Developing and Using the Iowa P-Index

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Individuals Contributing to Development of the Iowa P-Index

- Iowa State Univ.
  - James Baker
  - John Downing
  - Thomas Fenton
  - Antonio Mallarino
  - Gerald Miller
  - John Sawyer
  - Regis Voss
- NRCS
  - Mark Jensen
  - Douglas Johnson
  - Barbara Stewart
- USDA - NSTL
  - John Kovar
  - Thomas Sauer

Eutrophication of Surface Waters

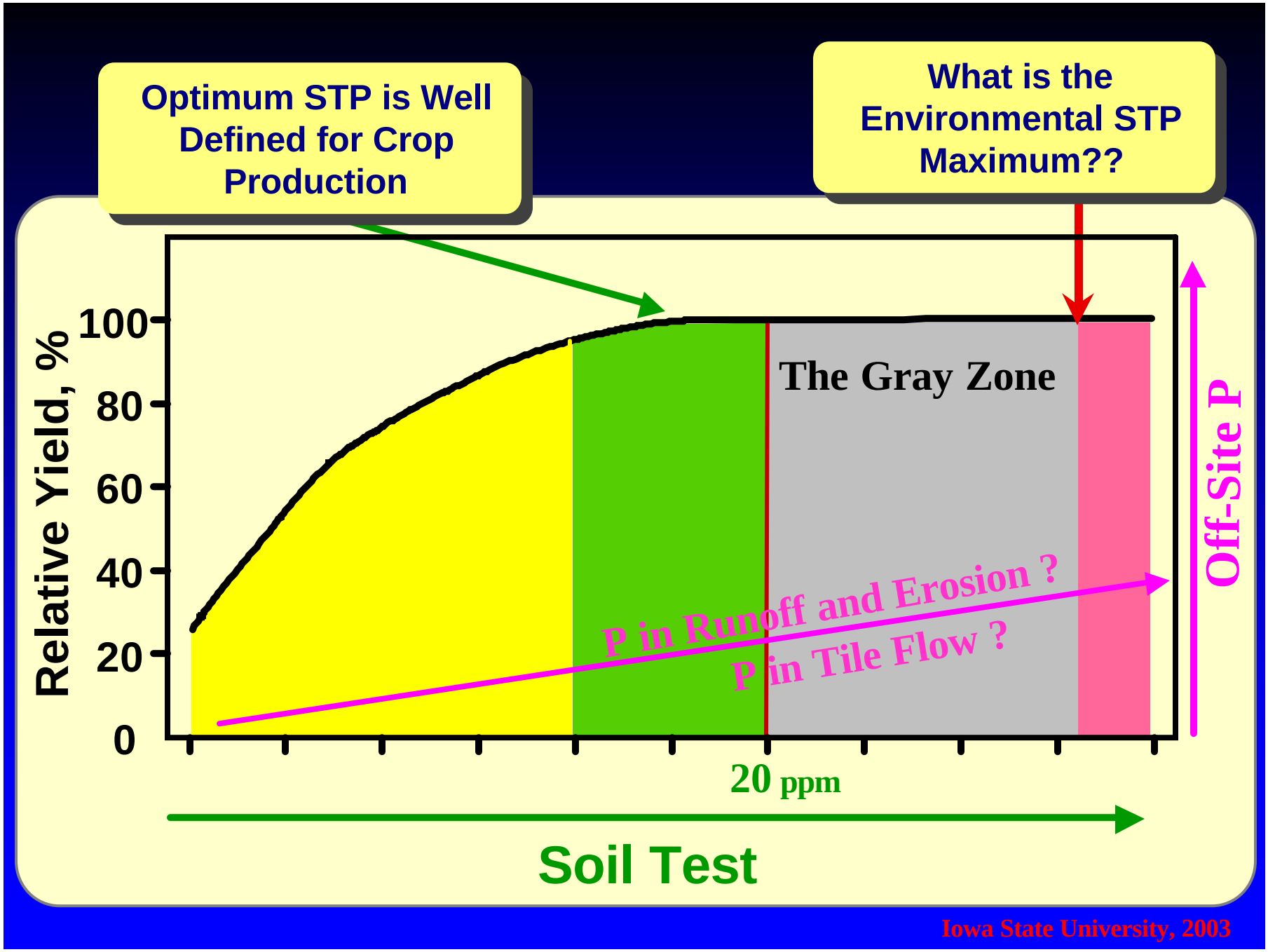
- Enrichment of dissolved nutrients, increased algal growth, and undesirable water conditions
  - Main issue is phosphorus (P)
  - For P only very low concentration
    - Surface water total P above approximately 70 to 100 ppb

