses or water bodies (definition from NRCS Virginia Conservation Practice Standard 390). Nutrient applications in strip should not exceed soil test recommendations.

Runoff – rainfall excess (difference between rainfall and infiltration during rainfall events) that flows over the ground surface and leaves a field

Runoff DRP (dissolved reactive orthophosphate) factor – Represents the dissolved phosphorus potentially available to be transported by surface runoff

Sediment total P factor – Represents the concentration of total phosphorus (expressed as ppm) that is contained in the eroded sediment

Soil texture/drainage class factor – Accounts for the effect of soil drainage class and soil texture on the potential for phosphorus losses in subsurface transport.

Stream buffer – small areas or strips of land in permanent vegetation adjacent to streams. Stream buffers are designed to intercept pollutants. Buffers slow the flow rate, increase infiltration and sediment deposition, and reduce phosphorus delivered to an intermittent or perennial stream.

Stream buffer width – minimum width of the vegetated buffer adjacent to an intermittent or perennial stream

Subsurface DRP (dissolved reactive orthophosphate) factor – Represents the dissolved phosphorus potentially available for subsurface loss

Vegetated filter strip – strips of land in permanent vegetation, with at least 70% herbaceous ground cover, located at the downslope edge of a field.

Appendix A

Table A.1. Virginia counties and cities with corresponding climatic division and physiographic region

County/City	Climatic Division	Physiographic Region
Accomack	Tidewater	Eastern Shore and Lower Coastal Plain
Albemarle	Western Piedmont	Piedmont and Upper Coastal Plain
Alexandria	Northern	Piedmont and Upper Coastal Plain
Alleghany	Central Mountain	Ridge and Valley
Amelia	Eastern Piedmont	Piedmont and Upper Coastal Plain
Amherst	Western Piedmont	Piedmont and Upper Coastal Plain
Appomattox	Western Piedmont	Piedmont and Upper Coastal Plain
Arlington	Northern	Piedmont and Upper Coastal Plain
Augusta	Central Mountain	Ridge and Valley
Bath	Central Mountain	Ridge and Valley
Bedford	Western Piedmont	Piedmont and Upper Coastal Plain
Bedford City	Western Piedmont	Piedmont and Upper Coastal Plain
Bland	Southwestern Mountain	Ridge and Valley
Botetourt	Central Mountain	Ridge and Valley
Bristol	Southwestern Mountain	Ridge and Valley
Brunswick	Eastern Piedmont	Piedmont and Upper Coastal Plain
Buchanan	Southwestern Mountain	Ridge and Valley
Buckingham	Eastern Piedmont	Piedmont and Upper Coastal Plain
Buena Vista	Central Mountain	Ridge and Valley
Campbell	Western Piedmont	Piedmont and Upper Coastal Plain
Caroline	Eastern Piedmont	Piedmont and Upper Coastal Plain
Carroll	Southwestern Mountain	Piedmont and Upper Coastal Plain
Charles City	Tidewater	Piedmont and Upper Coastal Plain
Charlotte	Western Piedmont	Piedmont and Upper Coastal Plain
Charlottesville	Western Piedmont	Piedmont and Upper Coastal Plain
Chesapeake	Tidewater	Eastern Shore and Lower Coastal Plain
Chesterfield	Eastern Piedmont	Piedmont and Upper Coastal Plain
Clarke	Northern	west of the Blue Ridge: Ridge and Valley the Blue Ridge and east: Piedmont and Upper Coastal Plain
Clifton Forge	Central Mountain	Eastern Shore and Lower Coastal Plain
Colonial Heights	Eastern Piedmont	Piedmont and Upper Coastal Plain
Covington	Central Mountain	Ridge and Valley
Craig	Central Mountain	Ridge and Valley
Culpeper	Northern	Piedmont and Upper Coastal Plain
Cumberland	Eastern Piedmont	Piedmont and Upper Coastal Plain
Danville	Western Piedmont	Piedmont and Upper Coastal Plain
Dickenson	Southwestern Mountain	Ridge and Valley
Dinwiddie	Eastern Piedmont	Piedmont and Upper Coastal Plain
Emporia	Tidewater	Piedmont and Upper Coastal Plain
Essex	Tidewater	Eastern Shore and Lower Coastal Plain

