Aquatic Critical Loads in Virginia and West Virginia

Results of the Southeast Multi-Agency Critical Loads Modeling Project

National Atmospheric Deposition Program (NADP)

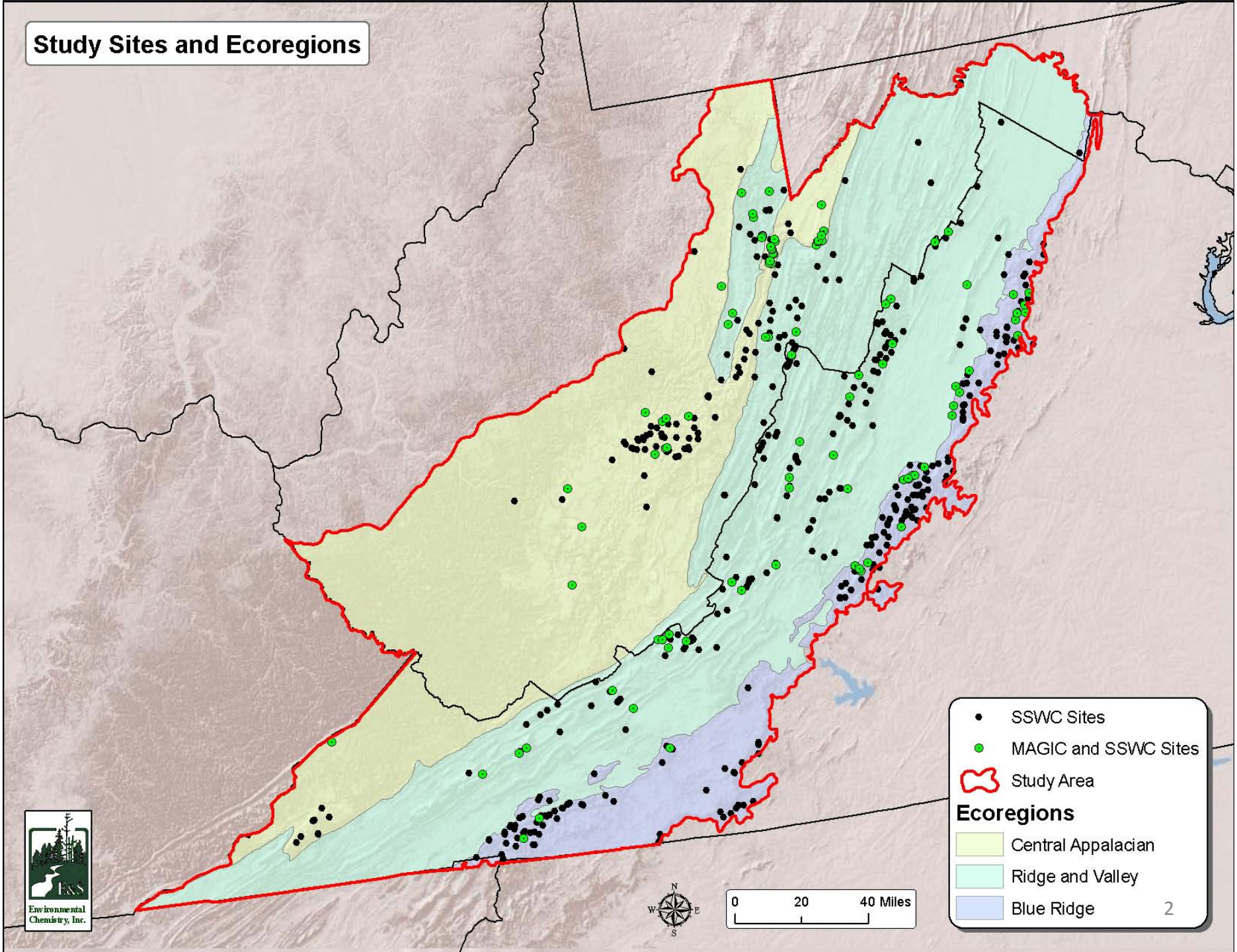
Saratoga Springs, NY

October, 2009

T.J. Sullivan[1], B.J. Cosby[2], T.C. McDonnell[1]

[1] E&S Environmental Chemistry, Inc., P.O. Box 609, Corvallis, OR 97339

[2] Department of Environmental Sciences, University of Virginia, Charlottesville, VA 22932


Study Sites and Ecoregions
SSWC Sites
MAGIC and SSWC Sites
Study Area
Ecoregions
Central Appalacian
Ridge and Valley
Blue Ridge
0
20
40 Miles
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Steady State Water Chemistry Model (SSWC)

$$CL(A) = BC_{dep} + BC_{w} - Bc_{up} - ANC_{limit}$$

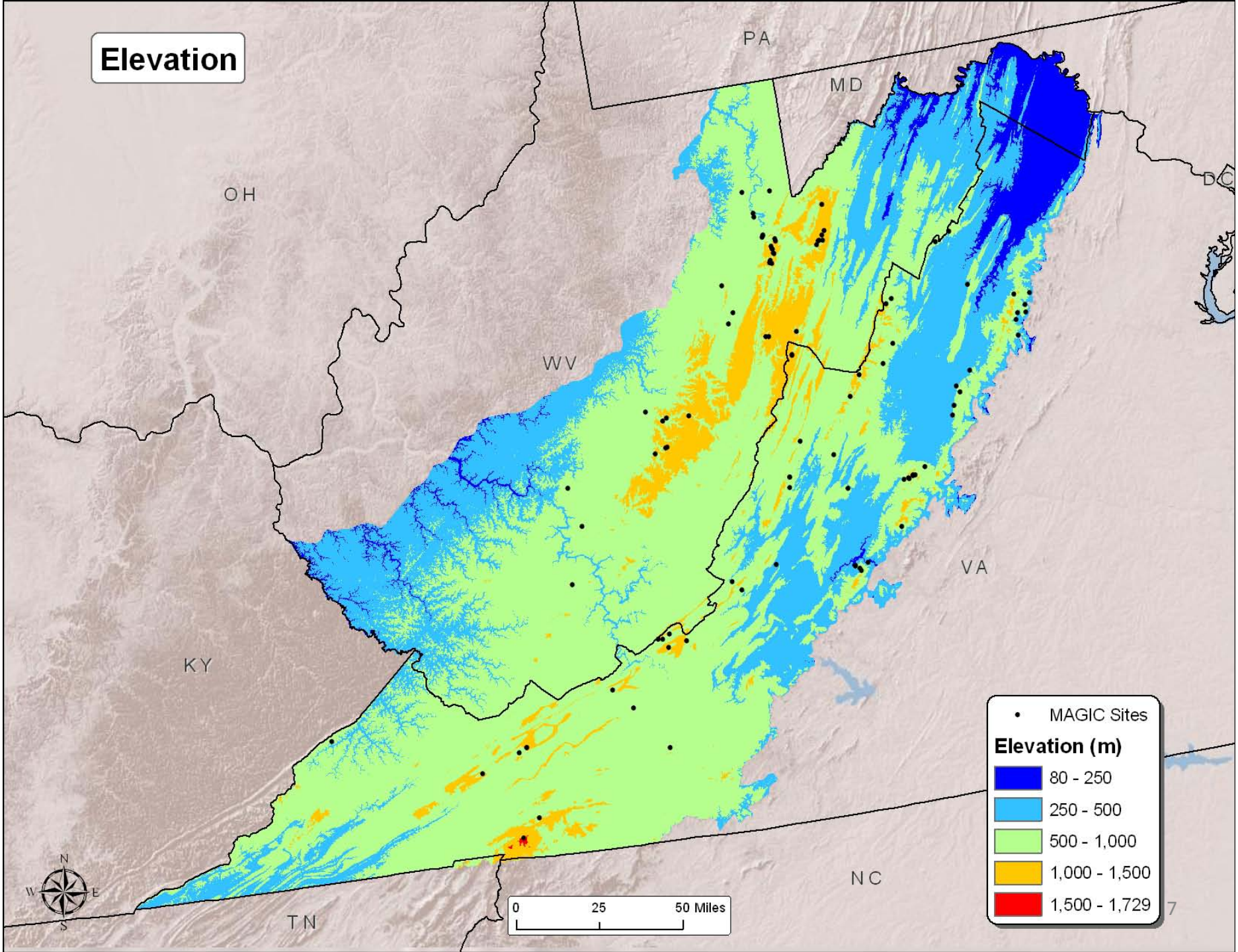
What to do about weathering?