Focus on Phosphorus Moving from Farm Fields

- NRCS Nutrient Management Alternatives
  - By spring 2001 states must adopt one of these approaches:
    - Soil-test P for crop production
    - Soil P threshold
    - P risk index

Reasons for Choice of the P-Index Concept

- Soil-test P interpretation classes for crop production not useful for environmental considerations
- Soil P thresholds may vary with soils, soil management practices and P management


Optimum STP is Well Defined for Crop Production
What is the Environmental STP Maximum??
Relative Yield, %
100
80
60
40
20
0
The Gray Zone
Off-Site P
P in Runoff and Erosion ?
P in Tile Flow ?
20 ppm
Soil Test
Iowa State University, 2003

Advantages of the Iowa P-Index

- Integrates soil, landscape, and management factors that influence P delivery to surface water bodies
- Provides a risk rating
- Helps identify causes of high P delivery and provides options for improved soil conservation and P management

Iowa P-Index

- Two source factors
  - Soil P
  - P application
- Three P transport mechanisms (components)
  - Soil erosion
  - Water runoff
  - Subsurface drainage

Basic Concepts of the Iowa P- Index

- **The sum of the three components gives an overall estimate of P delivery from fields**
  - Soil Erosion, Water Runoff, Subsurface Drainage
- **Five risk classes (VL to VH)**
- **Uses NRCS tools to estimate impact of landforms, soil map units, and management on soil and water loss**
- **Uses common soil P test values**

Basic Concepts of the Iowa P- Index

- Considers dissolved P in water and P in sediment that will be released to water over a period of time
- Does NOT differentiate between P sources (water solubility of some organic sources may influence the short-term impact of P applications but not necessarily long-term loss)

Basic Concepts of the Iowa P- Index

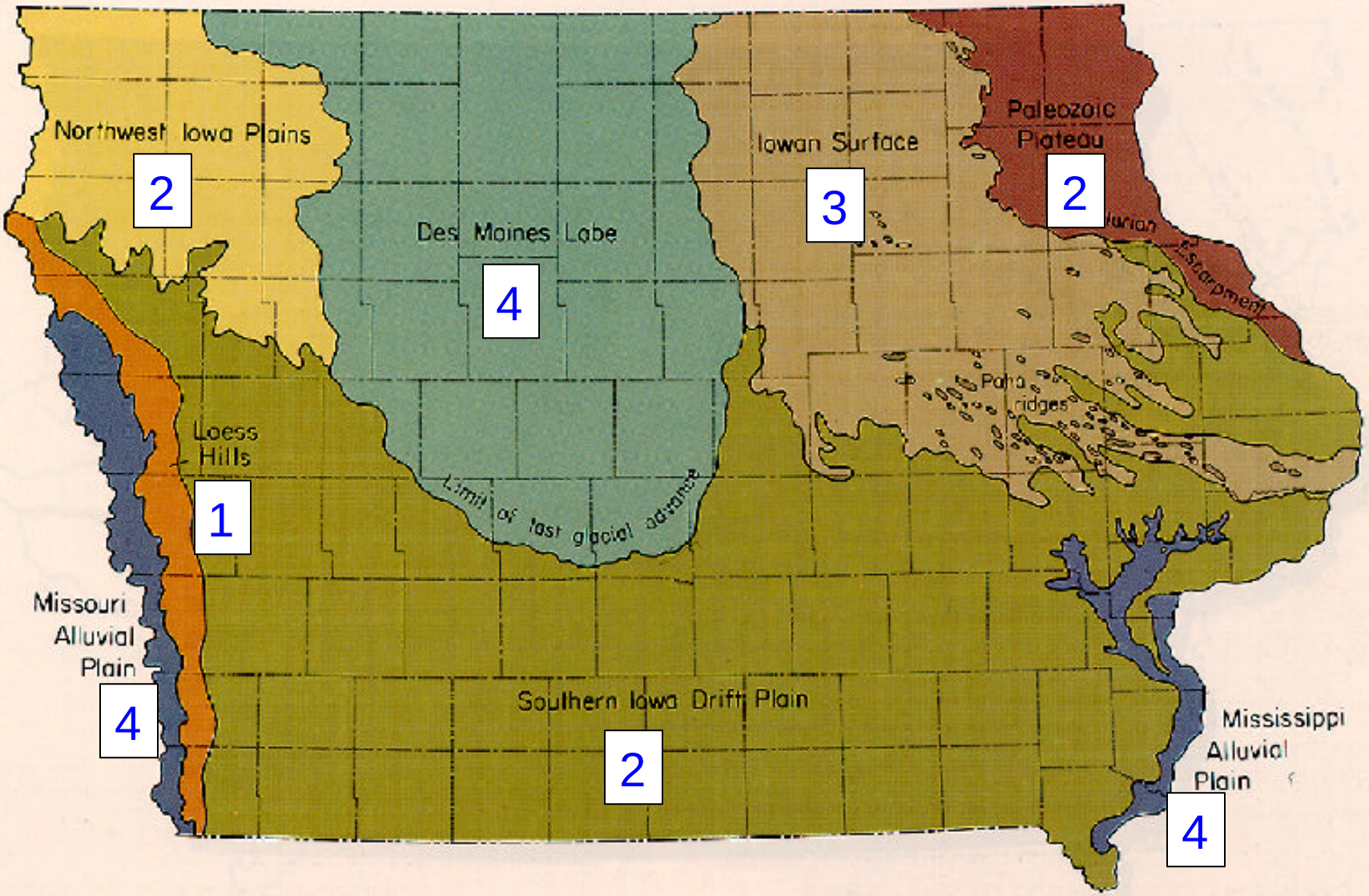
- Can be applied to a field or to conservation management units (CMU) as defined by NRCS:
  - a field or field portions of the same land use and management plans
  - is based on the most representative part of the field or CMU