County/City	Climatic Division	Physiographic Region
Fairfax	Northern	Piedmont and Upper Coastal Plain
Fairfax City	Northern	Piedmont and Upper Coastal Plain
Falls Church	Northern	Piedmont and Upper Coastal Plain
Fauquier	Northern	Piedmont and Upper Coastal Plain
Floyd	Southwestern Mountain	Piedmont and Upper Coastal Plain
Fluvanna	Eastern Piedmont	Piedmont and Upper Coastal Plain
Franklin	Western Piedmont	Piedmont and Upper Coastal Plain
Franklin City	Tidewater	Piedmont and Upper Coastal Plain
Frederick	Northern	Ridge and Valley
Fredericksburg	Eastern Piedmont	Piedmont and Upper Coastal Plain
Galax	Southwestern Mountain	Piedmont and Upper Coastal Plain
Giles	Southwestern Mountain	Ridge and Valley
Gloucester	Tidewater	Eastern Shore and Lower Coastal Plain
Goochland	Eastern Piedmont	Piedmont and Upper Coastal Plain
Grayson	Southwestern Mountain	Piedmont and Upper Coastal Plain
Greene	Northern	Piedmont and Upper Coastal Plain
Greensville	Tidewater	Piedmont and Upper Coastal Plain
Halifax	Western Piedmont	Piedmont and Upper Coastal Plain
Hampton	Tidewater	Eastern Shore and Lower Coastal Plain
Hanover	Eastern Piedmont	Piedmont and Upper Coastal Plain
Harrisonburg	Central Mountain	Ridge and Valley
Henrico	Eastern Piedmont	Piedmont and Upper Coastal Plain
Henry	Western Piedmont	Piedmont and Upper Coastal Plain
Highland	Central Mountain	Ridge and Valley
Hopewell	Tidewater	Piedmont and Upper Coastal Plain
Isle of Wight	Tidewater	Eastern Shore and Lower Coastal Plain
James City	Tidewater	Eastern Shore and Lower Coastal Plain
King and Queen	Tidewater	Eastern Shore and Lower Coastal Plain
King George	Tidewater	Piedmont and Upper Coastal Plain
King William	Tidewater	Piedmont and Upper Coastal Plain
Lancaster	Tidewater	Eastern Shore and Lower Coastal Plain
Lee	Southwestern Mountain	Ridge and Valley
Lexington	Central Mountain	Ridge and Valley
Loudoun	Northern	Piedmont and Upper Coastal Plain
Louisa	Eastern Piedmont	Piedmont and Upper Coastal Plain
Lunenburg	Eastern Piedmont	Piedmont and Upper Coastal Plain
Lynchburg	Western Piedmont	Piedmont and Upper Coastal Plain
Madison	Northern	Piedmont and Upper Coastal Plain
Manassas City	Northern	Piedmont and Upper Coastal Plain
Manassas Park City	Northern	Piedmont and Upper Coastal Plain
Martinsville	Western Piedmont	Piedmont and Upper Coastal Plain
Mathews	Tidewater	Eastern Shore and Lower Coastal Plain
Mecklenburg	Eastern Piedmont	Piedmont and Upper Coastal Plain
Middlesex	Tidewater	Eastern Shore and Lower Coastal Plain
Montgomery	Southwestern Mountain	Ridge and Valley
Nelson	Western Piedmont	Piedmont and Upper Coastal Plain

County/City	Climatic Division	Physiographic Region
New Kent	Tidewater	Eastern Shore and Lower Coastal Plain
Newport News	Tidewater	Eastern Shore and Lower Coastal Plain
Norfolk	Tidewater	Eastern Shore and Lower Coastal Plain
Northampton	Tidewater	Eastern Shore and Lower Coastal Plain
Northumberland	Tidewater	Eastern Shore and Lower Coastal Plain
Norton	Southwestern Mountain	Ridge and Valley
Nottoway	Eastern Piedmont	Piedmont and Upper Coastal Plain
Orange	Northern	Piedmont and Upper Coastal Plain
Page	Northern	west of the Blue Ridge: Ridge and Valley the Blue Ridge and east: Piedmont and Upper Coastal Plain
Patrick	Western Piedmont	Piedmont and Upper Coastal Plain
Petersburg	Eastern Piedmont	Piedmont and Upper Coastal Plain
Pittsylvania	Western Piedmont	Piedmont and Upper Coastal Plain
Poquoson City	Tidewater	Eastern Shore and Lower Coastal Plain
Portsmouth	Tidewater	Eastern Shore and Lower Coastal Plain
Powhatan	Eastern Piedmont	Piedmont and Upper Coastal Plain
Prince Edward	Eastern Piedmont	Piedmont and Upper Coastal Plain
Prince George	Tidewater	Piedmont and Upper Coastal Plain
Prince William	Northern	Piedmont and Upper Coastal Plain
Pulaski	Southwestern Mountain	Ridge and Valley
Radford	Southwestern Mountain	Ridge and Valley
Rappahannock	Northern	Piedmont and Upper Coastal Plain
Richmond	Tidewater	Eastern Shore and Lower Coastal Plain
Richmond City	Eastern Piedmont	Piedmont and Upper Coastal Plain
Roanoke	Central Mountain	Ridge and Valley
Roanoke City	Central Mountain	Ridge and Valley
Rockbridge	Central Mountain	Ridge and Valley
Rockingham	Central Mountain	Ridge and Valley
Russell	Southwestern Mountain	Ridge and Valley
Salem	Central Mountain	Ridge and Valley
Scott	Southwestern Mountain	Ridge and Valley
Shenandoah	Northern	Ridge and Valley
Smyth	Southwestern Mountain	Ridge and Valley
South Boston	Western Piedmont	Piedmont and Upper Coastal Plain
Southampton	Tidewater	Eastern Shore and Lower Coastal Plain
Spotsylvania	Eastern Piedmont	Piedmont and Upper Coastal Plain
Stafford	Tidewater	Piedmont and Upper Coastal Plain
Staunton	Central Mountain	Ridge and Valley
Suffolk	Tidewater	Eastern Shore and Lower Coastal Plain
Surry	Tidewater	Eastern Shore and Lower Coastal Plain
Sussex	Tidewater	Eastern Shore and Lower Coastal Plain
Tazewell	Southwestern Mountain	Ridge and Valley
Virginia Beach	Tidewater	Eastern Shore and Lower Coastal Plain
Warren	Northern	west of the Blue Ridge: Ridge and Valley the Blue Ridge and east: Piedmont and Upper Coastal Plain

