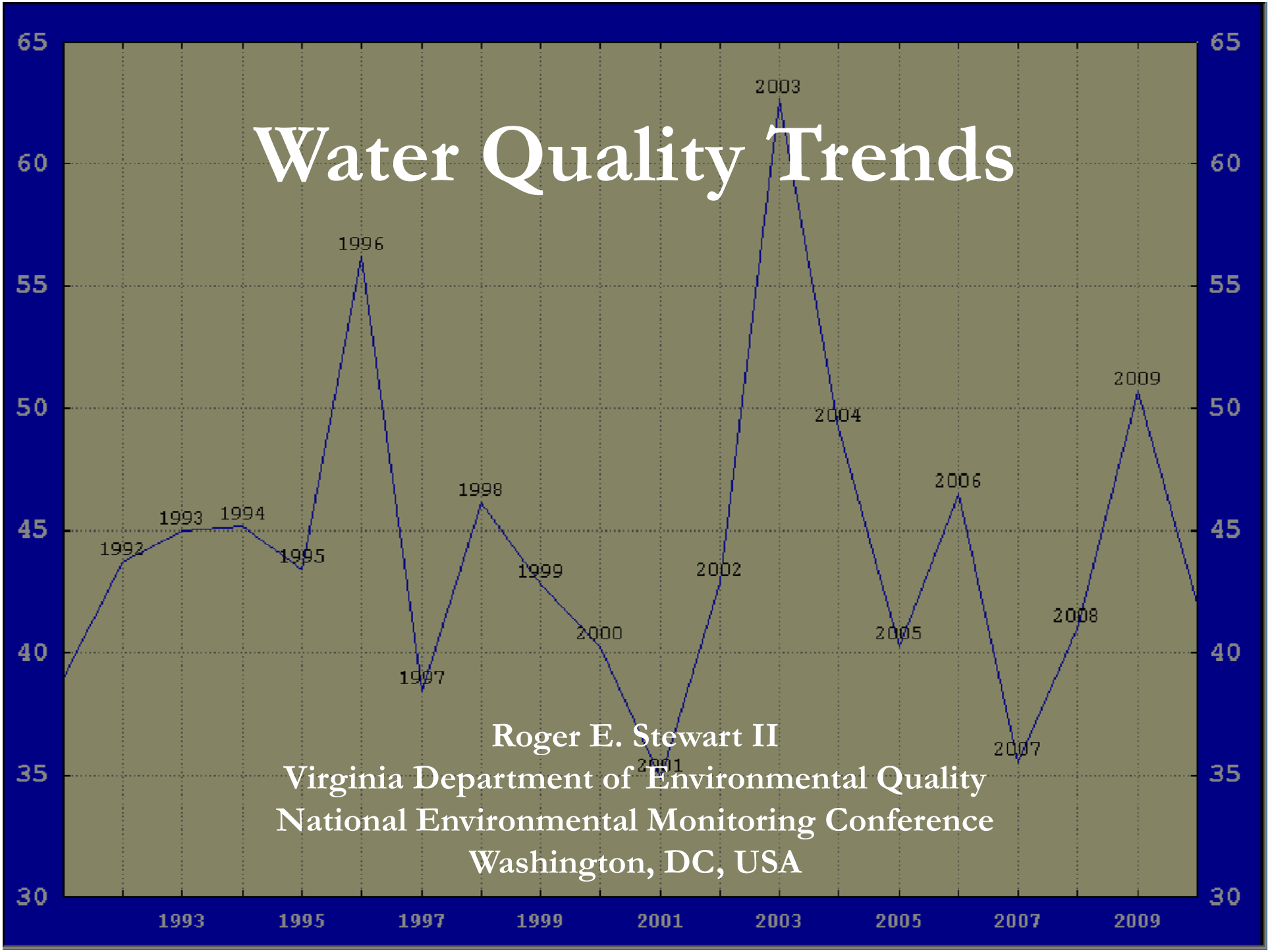