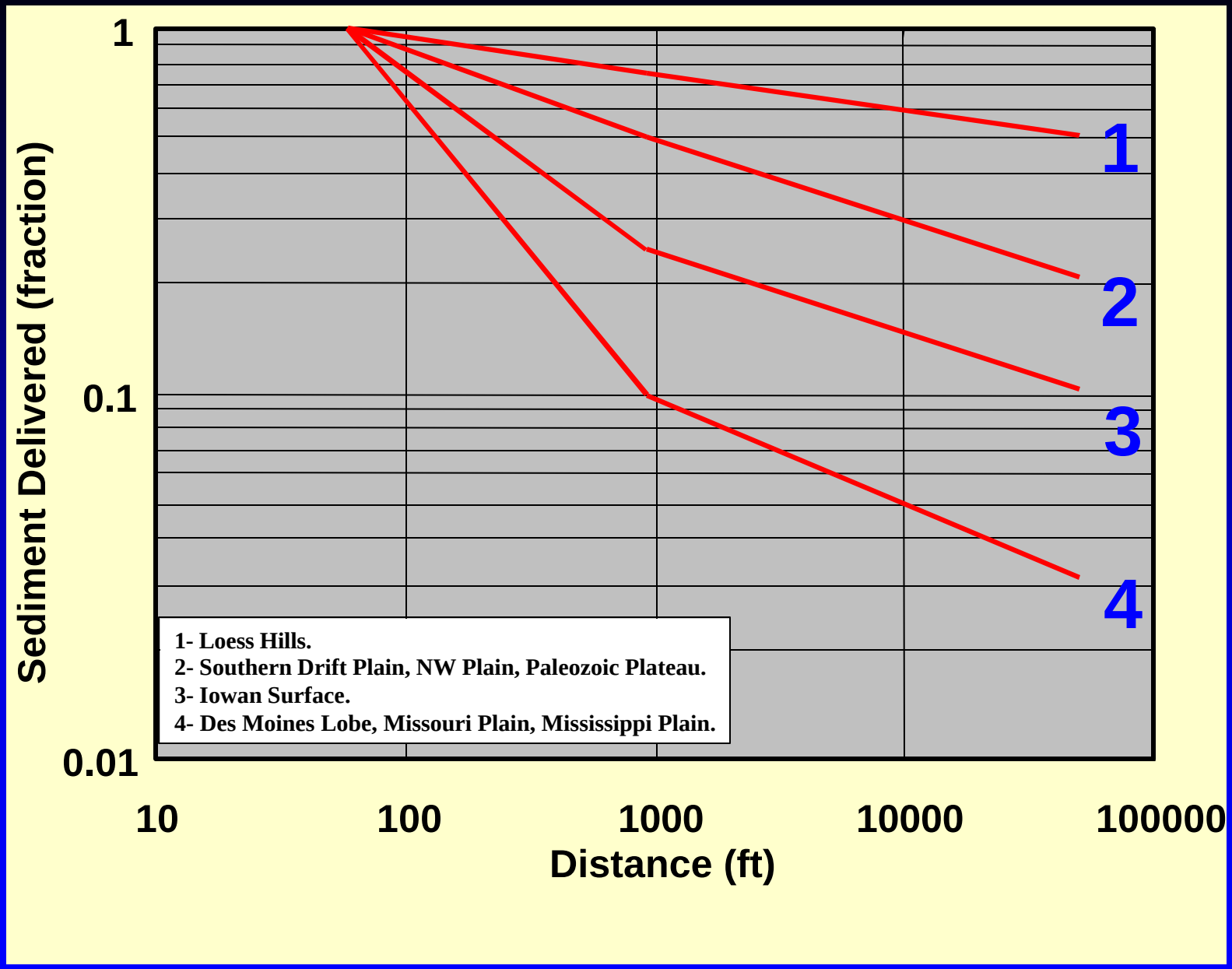
Erosion Component

- Total gross soil erosion estimates (RUSLE, ephemeral, gully)
- Sediment trap or NRCS Sediment Delivery Ratio (SDR) factor
- Buffer strip factor
- Sediment enrichment factor
- Total soil P (concentration) factor

SEDIMENT TRAP FACTOR

Conservation Practice	Factor
Level terrace	0.00
Ponds, tile inlet terrace, or grade stabilization impoundment	0.05
Water & sediment control basin	0.20


Northwest Iowa Plains
2
Des Moines Lobe
4
Iowan Surface
3
Paleozoic Plateau
2
Loess Hills
1
Limit of last glacial advance
Missouri Alluvial Plain
4
Southern Iowa Drift Plain
2
Mississippi Alluvial Plain
4


Sediment Delivered (fraction)
1
0.1
0.01
10
100
1000
10000
100000
Distance (ft)
1
2
3
4
1- Loess Hills.
2- Southern Drift Plain, NW Plain, Paleozoic Plateau.
3- Iowan Surface.
4- Des Moines Lobe, Missouri Plain, Mississippi Plain.

BUFFER (FILTER STRIP) FACTOR

Buffer Width	Factor
Less than 20 feet	1.0
20 to 75 feet	0.7
More than 75 feet	0.5

SEDIMENT ENRICHMENT FACTOR

Management Practice	Factor
Forage or no-till crop with buffer	1.3
No-till no buffer or till with buffer	1.2
Tillage without buffer	1.1