County/City	Climatic Division	Physiographic Region
Washington	Southwestern Mountain	Ridge and Valley
Waynesboro	Central Mountain	Ridge and Valley
Westmoreland	Tidewater	Eastern Shore and Lower Coastal Plain
Williamsburg	Tidewater	Eastern Shore and Lower Coastal Plain
Winchester	Northern	Ridge and Valley
Wise	Southwestern Mountain	Ridge and Valley
Wythe	Southwestern Mountain	Ridge and Valley
York	Tidewater	Eastern Shore and Lower Coastal Plain

Table A.2. Crop categories corresponding to Table 6 for various crop names (as designated in NutMan nutrient management planning software)

Crop Name	Crop Category
Alfalfa (hay)	Hayland
Alfalfa (hay), maint.	Hayland
Alfalfa-grass (hay)	Hayland
Alfalfa-grass (hay), maint.	Hayland
Barley (cover)	Small grain
Barley (grain)	Small grain
Barley (silage)	Small grain
Barley-soybean double crop (grain)	Row crop
Barley-soybean double crop (silage)	Row crop
Bermudagrass (hay)	Hayland
Bermudagrass (hay), maint.	Hayland
Bermudagrass pasture	Pasture
Bermudagrass pasture, maint.	Pasture
Canola (grain)	Small grain
Corn (grain)	Row crop
Corn (silage)	Row crop
Cotton (bolls)	Row crop
Cotton (seed)	Row crop
Fallow	Fallow
Fescue grass (hay)	Hayland
Fescue grass (hay), maint.	Hayland
Fescue grass-Ladino clover (hay)	Hayland
Fescue grass-Ladino clover (hay), maint.	Hayland
Hay/Pasture	Hayland/pasture
Legume cover crop	Legume
Native/unimproved pastures <=25% legume	Pasture
Native/unimproved pastures <=25% legume, maint.	Pasture
Native/unimproved pastures >25% legume	Pasture
Native/unimproved pastures >25% legume, maint.	Pasture
Oat (cover)	Small grain
Oats (grain, spring)	Small grain
Oats (grain, winter)	Small grain
Oats (silage, spring)	Small grain
Oats (silage, winter)	Small grain
Orchard grass (hay)	Hayland
Orchard grass (hay), maint.	Hayland
Orchard grass-Ladino clover (hay)	Hayland
Orchard grass-Ladino clover (hay), maint.	Hayland
Orchard grass/fescue pastures >25% legume	Pasture
Orchard grass/fescue pastures >25% legume, maint.	Pasture
Orchard grass/fescue pastures<=25% legume	Pasture
Orchard grass/fescue pastures<=25% legume, maint.	Pasture
Peanut (baled)	Row crop
Peanuts	Row crop
Red clover-grass (hay)	Hayland
Red clover-grass (hay), maint.	Hayland
Rye (cover)	Small grain
Rye (grain)	Small grain
Rye (silage)	Small grain

Crop Name	**Crop Category**
Rye + Legume cover crop	Small grain
Sorghum (grain)	Row crop
Sorghum (silage)	Row crop
Sorghum-sudan, millet, sudan (hay)	Row crop
Soybeans (DC)	Row crop
Soybeans (FS)	Row crop
Stockpiled tall fescue	Pasture
Tobacco -burley	Row crop
Tobacco -dark fired	Row crop
Tobacco -flue cured	Row crop
Tobacco -sun cured	Row crop
Wheat (cover)	Small grain
Wheat (grain)	Small grain
Wheat (silage)	Small grain)
Wheat-soybean double crop (grain)	Row crop
Wheat-soybean double crop (silage)	Row crop

Table A.3 Hydrologic soil group and soil texture/drainage class factor for soil mapping units in Virginia. When two hydrologic soil groups are given, e.g., B/D, the first applies to drained conditions and the second applies to undrained conditions.