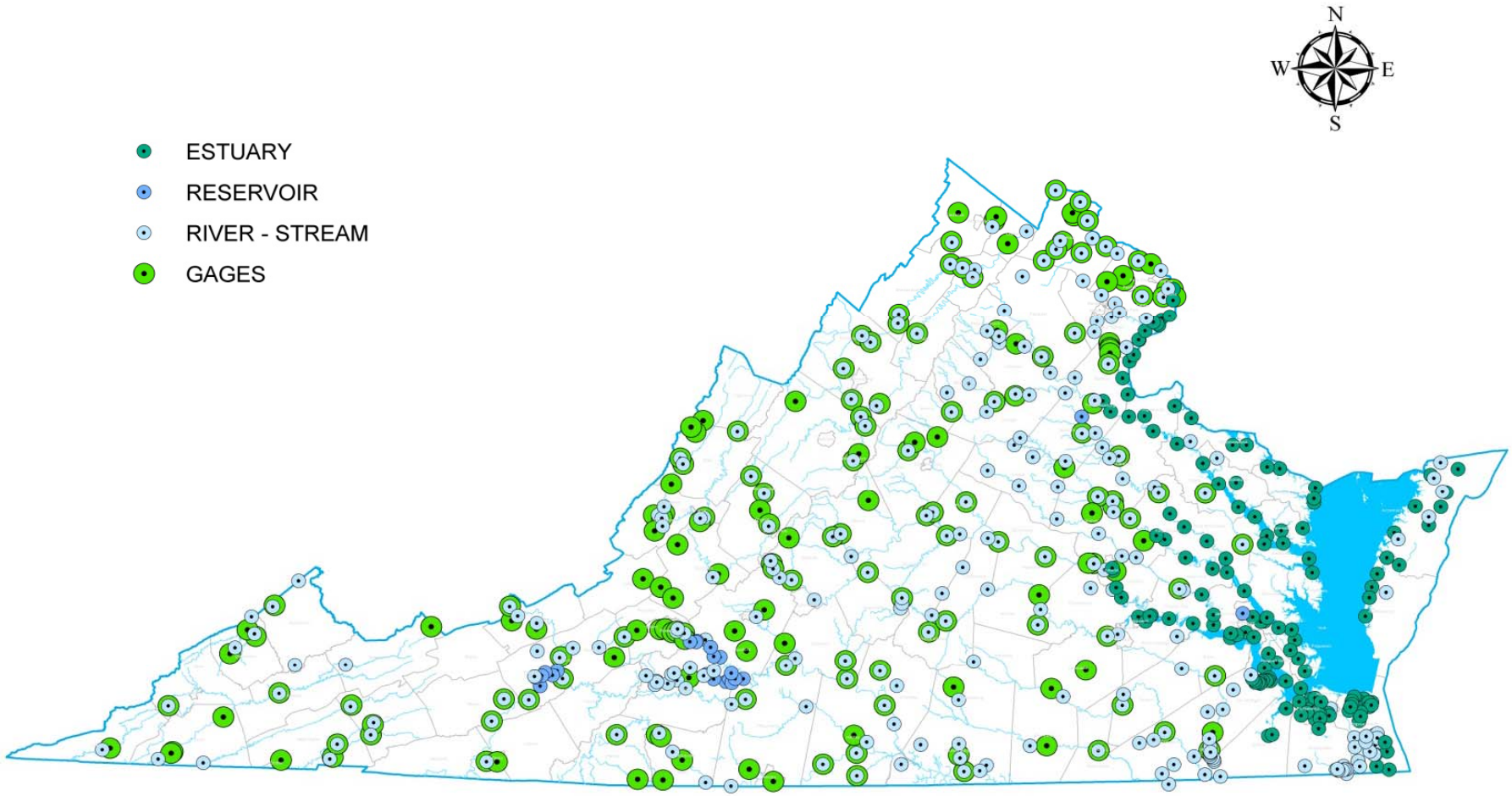