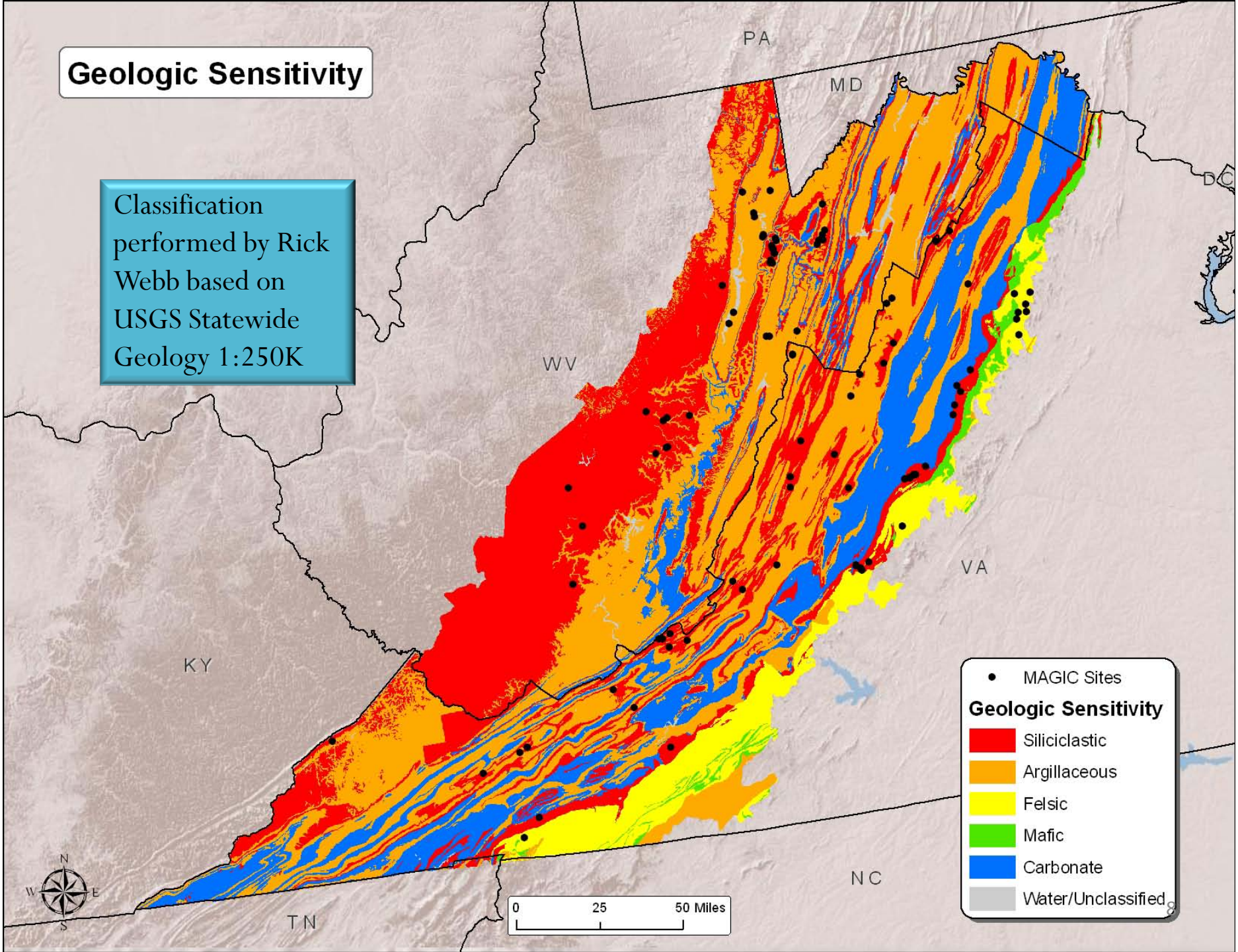
1) Simulate weathering at 92 sites using MAGIC
2) Extrapolate MAGIC estimates of weathering to the region
3) Model regional CLs using SSWC
4) Assign CLs to individual stream reaches
5) Calculate CL exceedances

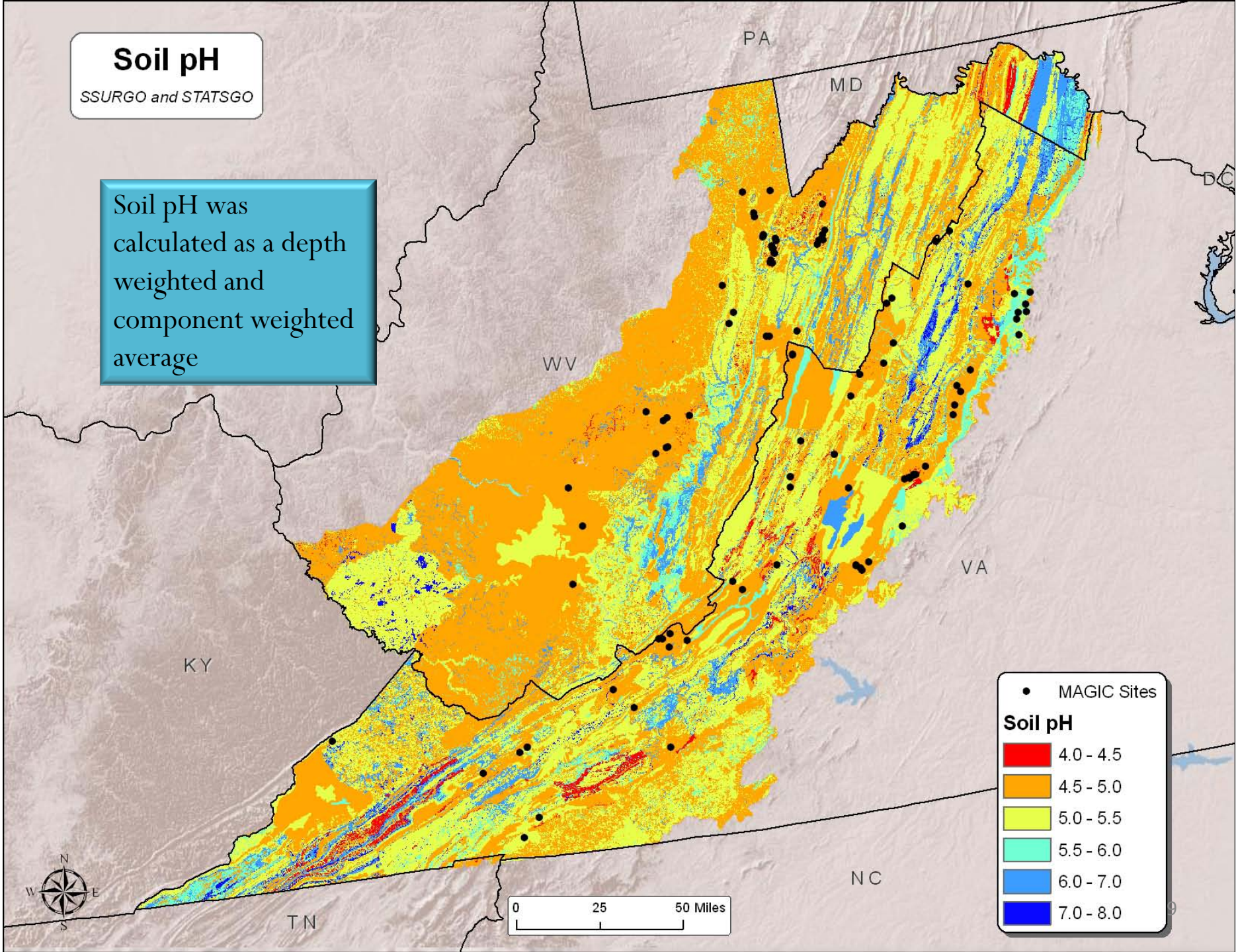
BC_w Predictor Variables

- Landscape Characteristics
  - Watershed Area
  - Elevation
  - Slope
  - Geologic classes
  - Soil variables (% clay, pH, depth)