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Abell	B	0.00
Ackwater	D	0.00
Acredale, drained	D	0.50
Aden	C	0.50
Airmont	C	0.00
Alaga	A	1.00
Alanthus	B	0.00
Albano	D	0.50
Albemarle	B	0.00
Alderflats	D	0.50
Aldino	C	0.00
Allegheny	B	0.00
Alonemill	B	0.00
Alonzville	B	0.00
Altavista	C	0.00
Altavista variant	C	0.00
Alticrest	B	0.00
Angie	C	0.00
Angie variant	C	0.00
Appling	B	0.00
Appling gritty	B	0.00
Appomattox	B	0.00
Aqualfs	D	0.25
Aquents	D	0.75
Aquic Udifluvents	B	0.00
Aquults	D	0.50
Arapahoe	B/D	0.75
Arcola	C	0.00
Argent	D	0.50
Ashburn	C	0.00
Ashe	B	0.50
Ashlar	B	0.00
Assateague	A	1.00
Atkins	D	0.75
Atlee	C	0.00
Augusta variant	C	0.25
Augusta, drained	C	0.25
Augusta, undrained	C	0.25
Aura	B	0.00
Austinville	B	0.00
Axis	D	0.75
Aycock	B	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Ayersville	B	0.00
Backbay	D	0.75
Badin	B	0.00
Baile	D	0.75
Bailegap	B	0.00
Balsam	B	0.00
Bama	B	0.00
Banister	C	0.00
Batteau	C	0.00
Beckham	B	0.00
Bedington	B	0.00
Beech Grove	C	0.00
Belhaven	D	1.00
Bellspur	B	0.00
Beltsville	C	0.00
Belvoir	C	0.25
Benthole	B	0.00
Bentley	C	0.00
Berks	C	0.00
Berks variant	D	0.25
Bermudian	B	0.00
Bertie	C	0.25
Bethera	D	0.50
Bethesda	C	0.00
Bibb	D	0.75
Biltmore	A	0.00
Birdsboro	B	0.00
Bladen	D	0.50
Blairton	C	0.00
Bland	C	0.00
Blocktown	C/D	0.00
Bloodyhorse	B	0.00
Bluemount	C	0.00
Bohicket	D	0.50
Bojac, Eastern Shore	B	0.00
Bojac, mainland	B	0.00
Bolling	C	0.00
Bolling variant	C	0.00
Bolton	B	0.00
Bonneau	A	0.00
Bookwood	B	0.00
Botetourt	C	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Bourne	C	0.00
Bourne variant	C	0.00
Bowmansville	B/D	0.25
Braddock	B	0.00
Brandywine	A	0.50
Brecknock	B	0.00
Bremo	C	0.00
Brentsville	C	0.00
Brevard	B	0.00
Brickhaven	C	0.00
Brinklow	C	0.00
Broadway	B	0.00
Brockroad	C	0.00
Brownwood	B	0.50
Brumbaugh	B	0.00
Brushy	C	0.00
Buchanan	C	0.00
Buckhall	B	0.00
Bucks	B	0.00
Buckton	B	0.00
Buffstat	C	0.00
Bugley	C/D	0.00
Buncombe	A	1.00
Burketown	C	0.00
Burrowsville	C	0.00
Calverton	C	0.00
Calvin	C	0.00
Camocca	A/D	1.00
Caneyville	C	0.00
Carbo	D	0.00
Carbo	C	0.00
Carbonton	C	0.00
Cardiff	B	0.00
Cardova	C	0.00
Caroline	C	0.00
Cartecay	C	0.25
Cataska	D	0.00
Catharpin	C	0.00
Catlett	C/D	0.00
Catoctin	C	0.00
Catpoint	A	0.00
Caverns	B	0.00
Cecil	B	0.00
Cedarcreek	C	0.00
Chagrin	B	0.00
Chagrin variant	A	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Chandler	B	0.50
Chapanoke	C	0.25
Chastain	D	0.50
Chatuge	D	0.75
Chavies	B	0.00
Chavies variant	B	0.00
Check	D	0.75
Chenneby	C	0.25
Chesapeake	B	0.00
Chester	B	0.00
Chestnut	B	0.00
Chewacla	C	0.25
Chickahominy	D	0.50
Chilhowie	C	0.00
Chincoteague	D	0.75
Chipley	C	0.00
Chiswell	D	0.00
Christian	C	0.00
Cid	C	0.00
Claiborne	B	0.00
Clapham	C	0.00
Clearbrook	D	0.25
Cliffield	B	0.00
Clifford	C	0.00
Clover	B	0.00
Cloverlick	B	0.00
Clubcaf	D	0.50
Clymer	B	0.00
Codorus	C	0.00
Codorus variant	C	0.00
Colescreek	C	0.00
Colfax	C	0.25
Colfax variant	C	0.25
Colleen	C	0.00
Colvard	B	0.00
Combs	B	0.00
Comus	B	0.00
Conetoe	A	0.00
Congaree	B	0.00
Coosaw	B	0.00
Cordorus	C	0.25
Corolla	D	0.00
Corydon	D	0.00
Cotaco	C	0.00
Cotaco variant	C	0.00
Cottonbend	B	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Coursey	C	0.00
Cowee	B	0.00
Coxville	D	0.75
Craggey	D	0.00
Craigsville	B	0.00
Craven	C	0.00
Creedmoor	C	0.00
Creedmoor variant	C	0.25
Croton	D	0.50
Cullasaja	B	0.00
Cullen	C	0.00
Culleoka	B	0.00
Culpeper	C	0.00
Daleville	D	0.75
Dan River	B	0.00
Dandridge	D	0.00
Danripple	C	0.00
Davidson	B	0.00
Dawhoo variant	D	1.00
Dekalb	C	0.00
Delanco	C	0.00
Delila	D	0.50
Dellwood	A	0.00
Deloss, drained	B/D	0.75
Deloss, undrained	B/D	0.75
Derroc	B	0.00
Devotion	B	0.50
Diana Mills	C	0.00
Dillard	C	0.00
Dillsboro	B	0.00
Dismal	C	0.00
Dogue	C	0.00
Dogue variant	C	0.00
Dorovan	D	1.00
Dothan	B	0.00
Downer	A	0.00
Dragston	C	0.25
Drall	B	0.50
Draper	B	0.00
Drapermill	B	0.00
Drypond	D	0.00
Duckston	A/D	1.00
Duffield	B	0.00
Dulles	D	0.00
Dumfries	B	0.00
Dunbar	D	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Dunning	D	0.50
Duplin	C	0.00
Durham	B	0.00
Dyke	B	0.00
Dystrochrepts	B/D	0.00
Easthamlet	D	0.00
Ebbing	C	0.00
Edgehill	C	0.00
Edgehill variant	B	0.00
Edgemont	B	0.00
Edneytown	B	0.00
Edneyville	B	0.00
Edom	C	0.00
Elbert	D	0.50
Elbert variant	D	0.50
Elioak	C	0.00
Elkton	C/D	0.50
Elliber	A	0.00
Elsinboro	B	0.00
Emporia	C	0.00
Endcav	C	0.00
Enon	C	0.00
Enott	C	0.00
Ernest	C	0.00
Escatawba	B	0.00
Eubanks	B	0.00
Eulonia	C	0.00
Eunola	C	0.00
Evansham	D	0.50
Evard	B	0.00
Exum	C	0.00
Faceville	B	0.00
Fairfax	B	0.00
Fairpoint	C	0.00
Fairview	B	0.00
Fairystone	B	0.00
Fallsington	B/D	0.75
Fauq	C	0.00
Fauquier	C	0.00
Faywood	C	0.00
Featherstone	D	0.75
Feedstone	B	0.00
Fisherman	D	0.00
Fiveblock	B	0.00
Flatwoods	C	0.00
Fletcher	B	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Fletcherville	C	0.00
Flume	C	0.00
Fluvanna	C	0.00
Fluvaquents	D	0.75
Fluvaquents, ponded	D	0.50
Fluvaquents, saline	B/D	0.75
Forestdale	D	0.50
Fork	C	0.25
Fork variant	C	0.25
Frankstown	B	0.00
Frederick	B	0.00
French	C	0.00
Fresh water swamp	B/D	1.00
Fripp	A	1.00
Gaila	B	0.00
Gainesboro	C	0.00
Galestown	A	0.00
Galtsmill	B	0.00
Georgeville	B	0.00
Germanna	B	0.00
Gertie	D	0.50
Gilpin	C	0.00
Gladehill	B	0.00
Glenelg	B	0.00
Glenelg, Blue Ridge	B	0.00
Glenelg, New River Valley	B	0.00
Glenville	C	0.00
Goblintown	B	0.00
Goldsboro	B	0.00
Goldston	C	0.00
Goldvein	C	0.00
Goresville	B	0.00
Grassland	C	0.00
Greenlee	B	0.00
Griffinsburg	C	0.00
Grigsby	B	0.00
Grimsley	B	0.00
Gritney	B	0.00
Groseclose	C	0.00
Grover	B	0.00
Guernsey	C	0.00
Gullion	C	0.00
Gunstock	C	0.00
Guyan	C	0.25
Gwinnett variant	B	0.00
Hagerstown	C	0.00
Halewood	C	0.00
Halifax	C	0.00
Haplaquepts	A/D	0.25
Hapludults	B/D	0.00
Happyland	B	0.00
Hartleton	B	0.00
Hatboro	D	0.75
Hawksbill	B	0.00
Hayesville	B	0.00
Haymarket	D	0.00
Hayter	B	0.00
Haywood	B	0.00
Hazel	C	0.50
Hazel Run	B	0.00
Hazleton	B	0.00
Helena	C	0.00
Herndon	B	0.00
Hibler	B	0.00
Hickoryknob	C	0.00
Highsplint	B	0.00
Hiwassee	B	0.00
Hoadly	C	0.00
Hobucken	D	0.75
Holly	D	0.75
Hollywood	D	0.00
Huntington	B	0.00
Hyde	B/D	0.75
Hydraquents	D	0.75
Ingledove	B	0.00
Iotla	B	0.25
Iredell	C/D	0.00
Irongate	B	0.00
Itmann	C	0.00
Iuka	C	0.00
Izagora	C	0.00
Jackland	D	0.00
Jedburg	C	0.25
Jefferson	B	0.00
Jefferson variant	B	0.00
Johns	C	0.00
Johns variant	C	0.00
Johnston	D	1.00
Junaluska	B	0.00
Kalmia	B	0.00
Kaymine	C	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Keener	B	0.00
Kelly	D	0.00
Kempsville	B	0.00
Kenansville	A	0.00
Kenansville variant	C	0.00
Keyport	C	0.00
Kibler	B	0.00
Kinkora	D	0.50
Kinston	B/D	0.75
Klinesville	C	0.00
Konnarock	C	0.00
Lackstown	C	0.00
Laidig	C	0.00
Lakehurst variant	A	0.00
Lakeland	A	1.00
Lakin	A	1.00
Lanexa	D	1.00
LaRoque	B	0.00
Lawnes	D	0.75
Leaf	D	0.50
Leaksville	D	0.50
Leck Kill	B	0.00
Leedsville	B	0.00
Leetonia	C	0.00
Legore	B	0.00
Lehew	C	0.00
Lenoir	D	0.00
Leon	B/D	1.00
Levy	D	0.50
Lew	B	0.00
Lewisberry	B	0.00
Library	D	0.00
Lignum	C	0.00
Lily	B	0.00
Lindside	C	0.00
Littlejoe	B	0.00
Litz	C	0.00
Lloyd	C	0.00
Lloyd variant	C	0.00
Lobdell	B	0.00
Lodi	B	0.00
Lostcove	B	0.00
Louisa	B	0.00
Louisa variant	B	0.00
Louisburg	B	0.00
Louisburg, hapludalfs	B	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Lowell	C	0.00
Lucketts	B	0.00
Lucy	A	0.00
Lumbee	B/D	1.00
Lumbee variant	B/D	1.00
Lunt	C	0.00
Lynchburg	C	0.25
Macove	B	0.00
Madison	B	0.00
Madsheep	C	0.00
Maggodee	B	0.00
Magotha	D	0.75
Manassas	B	0.00
Mandy	C	0.00
Manor	B	0.00
Mantachie	C	0.25
Manteo	C/D	0.00
Marbie	C	0.00
Marbleyard	B	0.00
Margo	B	0.00
Markes	D	0.75
Marlboro	B	0.00
Marr	B	0.00
Marrowbone	C	0.00
Marumsco	C	0.00
Masada	C	0.00
Massanetta	B	0.00
Massanutten	B	0.00
Matapeake	B	0.00
Matewan	B	0.00
Matneflat	B	0.00
Mattan	D	1.00
Mattapex	C	0.00
Mattaponi	C	0.00
Maurertown	D	0.50
Mayodan	B	0.00
McCamy	B	0.00
McClung	B	0.00
McGary	C	0.00
McQueen	C	0.00
Meadowfield	C	0.00
Meadows	D	0.00
Meadowville	B	0.00
Mecklenburg	C	0.00
Mecklenburg variant	C	0.00
Meggett	D	0.50