Water Quality Trends
65
60
55
50
45
40
35
30
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
1993
1995
1997
1999
2001
2003
2005
2007
2009
Roger E. Stewart II
Virginia Department of Environmental Quality
National Environmental Monitoring Conference
Washington, DC, USA

WATER QUALITY TREND AND GAGE STATIONS



Sources:
1. Virginia Department of Environmental Quality Comprehensive Environmental Data System.
2. National Hydrography Data Center.
3. Virginia Depatment of Transportation.
4. U.S. Department of Commerce, U.U. Census Bureau, Geography Division, 2008.
5. U.S. Geological Survey Stream Gage Network.

0 12.5 25 50 Miles

WATER QUALITY TRENDS 1991 TO 2010
NITROGEN ANNUAL PERCENT CHANGE
RIVERS AND STREAMS

SIGNIFICANT IMPROVEMENT

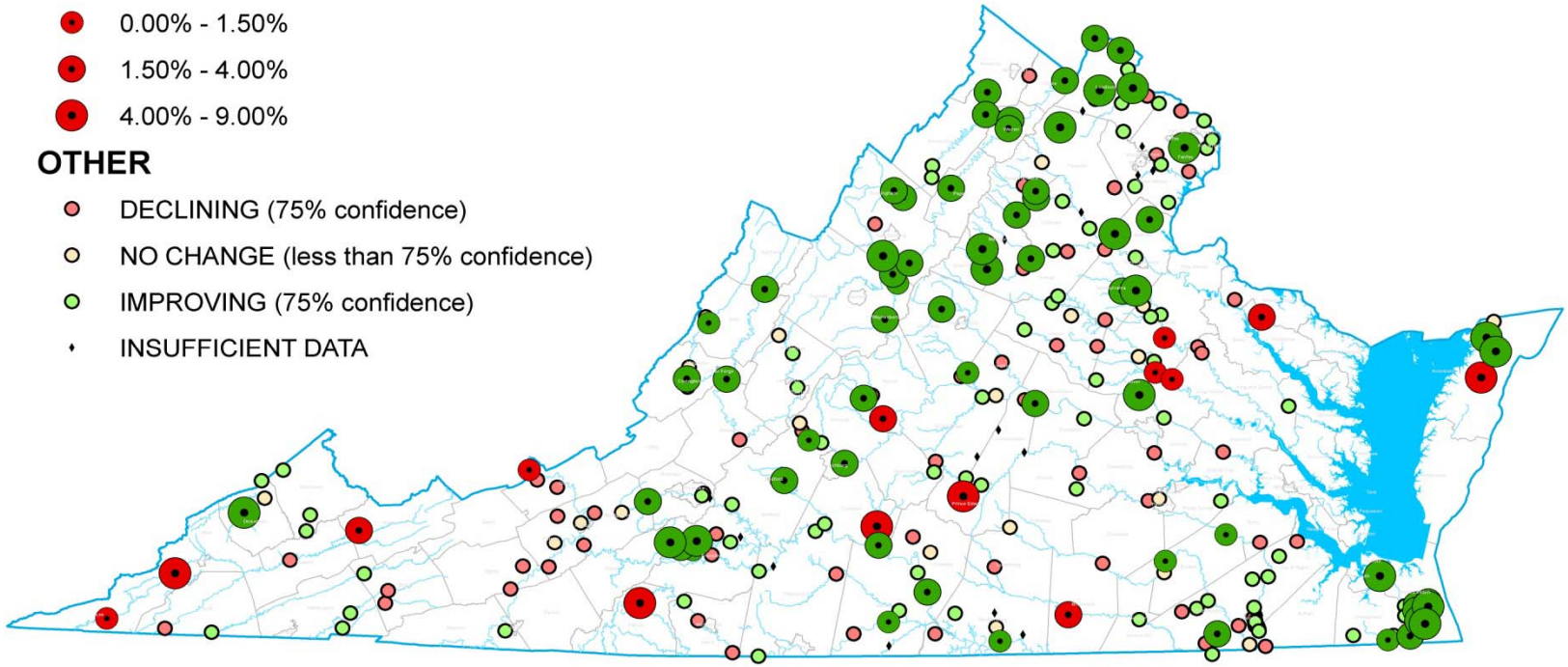
- 2.00% - 3.00%
- 1.00% - 2.00%
- 0.00% - 1.00%

SIGNIFICANT DECLINE

- 0.00% - 1.50%
- 1.50% - 4.00%
- 4.00% - 9.00%

OTHER

- DECLINING (75% confidence)
- NO CHANGE (less than 75% confidence)
- IMPROVING (75% confidence)
- INSUFFICIENT DATA