- Water Chemistry (500+ sites)
  - Sum of base cations
  - Sum of base cations – chloride
  - ANC
  - Sulfate
  - Nitrate


Elevation
PA
MD
DC
OH
WV
VA
KY
NC
TN
MAGIC Sites
Elevation (m)
80 - 250
250 - 500
500 - 1,000
1,000 - 1,500
1,500 - 1,729
0
25
50 Miles
N
W
E
S

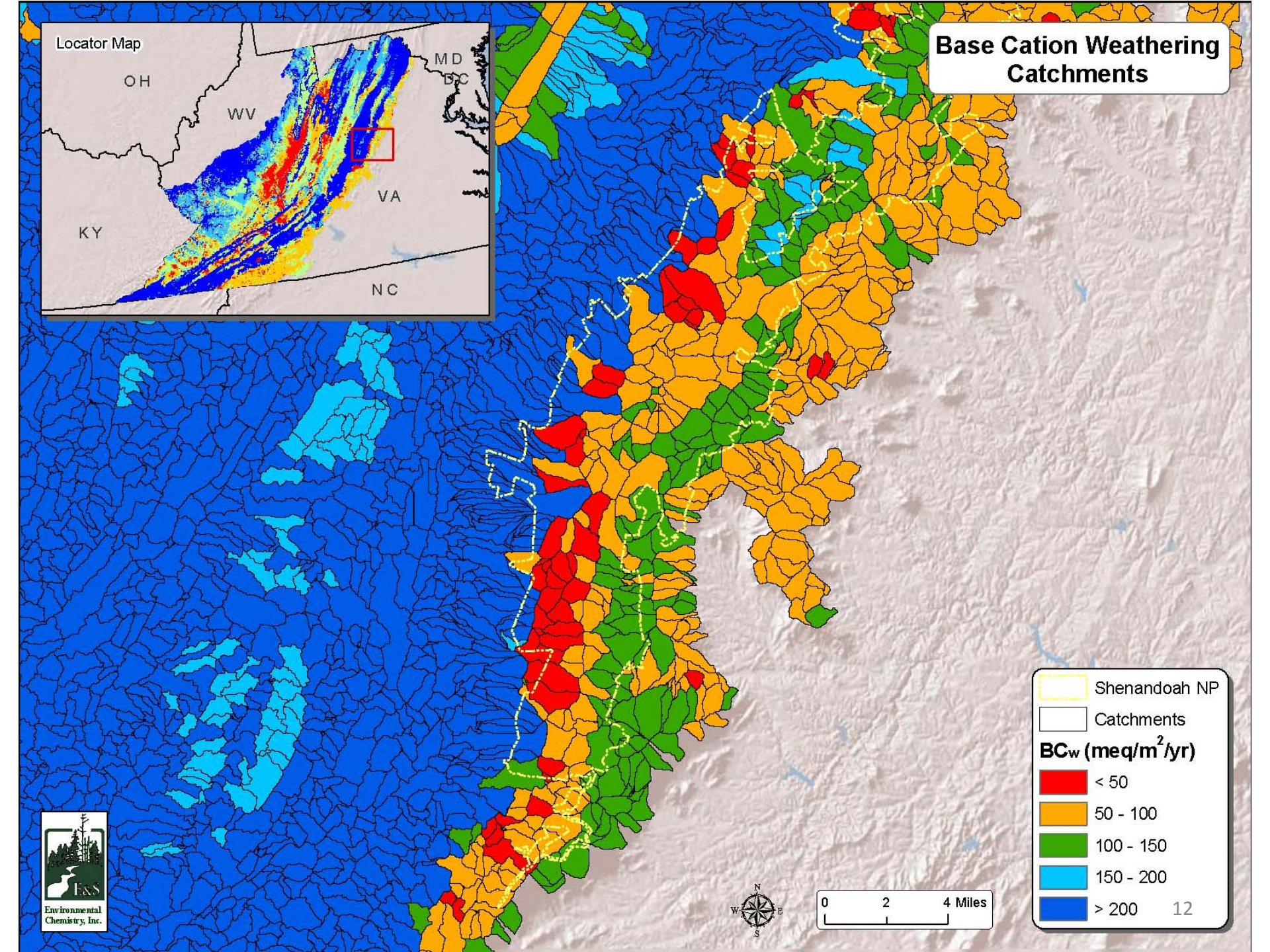

Geologic Sensitivity
Classification performed by Rick Webb based on USGS Statewide Geology 1:250K
PA
MD
DC
WV
VA
KY
NC
TN
N
W
E
S
0
25
50 Miles
MAGIC Sites
Geologic Sensitivity
Siliciclastic
Argillaceous
Felsic
Mafic
Carbonate
Water/Unclassified


Soil pH
SSURGO and STATSGO
Soil pH was calculated as a depth weighted and component weighted average
PA
MD
DC
WV
VA
KY
NC
TN
MAGIC Sites
Soil pH
4.0 - 4.5
4.5 - 5.0
5.0 - 5.5
5.5 - 6.0
6.0 - 7.0
7.0 - 8.0
0
25
50 Miles
N
W
E
S

Predicting BC_w from Available Spatial Data

Ecoregion	n	Predictor Variables	r^2
With Water Chemistry:			
Central Appalachian	24	SBC NO_3 WS Area	0.93
Ridge & Valley	42	SBC Elevation (-) Slope (-)	0.85
Blue Ridge	26	ANC NO_3	0.90

Ecoregion	n	Predictor Variables	r^2
Without Water Chemistry:			
Central Appalachian	24	Soil pH (-) WS Area Elevation (-)	0.66
Ridge & Valley	42	% Siliciclastic (-) % Carbonate Elevation (-)	0.64
Blue Ridge	26	% Siliciclastic (-) Soil % Clay Soil Depth (-)	0.86