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Melfa	D	0.75
Melvin, drained	D	0.50
Melvin, undrained	D	0.50
Middleburg	B	0.00
Millrock	A	0.00
Mine Run	B	0.50
Minnieville	C	0.00
Mirerock	D	0.00
Mixed alluvium, poorly drained	B/D	0.75
Mixed alluvium, well drained	B	0.00
Molena	A	0.00
Monacan	C	0.25
Mongle	C	0.25
Monongahela	C	0.00
Montalto	C	0.00
Montonia	B	0.00
Montross	C	0.00
Moomaw	C	0.00
Morven	B	0.00
Mount Lucas	C	0.00
Mt Rogers	B	0.00
Muckalee	D	0.75
Munden	B	0.00
Murrill	B	0.00
Myatt	D	0.75
Myatt variant	D	0.75
Myersville	B	0.00
Nahunta	C	0.25
Nanford	C	0.00
Nansemond	C	0.00
Nason	C	0.00
Nathalie	B	0.00
Nawney	D	0.75
Neabsco	C	0.00
Nestoria	C	0.00
Nevarc	C	0.00
Newark variant	C	0.25
Newark, drained	C	0.25
Newark, undrained	C	0.25
Newbern	C	0.00
Newflat	D	0.00
Newhan	A	1.00
Newmarc	C	0.25
Nicelytown	C	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Nicholson	C	0.00
Nikwasi	B/D	1.00
Nimmo	D	0.75
Nixa	C	0.00
Nolichucky	B	0.00
Nolin	B	0.00
Nomberville	B	0.00
Norfolk	B	0.00
Oak Level	C	0.00
Oakhill	B	0.00
Oaklet	C	0.00
Oatlands	B	0.00
Occoquan	B	0.00
Ochlockonee	B	0.00
Ochlockonee variant	C	0.00
Ochraquults	B/D	0.50
Ochrepts, A/D	A/D	0.00
Ochrepts, B/D	B/D	0.00
Ochrepts, D	D	0.00
Ocilla	B	0.00
Ogles	B	0.00
Okeetee	D	0.00
Opequon	C	0.00
Orange	D	0.00
Orange variant	D	0.00
Orangeburg	B	0.00
Orenda	B	0.00
Oriskany	B	0.00
Orrville	C	0.25
Orthents		0.00
Osier	A/D	1.00
Ostin	B	0.00
Othello	C/D	0.50
Ott	B	0.00
Pacolet	B	0.00
Pactolus	A	0.00
Paddyknob	C	0.00
Pagebrook	D	0.00
Palms variant	A/D	1.00
Pamlico	D	1.00
Pamunkey	B	0.00
Pamunkey variant	A	0.00
Panorama	B	0.00
Parker	B	0.00
Partlow	D	0.75
Pasquotank	B/D	0.75