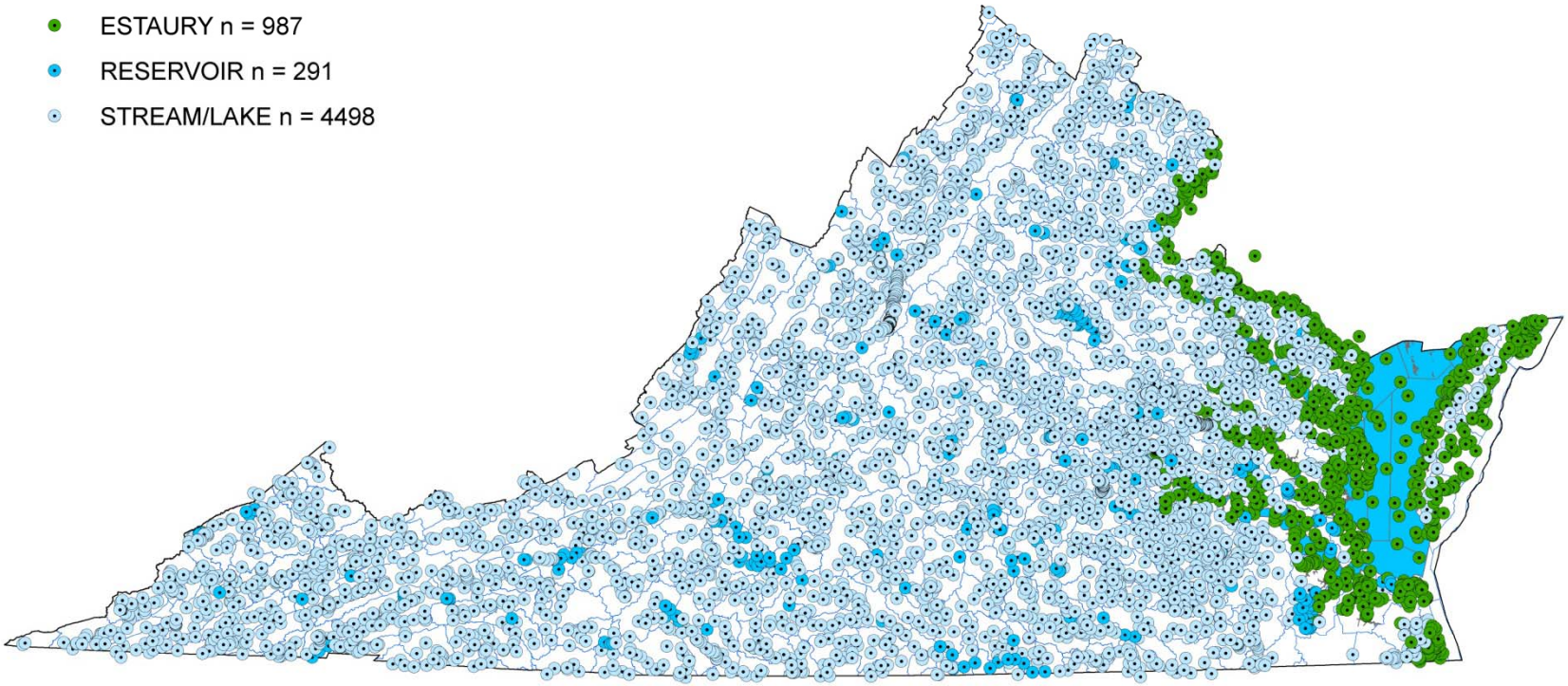
Sources:
1. Virginia Department of Environmental Quality Comprehensive Environmental Data System.
2. National Hydrography Data Center.
3. Virginia Depatment of Transportation.
4. U.S. Department of Commerce, U.U. Census Bureau, Geography Division, 2008.
5. U.S. Geological Survey Stream Gage Network.

0 15 30 60 Miles

Integrated Water Quality Trends 1991 to 2010
Water Monitoring Stations

IWQ STATIONS

- ESTAURY n = 987
- RESERVOIR n = 291
- STREAM/LAKE n = 4498



DEQ
Virginia Department of Environmental Quality

N
W E
S

Miles
0 4.5 9 18 27 36

Virginia Department of Environmental Quality
Comprehensive Environmental Data System
IWQ analysis developed by R.E.Stewart and D.H.Smith.

NWBD 5th order layer provided by the Virginia Department of Conservation and Recreation

Map created on 14 July 2010.