Base Cation Weathering Catchments
Locator Map
OH
WV
MD
DC
VA
KY
NC
Shenandoah NP
Catchments
BCw (meq/m2/yr)
< 50
50 - 100
100 - 150
150 - 200
> 200
0
2
4 Miles
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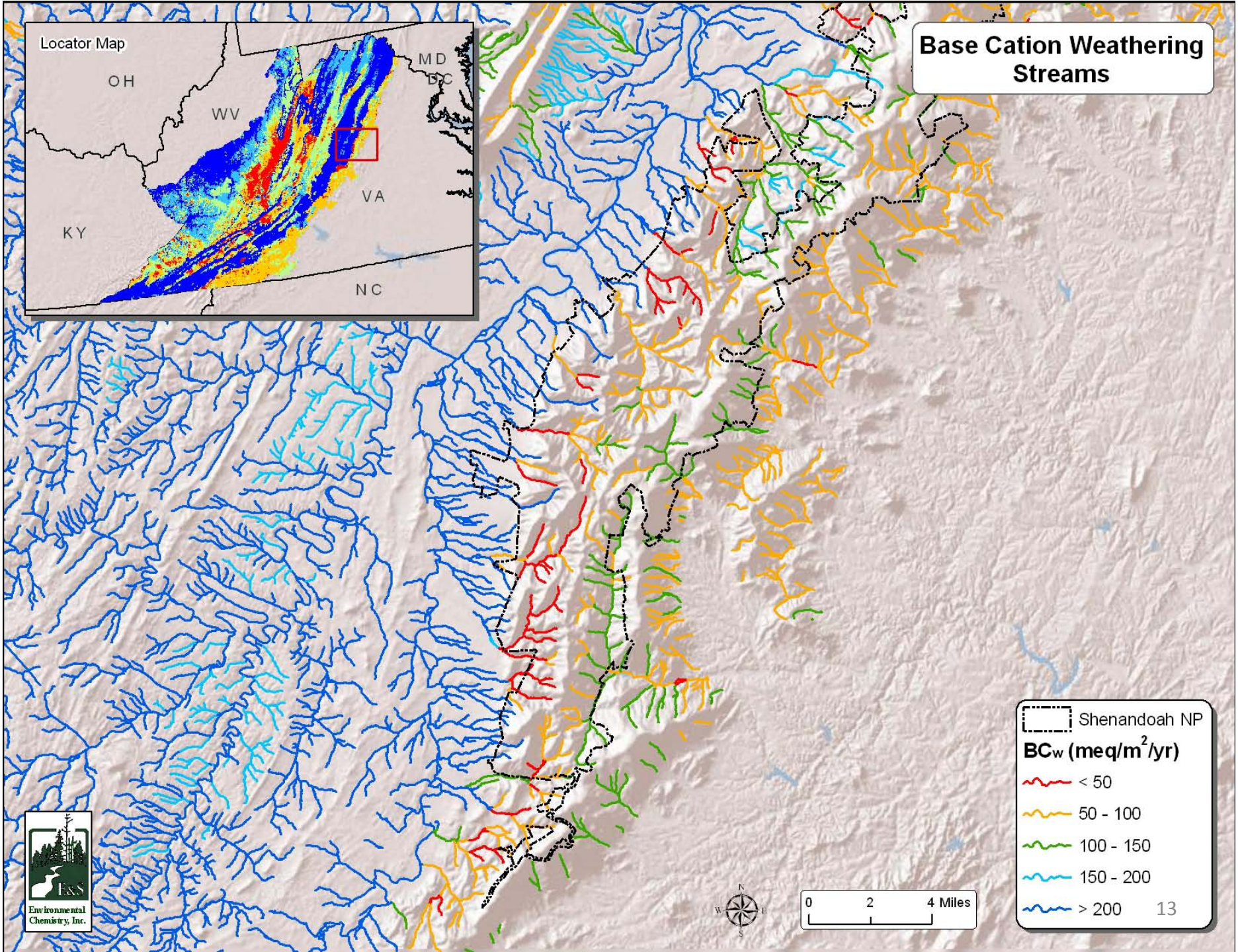
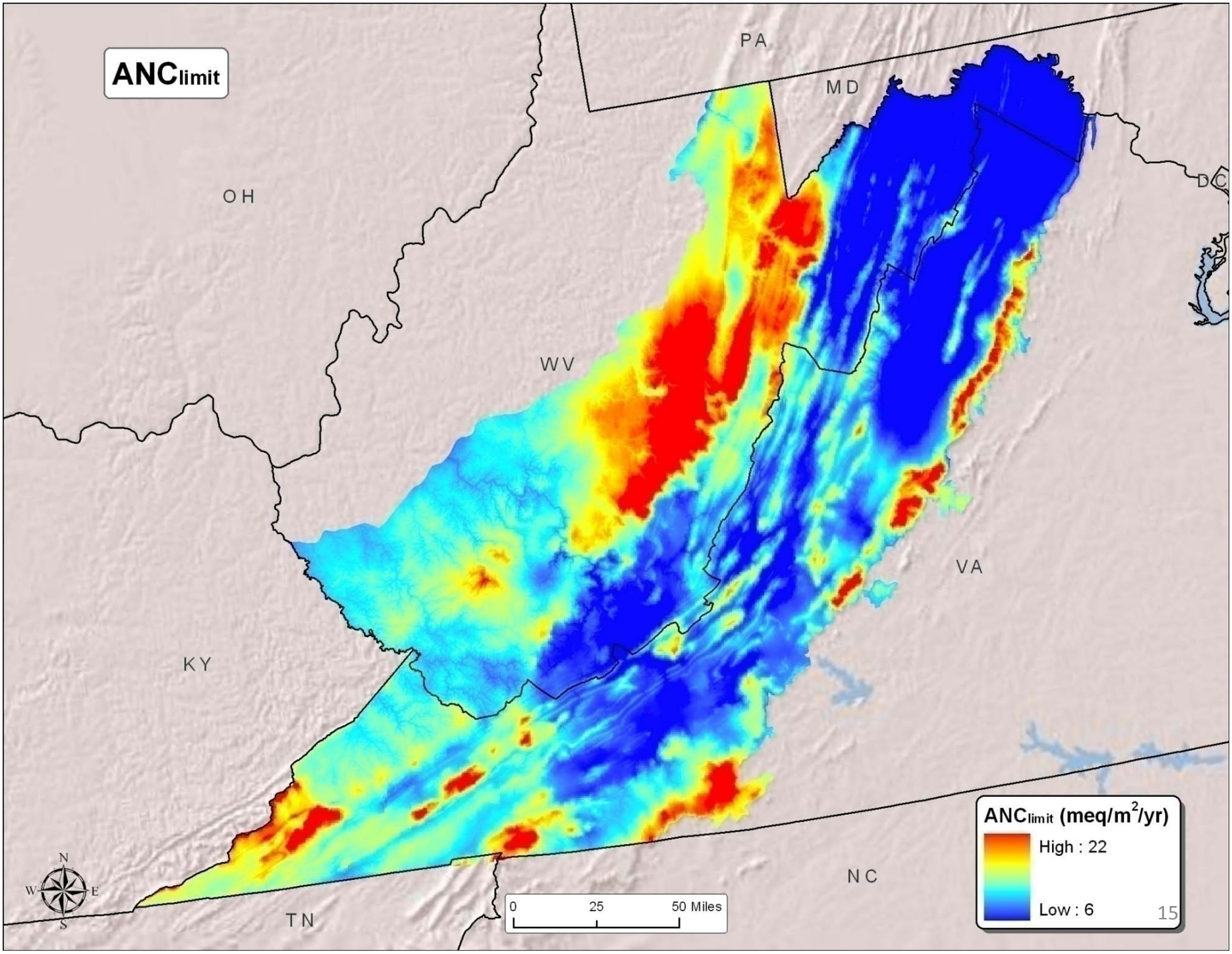
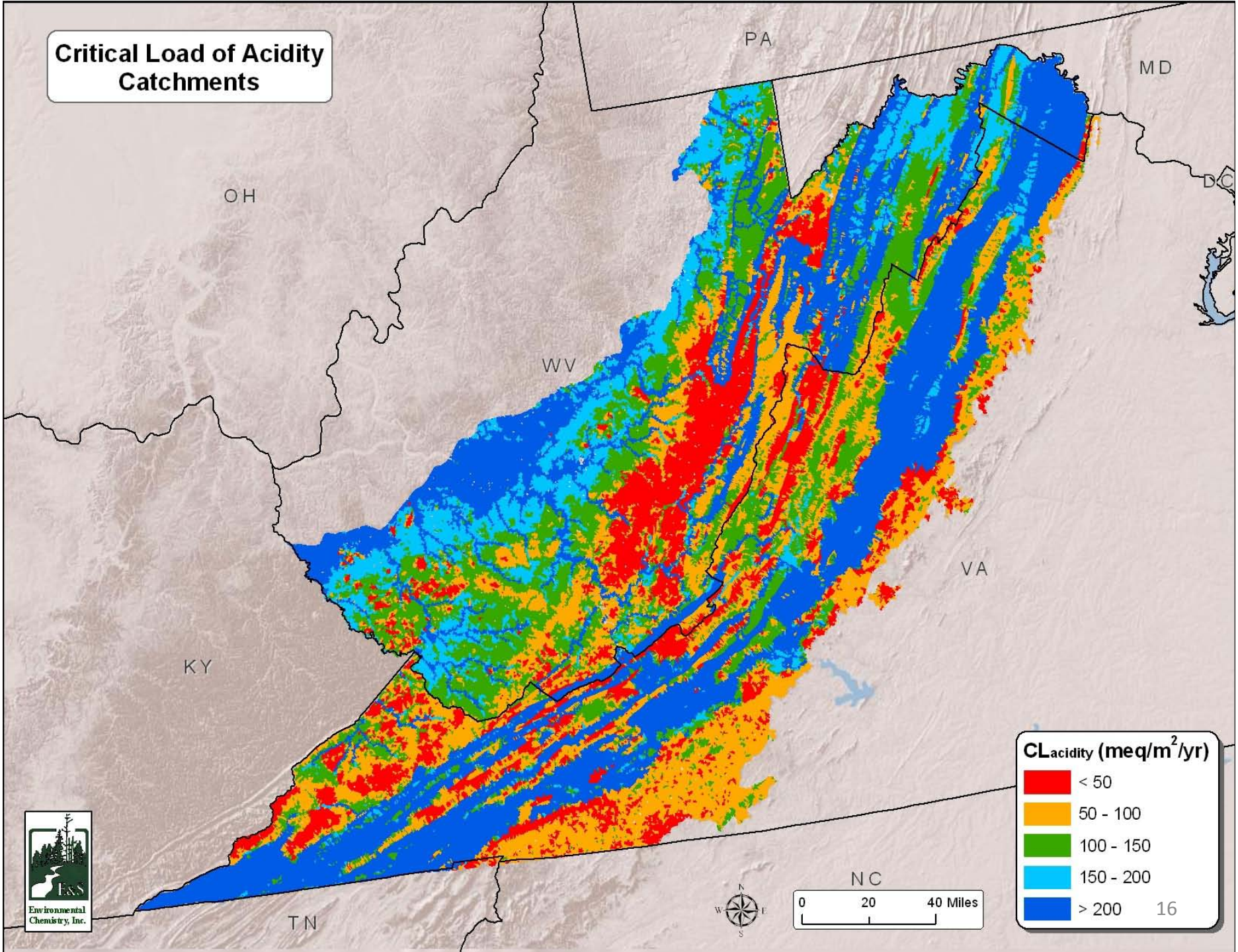
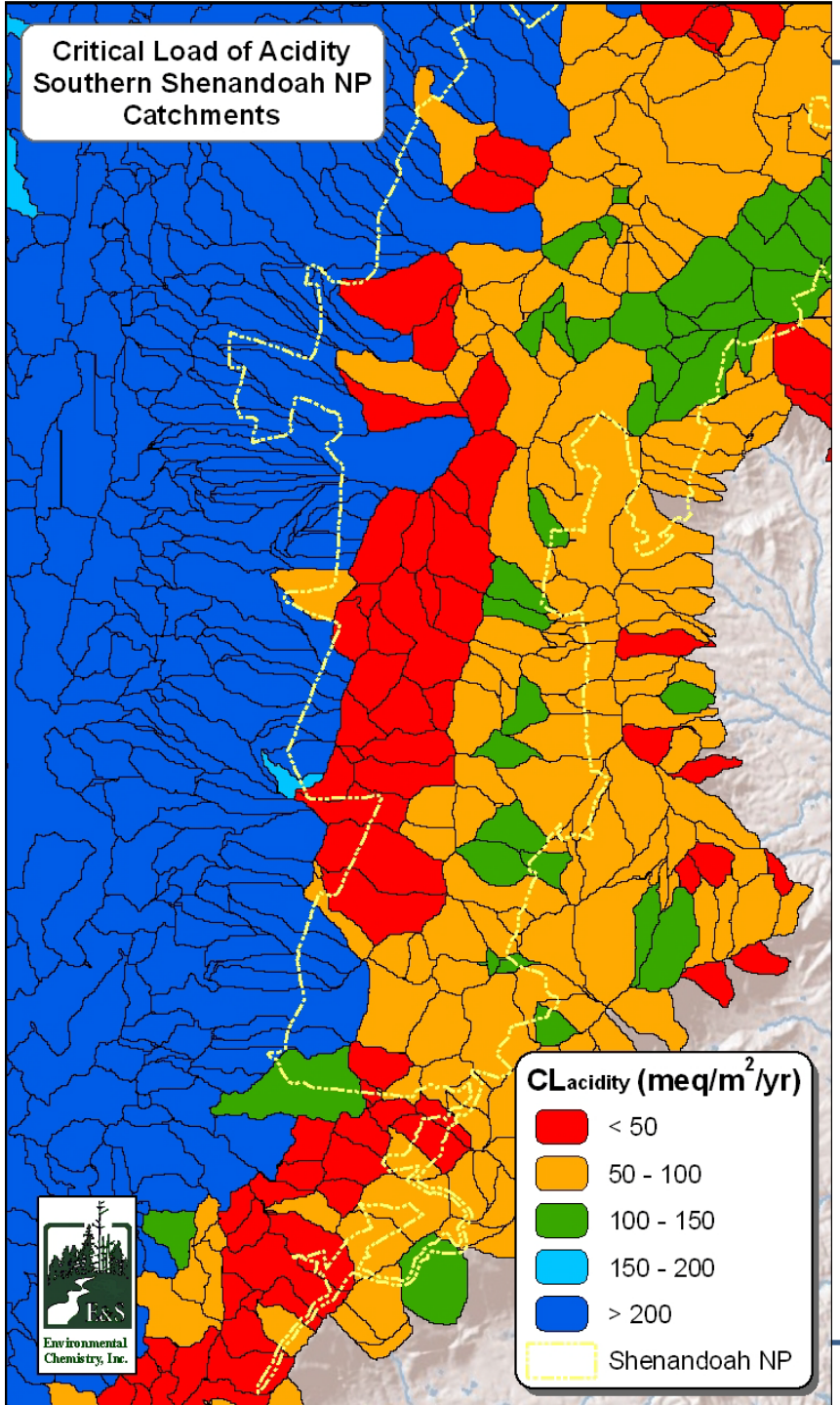