TOTAL SOIL P FACTOR

Total Soil P Content Adjusted Upward by 0-6 Inch Soil-Test P

$$\text{Total P}_{(ppm)} = 500 + (3 \times \text{STP})$$

70% of the total P available for aquatic plant growth

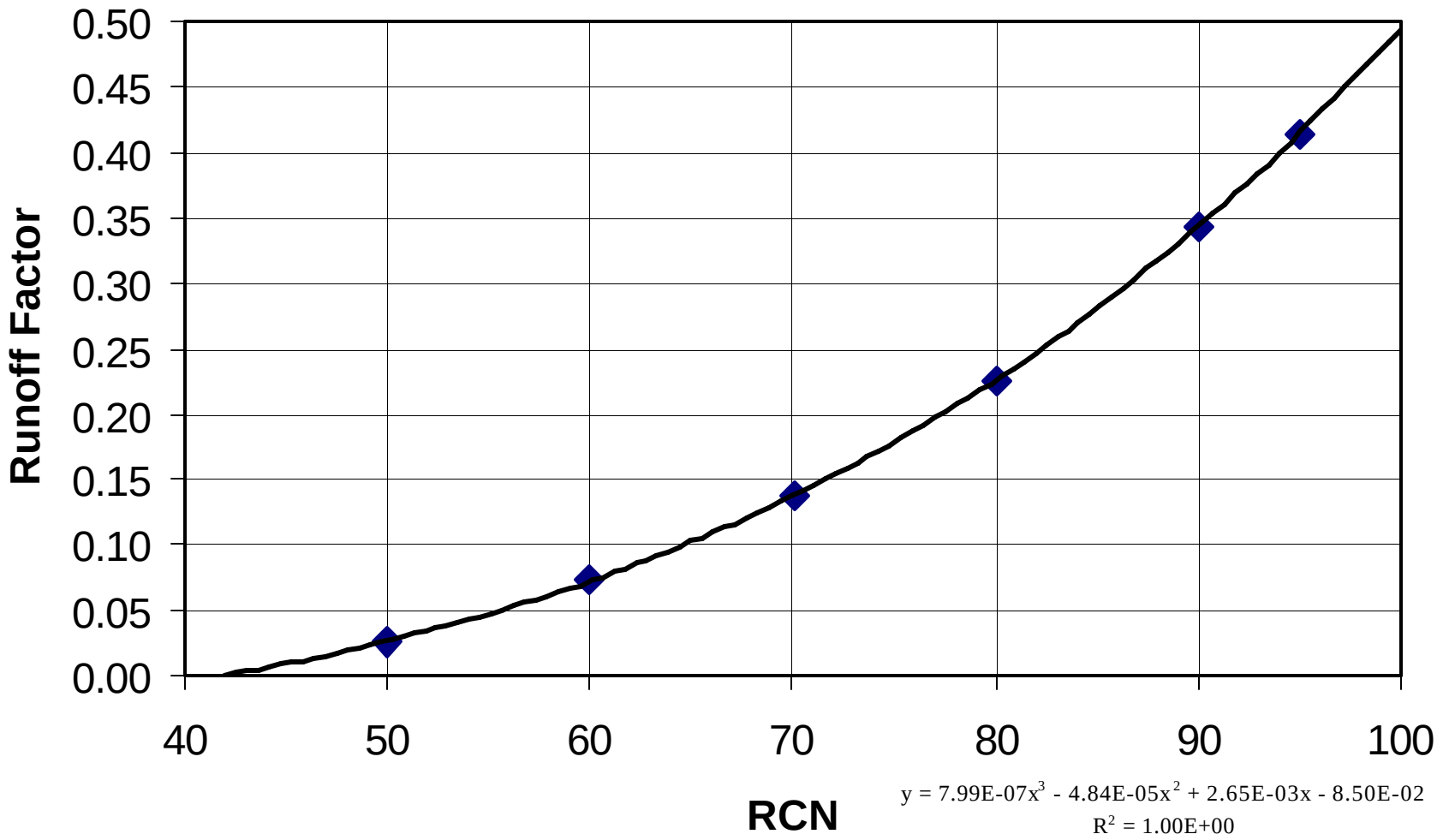
Water Runoff Component

- NRCS Runoff Curve Numbers (for landforms, vegetation cover, etc.)
- County average precipitation
- P application (concentration) factor:
  - Rate effect on soil-test P increase
  - Method and Time of application

  Dissolved (ppm P) = ((P_2O_5/4.58) x 0.5) x 0.005 x M&T
- Soil-test P runoff (concentration) factor

  Dissolved (ppm P) = 0.05 + (STP*0.005)