5,776 stations

Temp, pH, DO, SC, Bact, N, P, SS

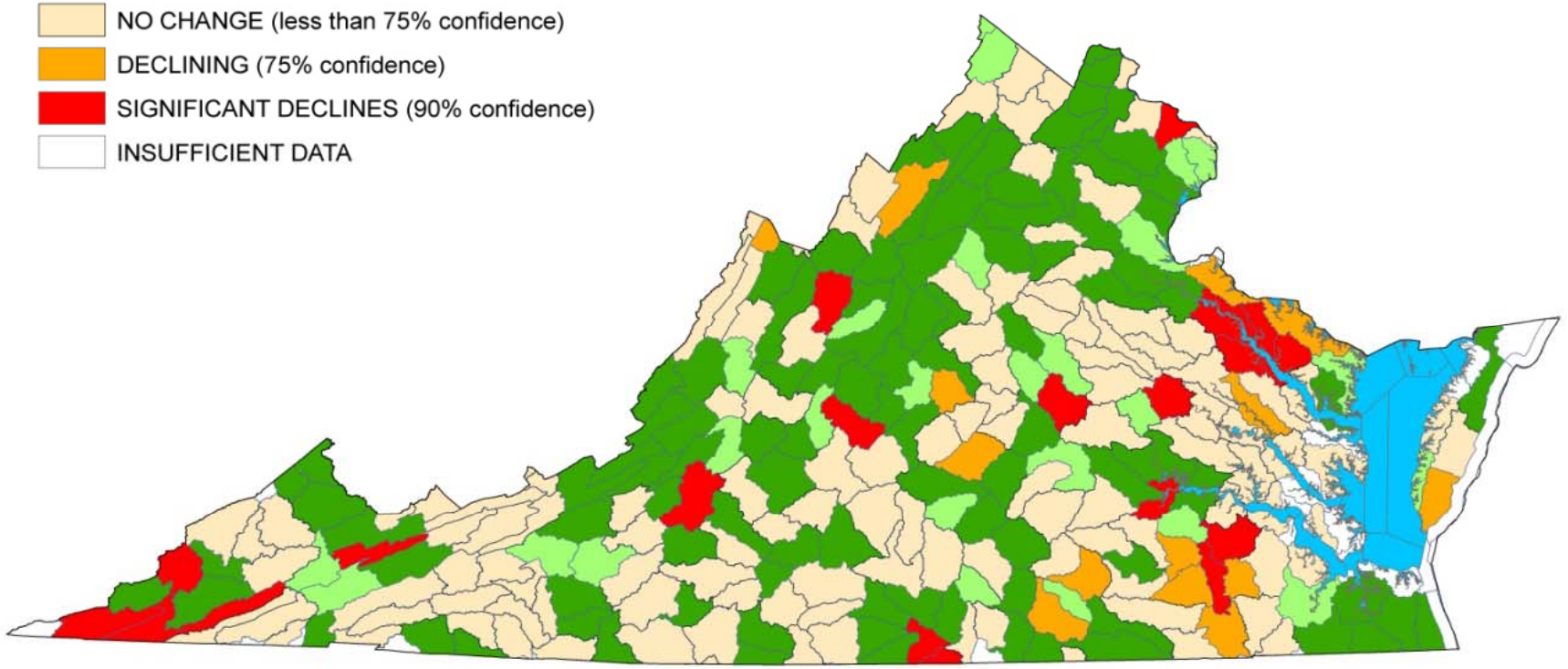
130,962 separate sample collection events

1,047,696 data points

TREND GROUPS	DATA SET PAGES
LAKES	379
ESTUARIES	2,352
STREAMS	4,295
FLOW	527
FLOW ADJUSTED	3,458
LOADS	2,622
IWQ	4,752
TOTAL DATA SET PAGES	18,385


ASSESSMENT
DATA

Integrated Water Quality Trends 1991 to 2010
Nitrogen in Rivers and Streams



DEQ
Virginia Department of Environmental Quality

Virginia Department of Environmental Quality
Comprehensive Environmental Data System
IWQ analysis developed by R.E.Stewart and D.H.Smith.