Locator Map
OH
WV
MD
DC
VA
KY
NC
Base Cation Weathering Streams
Shenandoah NP
BCw (meq/m2/yr)
< 50
50 - 100
100 - 150
150 - 200
> 200
0
2
4 Miles
E&S
Environmental Chemistry, Inc.

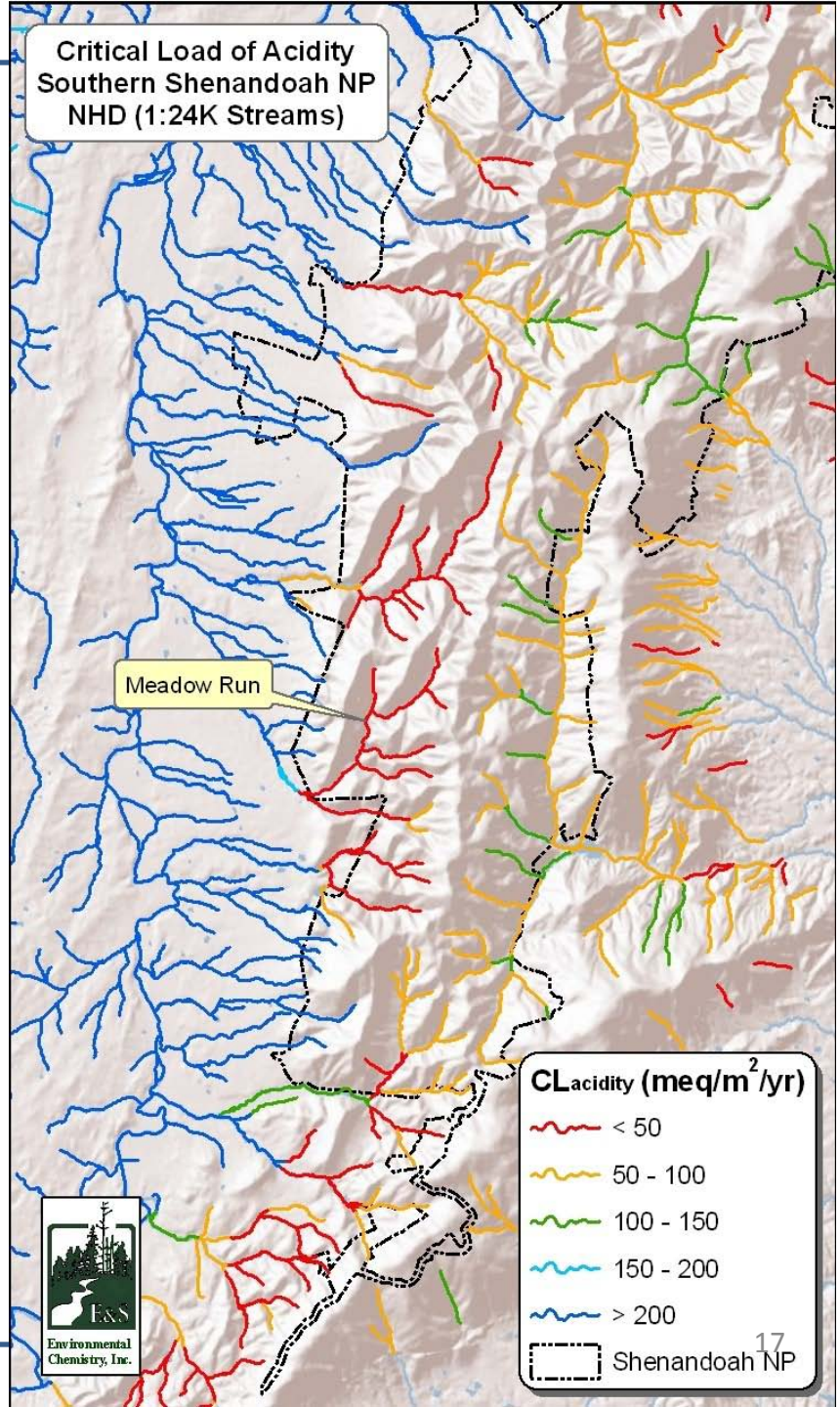
Steady State Water Chemistry Model (SSWC)

$$CL(A) = BC_{dep} + BC_{w} - Bc_{up} - ANC_{limit}$$


ANClimit
PA
MD
DC
OH
WV
VA
KY
TN
NC
N
W
E
S
0
25
50 Miles
ANClimit (meq/m2/yr)
High : 22
Low : 6


Critical Load of Acidity Catchments
PA
MD
DC
OH
WV
VA
KY
TN
NC
CLacidity (meq/m2/yr)
< 50
50 - 100
100 - 150
150 - 200
> 200
0
20
40 Miles
Environmental Chemistry, Inc.
16


Critical Load of Acidity
Southern Shenandoah NP
Catchments
CLacidity (meq/m2/yr)
< 50
50 - 100
100 - 150
150 - 200
> 200
Shenandoah NP
E&S
Environmental
Chemistry, Inc.