Phosphorous Index Factors for Surface Runoff Using Runoff Curve Numbers



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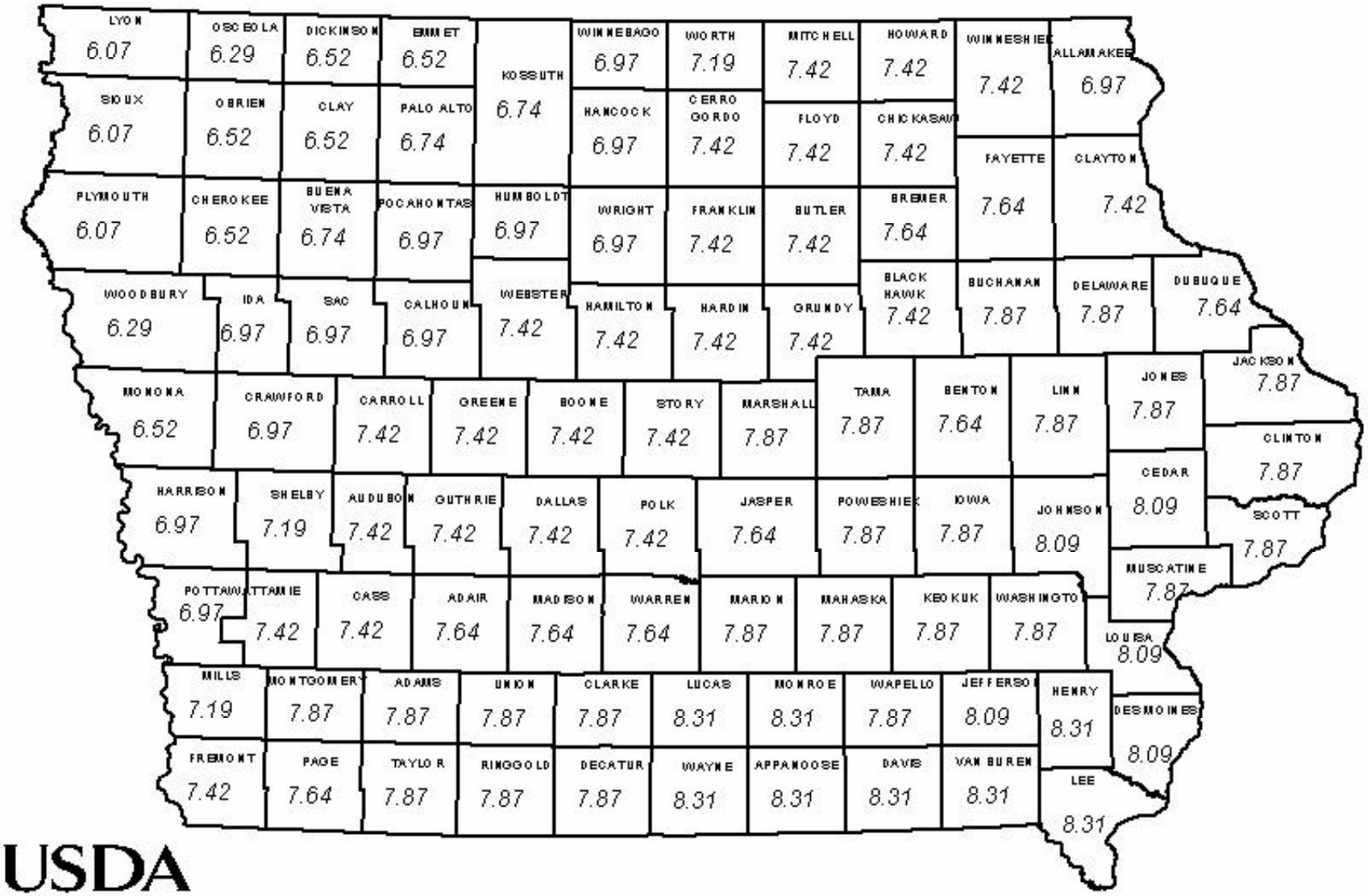
Phosphorus Index Precipitation Factor



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METHOD OF P APPLICATION

Method/Time of Application	Coefficient
Incorporation/injection within 24 hrs	0.4
Incorporate within one week	0.6
Surface applied (good conditions)	1.0
Surface app. to frozen/snow ground	1.5

Runoff Factor for P Application Rate and Method of Application

P Application Rate	Incorporate or Inject Within 24 Hours	Incorporate Within One Week	Surface Application No Incorporation	Surface Application Frozen/Snow Covered, Saturated, or Floodplain
lb P_2O_5/acre				
0	0.00	0.00	0.00	0.00
10	0.00	0.00	0.01	0.01
20	0.00	0.01	0.01	0.02
30	0.01	0.01	0.02	0.02
40	0.01	0.01	0.02	0.03
50	0.01	0.02	0.03	0.04
60	0.01	0.02	0.03	0.05
70	0.02	0.02	0.04	0.06
80	0.02	0.03	0.04	0.07
90	0.02	0.03	0.05	0.07
100	0.02	0.03	0.05	0.08
120	0.03	0.04	0.07	0.10
140	0.03	0.05	0.08	0.11
160	0.03	0.05	0.09	0.13
180	0.04	0.06	0.10	0.15
200	0.04	0.07	0.11	0.16
220	0.05	0.07	0.12	0.18
240	0.05	0.08	0.13	0.20
260	0.06	0.09	0.14	0.21
280	0.06	0.09	0.15	0.23
300	0.07	0.10	0.16	0.25