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Peaks	C	0.00
Peawick	D	0.00
Penhook	B	0.00
Penn	C	0.00
Philo	B	0.00
Philomont	B	0.00
Pigeonroost	B	0.00
Pilot Mountain	B	0.00
Pineola	B	0.00
Pineville	B	0.00
Pineywoods	D	0.50
Pinkston	B	0.00
Pinoka	B	0.00
Pisgah	C	0.00
Pocaty	D	1.00
Poindexter	B	0.00
Polawana	A/D	1.00
Pooler variant	D	0.50
Pope	A	0.00
Poplimento	C	0.00
Porters	B	0.00
Portsmouth, drained	B/D	0.75
Portsmouth, undrained	B/D	0.75
Pouncey	D	0.50
Poynor	B	0.00
Psamments, mod well	A	0.00
Psamments, somewhat poorly	A	0.25
Psamments, well drained	A	0.00
Pungo	D	1.00
Purcellville	B	0.00
Purdy	D	0.50
Quantico	B	0.00
Rabun	B	0.00
Rains	B/D	0.75
Ramsey	D	0.00
Rapidan	B	0.00
Rappahannock	D	1.00
Raritan	C	0.00
Rasalo	C	0.00
Rayne	B	0.00
Readington	C	0.00
Reaville	C	0.25
Redbrush	C	0.00
Remlik	A	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Rhodhiss	B	0.00
Rigley	B	0.00
Rion	B	0.00
Riverview	B	0.00
Rixeyville	C	0.50
Roanoke	D	0.50
Roanoke, drained	D	0.50
Roanoke, undrained	D	0.50
Rockbarn	C	0.00
Rohrersville	D	0.25
Ross	B	0.00
Rough	D	0.00
Rowland	C	0.00
Rumford	B	0.00
Rushtown	A	0.00
Ruston	B	0.00
Santuc	C	0.00
Sassafras	B	0.00
Saunook	B	0.00
Sauratown	B	0.00
Savannah	C	0.00
Scattersville	C	0.25
Schaffenaker	A	0.00
Seabrook	C	0.00
Sedgefield	C	0.00
Sekil	B	0.00
Seneca	B	0.00
Sequoia	C	0.00
Sewell	C	0.00
Shelocta	B	0.00
Shelocta variant	B	0.00
Shenval	B	0.00
Sherando	B	0.00
Sheva	C	0.00
Shottower	B	0.00
Siloam	C	0.00
Sindion	B	0.00
Sketerville	C	0.00
Slabtown	B	0.00
Slagle	C	0.00
Snowdog	C	0.00
Spears Mountain	B	0.00
Speedwell	B	0.00
Spessard	A	0.00
Spotsylvania	C	0.00
Spriggs	C	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Springwood	B	0.00
Starr	C	0.00
State	B	0.00
Statler	B	0.00
Steinsburg	B	0.00
Stonecoal	C	0.00
Stoneville	B	0.00
Stott Knob	B	0.00
Straightstone	B	0.00
Strawfield	B	0.00
Stumptown	B	0.00
Suches	B	0.00
Sudley	B	0.00
Suffolk	B	0.00
Sugarhol	B	0.00
Sulfaquents	D	0.75
Susquehanna	D	0.00
Swamp		1.00
Swampoodle	C	0.00
Sweetapple	B	0.50
Swimley	C	0.00
Sycoline	D	0.00
Sylco	C	0.00
Sylvatus	D	0.00
Talladega	C	0.00
Tallapoosa	C	0.00
Tallapoosa variant	C	0.00
Tanasee	B	0.00
Tankerville	D	0.00
Tarboro	A	1.00
Tarrus	B	0.00
Tate	B	0.00
Tatum	B	0.00
Terric Haplohemists	D	1.00
Tetotum	C	0.00
Tetotum variant	C	0.00
Thunder	B	0.00
Thurmont	B	0.00
Timberville	B	0.00
Timberville variant	B	0.00
Tioga	B	0.00
Tipples	C	0.00
Toast	B	0.00
Toccoa	B	0.00
Toddstav	D	0.50
Tomotley, drained	B/D	0.75