Critical Load of Acidity
Southern Shenandoah NP
NHD (1:24K Streams)
Meadow Run
CLacidity (meq/m2/yr)
< 50
50 - 100
100 - 150
150 - 200
> 200
Shenandoah NP
E&S
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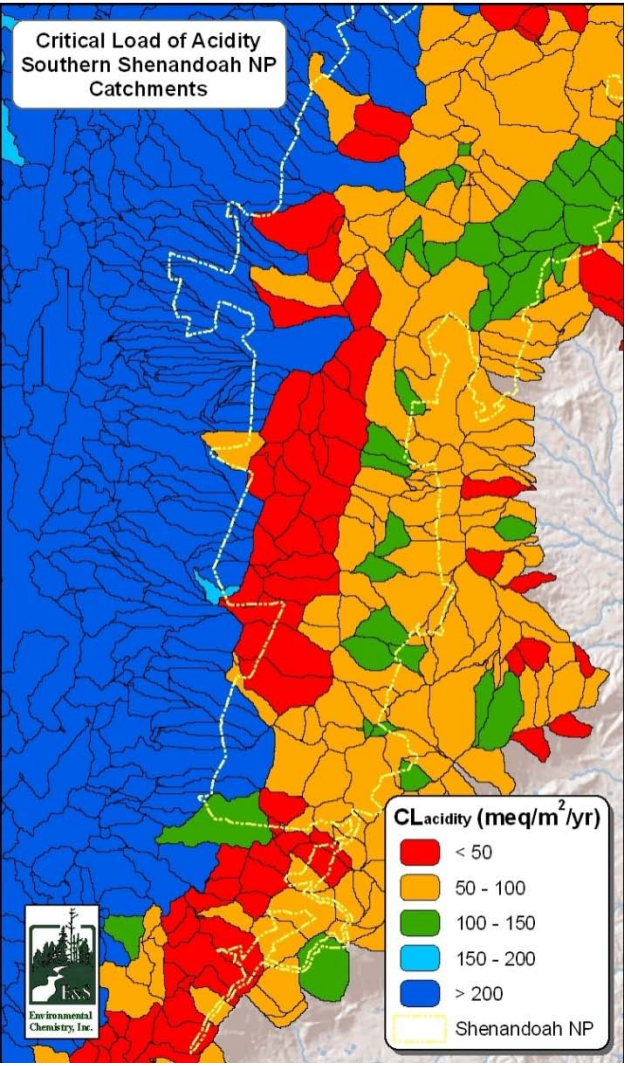
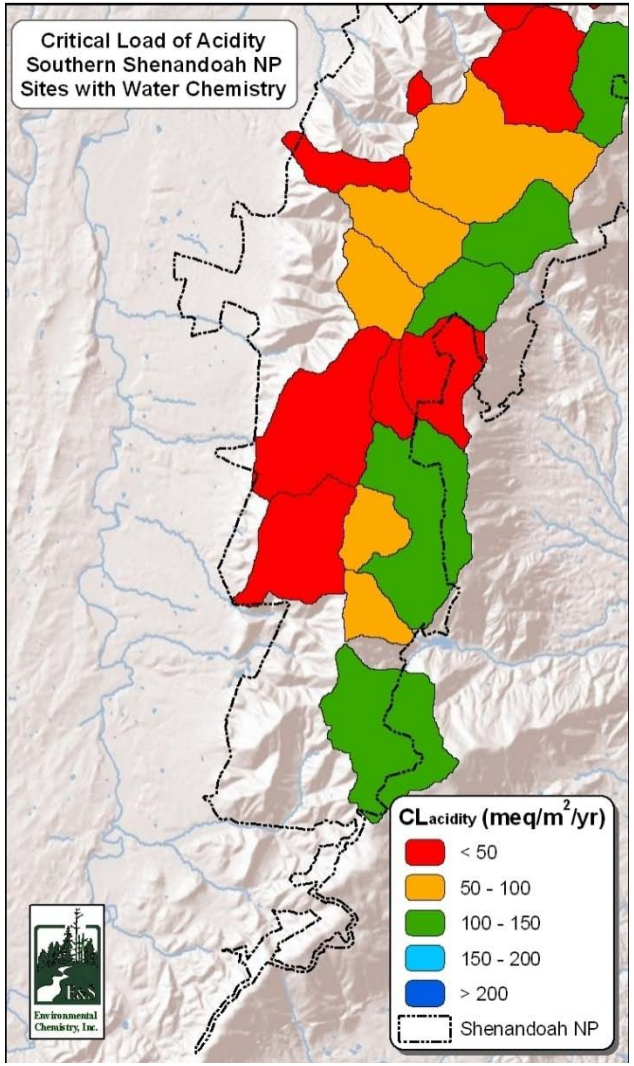
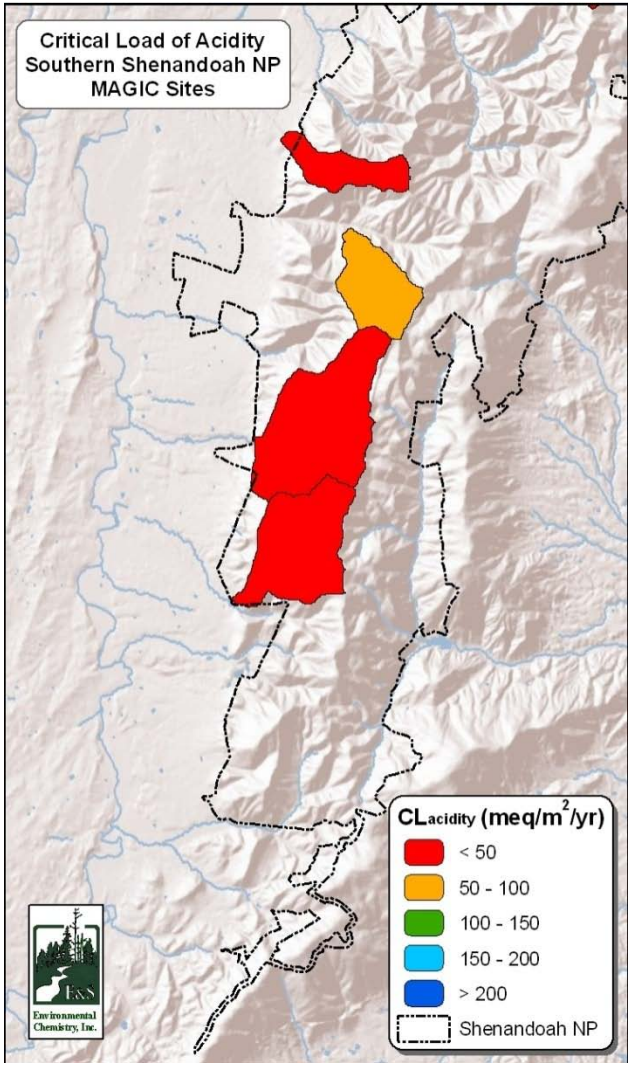
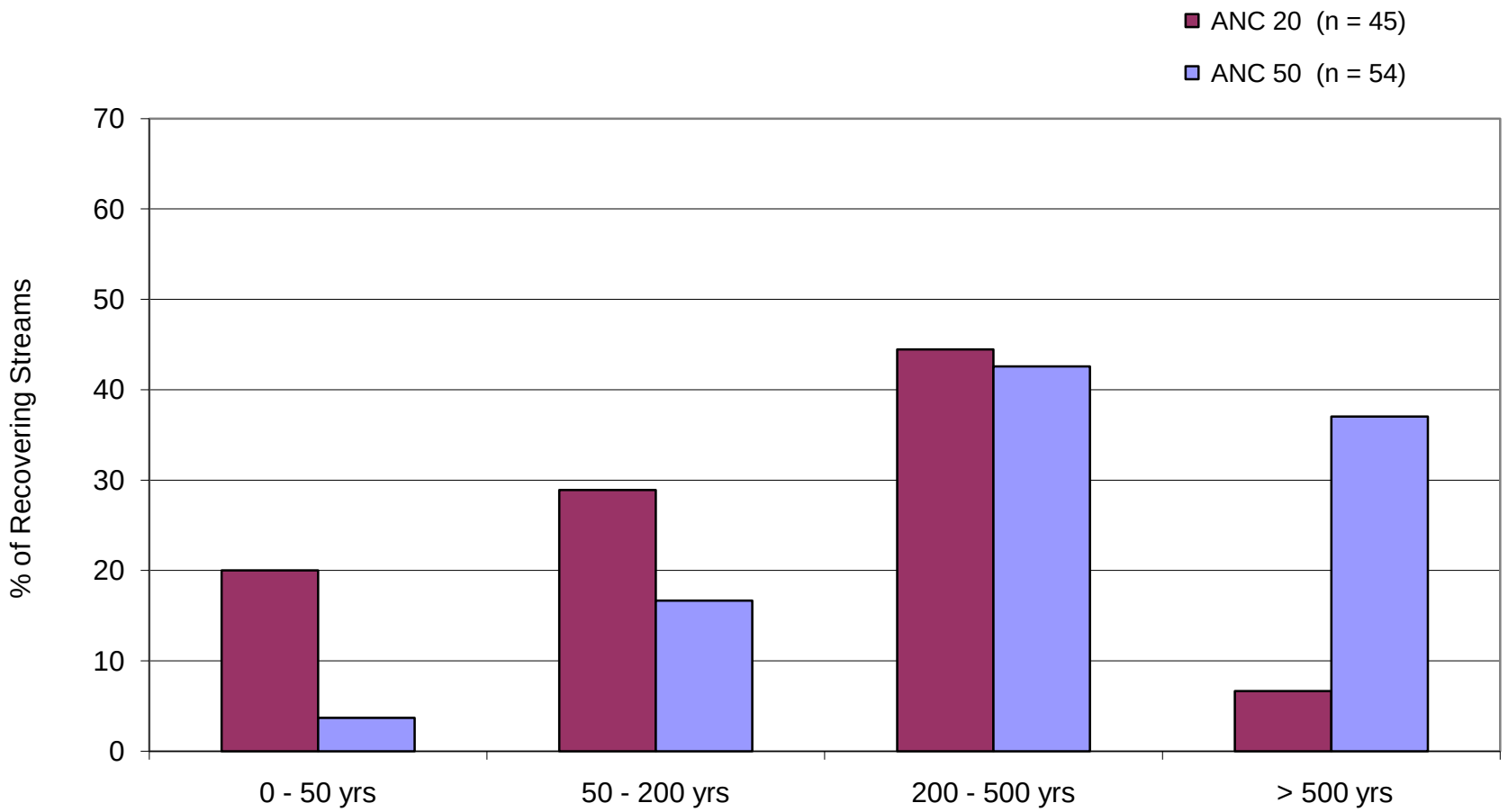

Critical Load of Acidity
Southern Shenandoah NP
Catchments
CLacidity (meq/m2/yr)
< 50
50 - 100
100 - 150
150 - 200
> 200
Shenandoah NP
Environmental Chemistry, Inc.


Critical Load of Acidity
Southern Shenandoah NP
Sites with Water Chemistry
CLacidity (meq/m2/yr)
< 50
50 - 100
100 - 150
150 - 200
> 200
Shenandoah NP
Environmental Chemistry, Inc.


Critical Load of Acidity
Southern Shenandoah NP
MAGIC Sites
CLacidity (meq/m2/yr)
< 50
50 - 100
100 - 150
150 - 200
> 200
Shenandoah NP
Environmental Chemistry, Inc.