Subsurface Drainage Component

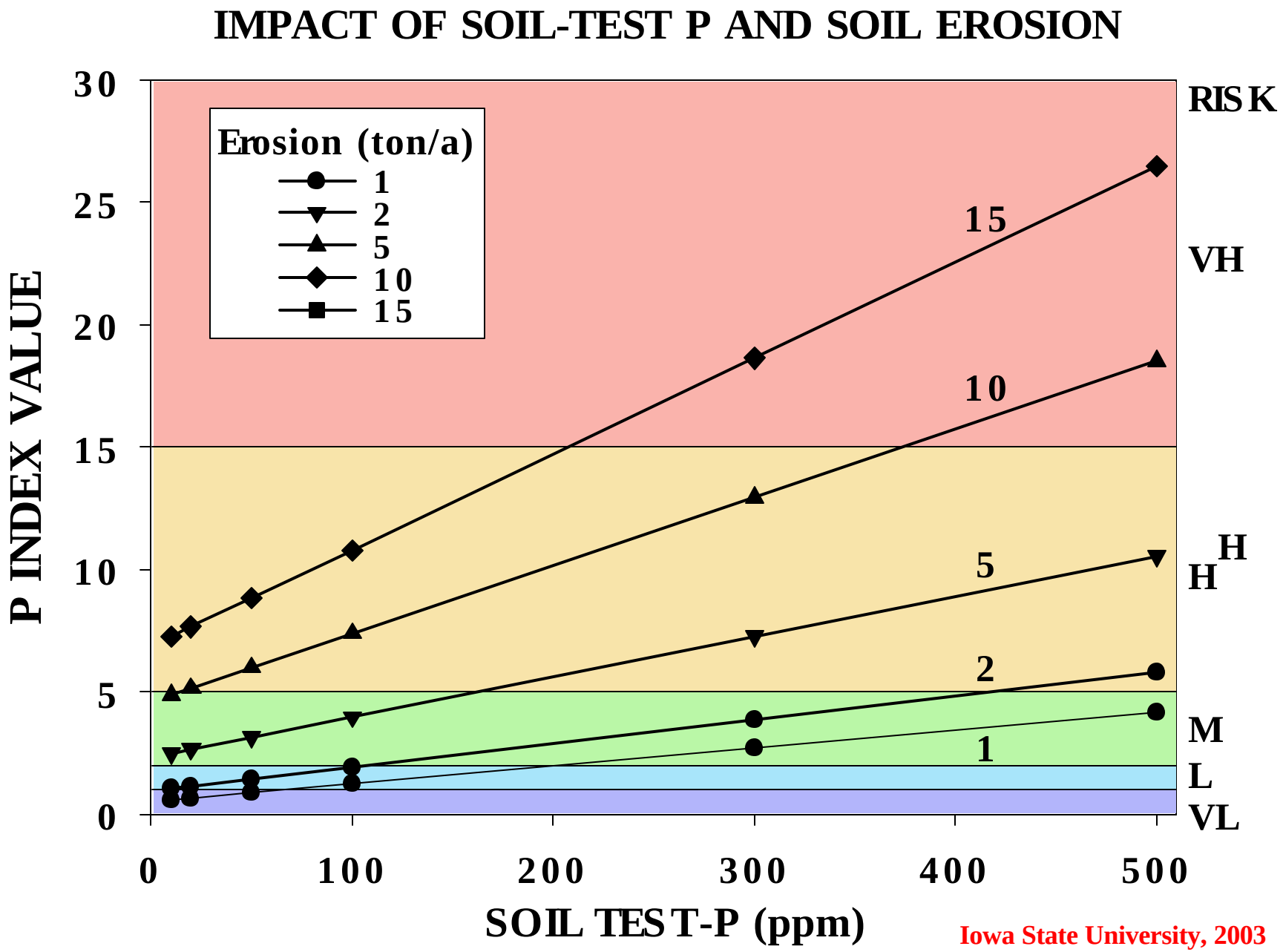
- A 10% flow estimate
- Presence of tiles or sandy subsoil recharge to surface water yes/no: value = 0 if no
- County average precipitation
- Soil-test P drainage factor:
  - 0.1 if STP < 100 ppm Bray 1-P
  - 0.2 if STP ³ 100 ppm Bray 1-P