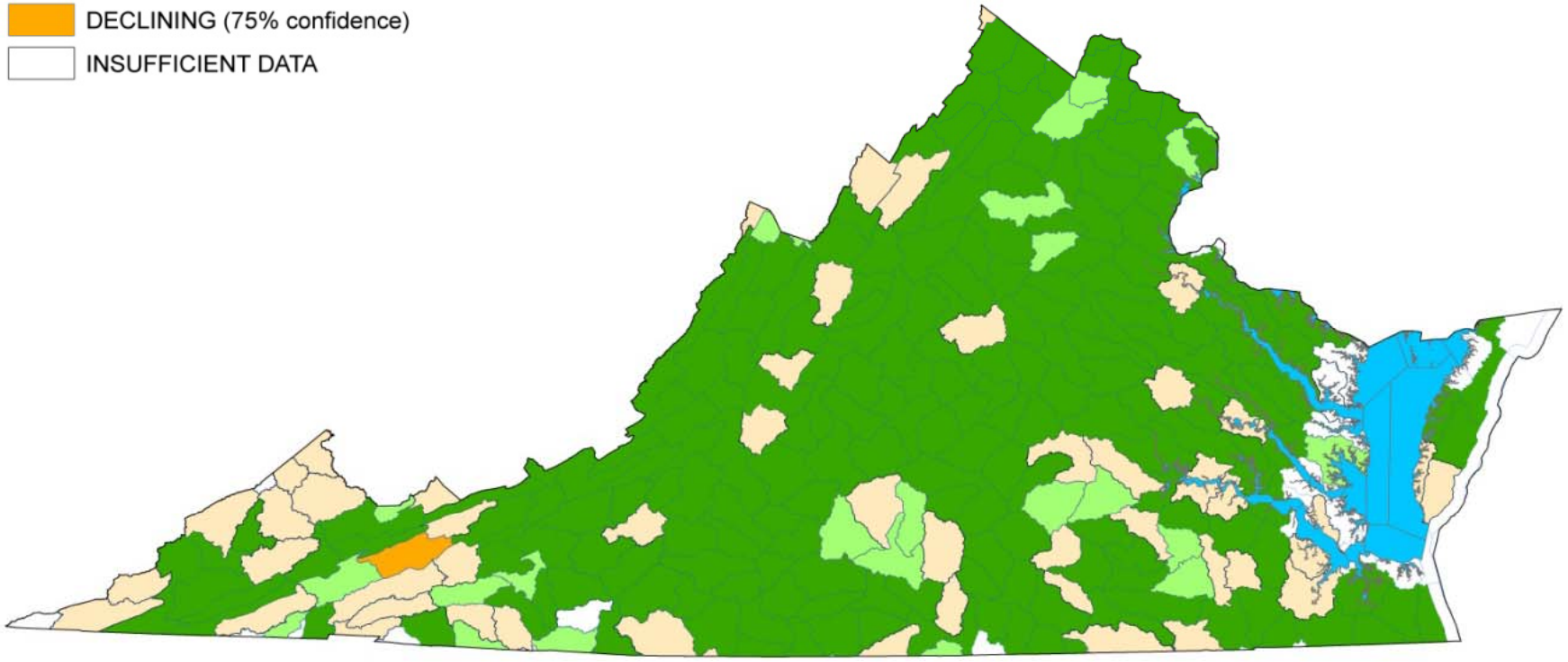
NWBD 5th order layer provided by the Virginia Department of Conservation and Recreation

Map created on 14 July 2010.

Integrated Water Quality Trends 1991 to 2010
Bacteria in Rivers and Streams

STREAM BACTERIA

- SIGNIFICANT IMPROVEMENTS (90% confidence)
- IMPROVING (75% confidence)
- NO CHANGE (less than 75% confidence)
- DECLINING (75% confidence)
- INSUFFICIENT DATA