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Tomotley, undrained	B/D	0.75
Toms	C	0.25
Torhunta	C	1.00
Totier	C	0.00
Toxaway	B/D	0.75
Trappist	C	0.00
Trego	B	0.00
Trenholm	D	0.00
Trimont	B	0.00
Trussell	C	0.75
Tuckahoe	B	0.00
Tuckasegee	B	0.00
Tugglesgap	B	0.25
Tumbling	B	0.00
Turbeville	C	0.00
Tusquitee, coarse loamy	B	0.00
Tusquitee, fine loamy	B	0.00
Tygart	D	0.00
Typic Udorthents	A/D	0.00
Uchee	A	0.00
Udalfs	B/D	0.00
Udifluvents, coarse loamy	B	0.00
Udifluvents, fine loamy	B/D	0.00
Udipsamments, mod well	A	0.00
Udipsamments, well	D	0.00
Udults, mod well drained	C/D	0.00
Udults, well drained	B/D	0.00
Unison	B	0.00
Unison variant	B	0.00
Vance	C	0.00
Varina	C	0.00
Vaucluse	C	0.00
Vertrees	B	0.00
Virgilina	C	0.00
Wadesboro	B	0.00
Wadesboro	B	0.00
Wahee	D	0.00
Wallen	B	0.00
Walnut	B	0.00
Wando	A	0.00
Warminster	C	0.00
Watahala	B	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Watauga	B	0.00
Wateree	B	0.00
Watt	D	0.00
Watt variant	D	0.00
Waxpool	D	0.50
Weaver	C	0.00
Webbtown	C	0.00
Wedowee	B	0.00
Weeksville	B/D	0.75
Wehadkee	D	0.75
Weikert	D	0.00
Weikert, exc drained	B/D	0.00
Westfield	B	0.00
Westmoreland	B	0.00
Weston	D	0.75
Westphalia	B	0.00
Weverton	B	0.00
Wharton	C	0.00
Wheeling	B	0.00
White Store	D	0.00
White Store variant	D	0.00
Whiteford	B	0.00
Wickham	B	0.00
Wickham variant	B	0.00