Time to Steady State ANC (μeq/L) Starting 2020 Using SSWC Critical Loads



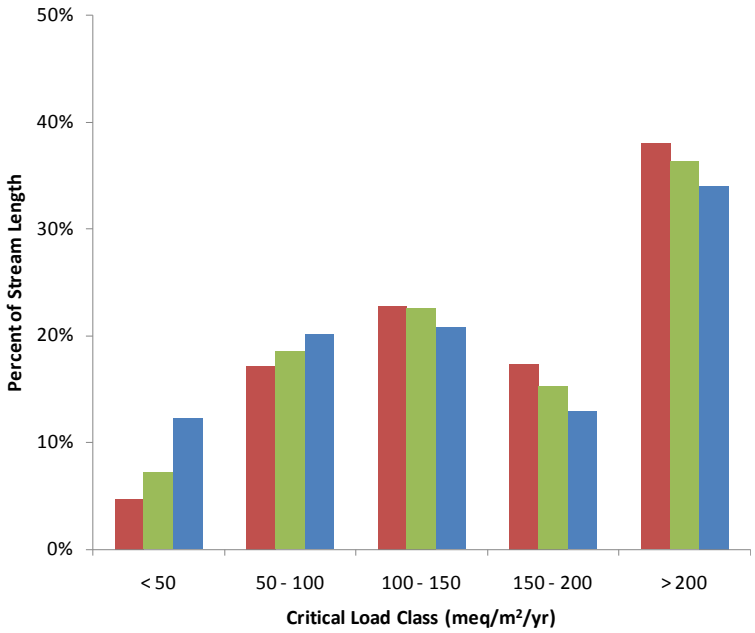
Things to move from the back of your mind to the front of your mind when addressing critical and target loads

1. Time frame matters.
2. There are multiple possible chemical indicators; each relates somehow to biology.
3. Do you want to base policy on one lake or one stream? You need to know about the broader population of lakes and/or streams.

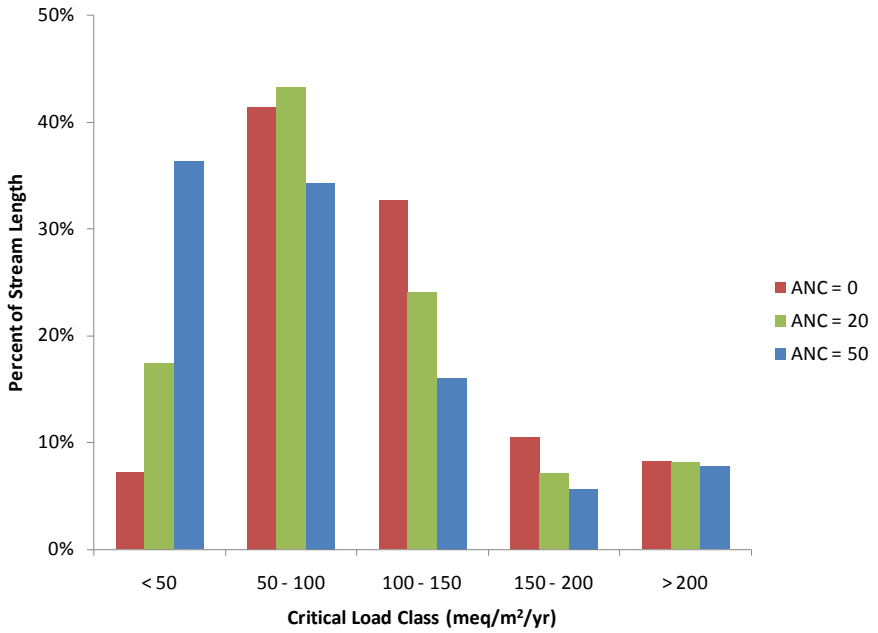
4. Most lakes or streams in a given region are generally NOT acid-sensitive (critical load is very high). Focus on the relatively small number of waters that are sensitive.
5. Some acidified lakes and streams are not projected to recover to critical criteria values even if deposition is reduced to zero because they were not that high to begin with.
6. It's important to separate the science (objective) from the policy (judgment). The science is reflected in the modeling. There are MANY policy judgments to be made, and they should be clearly documented.

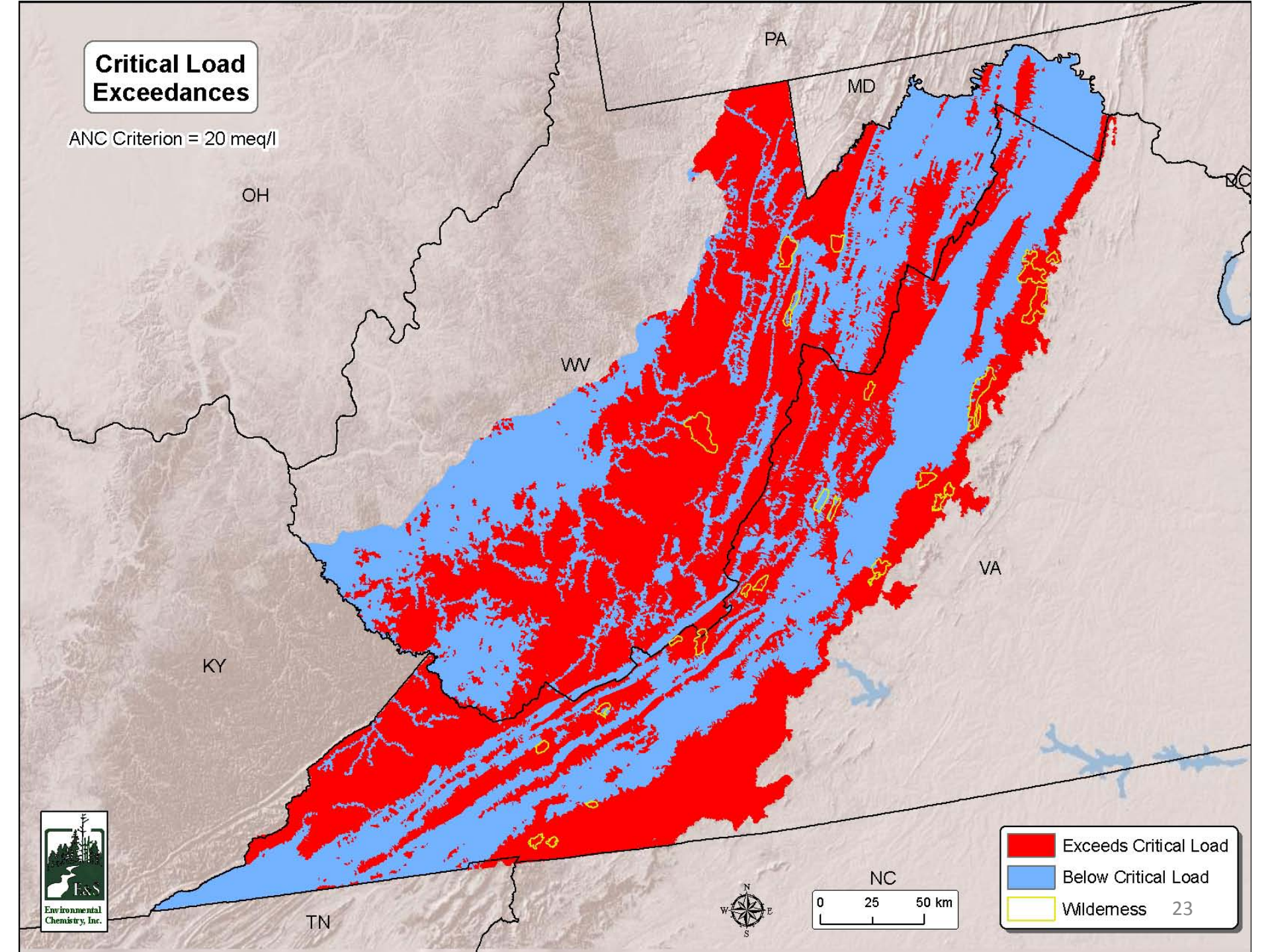
Critical Loads of Acidity

Study Area



Designated Wilderness




Critical Load Exceedances
ANC Criterion = 20 meq/l
PA
MD
OH
WV
VA
KY
TN
NC
0 25 50 km
Exceeds Critical Load
Below Critical Load
Wilderness
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