Site Vulnerability Ratings

- **Very Low (0 - 1): Small impact**
- **Low (1 - 2): Greater than for VL but still low impact**
- **Medium (2 - 5): Acceptable impact, but watch future practices so there is no increase in the risk of P delivery**

Site Vulnerability Ratings

- **High (5 - 15): Large impact - new soil conservation and/or P management practices must be implemented**
- **Very High (>15): Extreme impact - new soil conservation practices plus a P management plan that may require discontinuing P applications must be implemented**


IMPACT OF SOIL-TEST P AND SOIL EROSION
P INDEX VALUE
SOIL TEST-P (ppm)
Erosion (ton/a)
1
2
5
10
15
RISK
VH
H
M
L
VL
30
25
20
15
10
5
0
0
100
200
300
400
500
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Index Component		Fayette County A
Gross Erosion	5	RUSLE erosion: 5 ton
Sediment Trap/SDR	0.64	PP: 350 feet
Buffer Factor	1	Buffer: None
Enrichment Factor	1.1	Tillage without Buffer
STP Erosion Factor	1.03	Bray 1-P: 79 ppm
Erosion	**3.63**	
Runoff Factor	0.22	RCN: 79
Precipitation Factor	7.6	Fayette County
STP Runoff Factor	0.45	Bray 1-P: 79 ppm
P Application Factor	0.03	83 lb P_2O_5/acre; Inc. One Week
Runoff	**0.80**	
Flow Factor	0.1	Tile/Coarse Subsurface: No
Precipitation Factor	7.6	Fayette County
STP Drainage Factor	0.1	Bray 1-P: 79 ppm
Subsurface	**0.08**	
		Iowa State University, 2003
P-Index	**4.50**	[0-1 VL; 1-2 L; 2-5 M; 5-15 H; >15 VH]

Index Component		Fayette County A - 12
Gross Erosion	12	RUSLE erosion: 12 ton
Sediment Trap/SDR	0.64	PP: 350 feet
Buffer Factor	1	Buffer: None
Enrichment Factor	1.1	Tillage without Buffer
STP Erosion Factor	1.03	Bray 1-P: 79 ppm
Erosion	**8.70**	
Runoff Factor	0.22	RCN: 79
Precipitation Factor	7.6	Fayette County
STP Runoff Factor	0.45	Bray 1-P: 79 ppm
P Application Factor	0.03	83 lb P_2O_5/acre; Inc. One Week
Runoff	**0.80**	
Flow Factor	0.1	Tile/Coarse Subsurface: No
Precipitation Factor	7.6	Fayette County
STP Drainage Factor	0.1	Bray 1-P: 79 ppm
Subsurface	**0.08**	
P-Index	**9.58**	[0-1 VL; 1-2 L; 2-5 M; 5-15 H; >15 VH]

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Review of Main Concepts

- A comprehensive assessment tool
- Considers P management **and** soil conservation practices
- No soil-test P or P application limits
- Provides alternative P management and soil conservation practices to reduce the risk of offsite P delivery

Iowa P-Index Applied When:
(Iowa NRCS 590 Standard: as of 11-22-00)

- With voluntary cost share program addressing water quality
  - Impaired surface water body
    - By DNR 303d list - impaired for P
  - Manure application
  - Very high soil test P
    - Agronomic very high class
  - Soil Loss > T

Iowa P-Index
Web Site and Documents

- **http://www.ia.nrcs.usda.gov/**
  - **Technical Note 25 – The Iowa P Index**
  - **Background and Basic Concepts**
  - **P Index Fact Sheet**
  - **Iowa P Index Calculator**
- **http://www.swcs.org/t_pubs_journal_NovDec02_phosphorusindexing.htm**
  - **Phosphorus indexing for cropland: Overview and basic concepts of the Iowa phosphorus index**

Questions/Issues

- Emphasis on soil erosion and soil conservation practices
- Low incidence of risk above medium rating
- NRCS suggesting use of “worst case scenario” in fields
- Use of index in sub-field areas

Questions/Issues

- May allow soil test P buildup to "unreasonable" levels
- Does not "determine" P application rate
- No inclusion of catastrophic P loss events
- Regulatory use

P-Index Future in Iowa?

- Senate File 2293 passed spring 2002
  - Iowa DNR to develop P Index by rule based on NRCS Technical Guide for Iowa
  - Cooperate with NRCS State Technical Committee to refine and calibrate P Index
  - P Index shall be used to determine application rates
- Legislative action in 2003?


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