Soil Mapping Unit	Hydrologic Soil Group	Soil texture/ Drainage class factor
Widgett	B	0.00
Wilkes	C	0.00
Wingina	B	0.00
Winnsboro	C	0.00
Wintergreen	B	0.00
Winton	C	0.00
Wolfgap	B	0.00
Wolftrap	D	0.00
Woodington	B/D	0.75
Woodstown	C	0.00
Woolwine	B	0.00
Worsham	D	0.50
Worsham variant	D	0.50
Wrightsboro	C	0.00
Wurno	C	0.00
Wyrick	B	0.00
Yellowbottom	C	0.00
Yemassee	C	0.25
Yeopim	B	0.00
Yogaville	D	0.75
York	C	0.00
Zepp	B	0.00
Zion variant	C	0.00
Zoar	C	0.00

Table A.4. Crop removal for selected row crops and forages (adapted from Crop Removal for Selected Row Crops and Forages, Virginia Department of Conservation and Recreation, NMP-CR1)

Crop	Phosphate Removal per Unit of Yield
Alfalfa Hay: Establishment	1/2 yield if spring planted, 0 if fall planted
Alfalfa Hay: Maintenance	14.5 lbs P_2O_5/ton
Alfalfa-Grass Hay: Establishment	1/2 yield if spring planted, 0 if fall planted
Alfalfa-Grass Hay: Maintenance	14.5 lbs P_2O_5/ton
Barley Grain	0.4 lbs P_2O_5/bushel
Barley Silage	5.1 lbs P_2O_5/ton
Barley-Soybean Double Crop: Grain	Add removal (lbs P_2O_5/bushel) for each crop
Barley-Soybean Double Crop: Silage	Add removal (lbs P_2O_5/ton) for each crop
Bermudagrass Hay: Establishment	1/2 yield if spring planted, 0 if fall planted
Bermudagrass Hay: Maintenance	10.4 lbs P_2O_5/ton
Bermudagrass Pasture: Establishment	1/2 yield if spring planted, 0 if fall planted
Bermudagrass Pasture: Maintenance	See note on **Pastures** Below
Canola Grain	1.3 lbs P_2O_5/bushel
Corn Grain	0.38 lbs P_2O_5/bushel
Corn Silage	4.0 lbs P_2O_5/ton
Cotton (seed cotton)	0.013 lbs P_2O_5/lb seed cotton
Cover Crops: Legume, Small Grain	0
Fescue Hay: Establishment	1/2 yield if spring planted, 0 if fall planted
Fescue Hay: Maintenance	16 lbs P_2O_5/ton
Fescue-Ladino Clover Hay: Establishment	1/2 yield if spring planted, 0 if fall planted
Fescue-Ladino Clover Hay: Maintenance	14 lbs P_2O_5/ton
Hay/Pasture	Use 2/3 hay yield with 16 lbs P_2O_5/ton
Native/Unimproved Pasture: Establishment	See note on **Pastures** Below
Native/Unimproved Pasture: Maintenance	See note on **Pastures** Below
Oats Grain: Spring & Winter	0.33 lbs P_2O_5/bushel
Oats Silage: Spring & Winter	5 lbs P_2O_5/ton
Orchardgrass Hay: Establishment	1/2 yield if spring planted, 0 if fall planted
Orchardgrass Hay: Maintenance	16 lbs P_2O_5/ton
Orchardgrass-Ladino Clover Hay: Establishment	1/2 yield if spring planted, 0 if fall planted
Orchardgrass-Ladino Clover Hay: Maintenance	16 lbs P_2O_5/ton
Orchardgrass/Fescue Pasture: Establishment	See note on **Pastures** Below
Orchardgrass/Fescue Pasture: Maintenance	See note on **Pastures** Below
Peanuts - Baled	6.8 lbs P_2O_5/ton
Peanuts	0.0098 lbs P_2O_5/lb
Red Clover-Grass Hay: Establishment	1/2 yield if spring planted, 0 if fall planted
Red Clover-Grass Hay: Maintenance	14 lbs P_2O_5/ton
Rye Grain	0.45 lbs P_2O_5/bushel
Rye Silage	5.6 lbs P_2O_5/ton
Sorghum Grain	0.4 lbs P_2O_5/bushel
Sorghum Silage	5.4 lbs P_2O_5/ton
Sorghum-Sudan, Millet, Sudan Hay	10 lbs P_2O_5/ton
Soybeans: DC & FS	0.89 lbs P_2O_5/bushel
Tobacco: Burley, Dark Fired, Flue & Sun Cured	0.009 lbs P_2O_5/lb leaves
Wheat Grain	0.51 lbs P_2O_5/bushel
Wheat Silage	4.2 lbs P_2O_5/ton
Wheat-Soybean Double Crop for Grain	Add removal (lbs P_2O_5/bushel) for each crop
Wheat-Soybean Double Crop for Silage	Add removal (lbs P_2O_5/ton) for each crop

Pastures: 30 lbs P_2O_5 removal for Productivity Group I & II soils
25 lbs P_2O_5 removal for Productivity Group III soils
20 lbs P_2O_5 removal for Productivity Group IV soils