DEQ
Virginia Department of Environmental Quality

N
W E
S

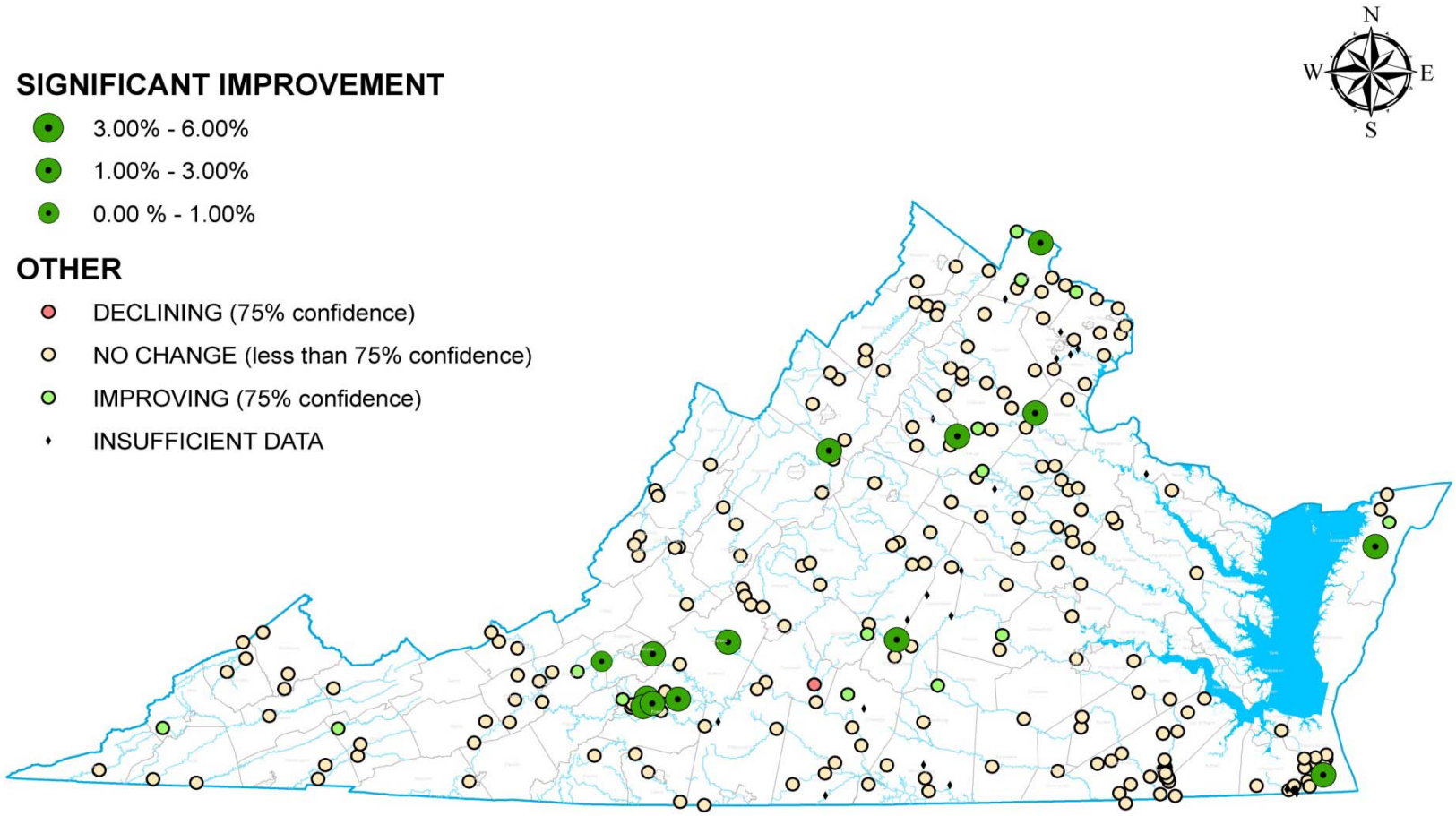
0 12.5 25 50 75 100 Miles

Virginia Department of Environmental Quality
Comprehensive Environmental Data System
IWQ analysis developed by R.E.Stewart and D.H.Smith.

NWBD 5th order layer provided by the Virginia Department of Conservation and Recreation

Map created on 14 July 2010.

WATER QUALITY TRENDS 1991 TO 2010
BACTERIA ANNUAL PERCENT CHANGE
RIVERS AND STREAMS



Sources:
1. Virginia Department of Environmental Quality Comprehensive Environmental Data System.
2. National Hydrography Data Center.
3. Virginia Depatment of Transportation.
4. U.S. Department of Commerce, U.U. Census Bureau, Geography Division, 2008.
5. U.S. Geological Survey Stream Gage Network.

0 15 30 60 Miles

A Total Maximum Daily Load Implementation Plan For Fecal Coliform and Nitrate Reductions

DRAFT

Submitted to
The Stakeholders of
Muddy Creek, Dry River, Pleasant Run, and Mill Creek Watersheds

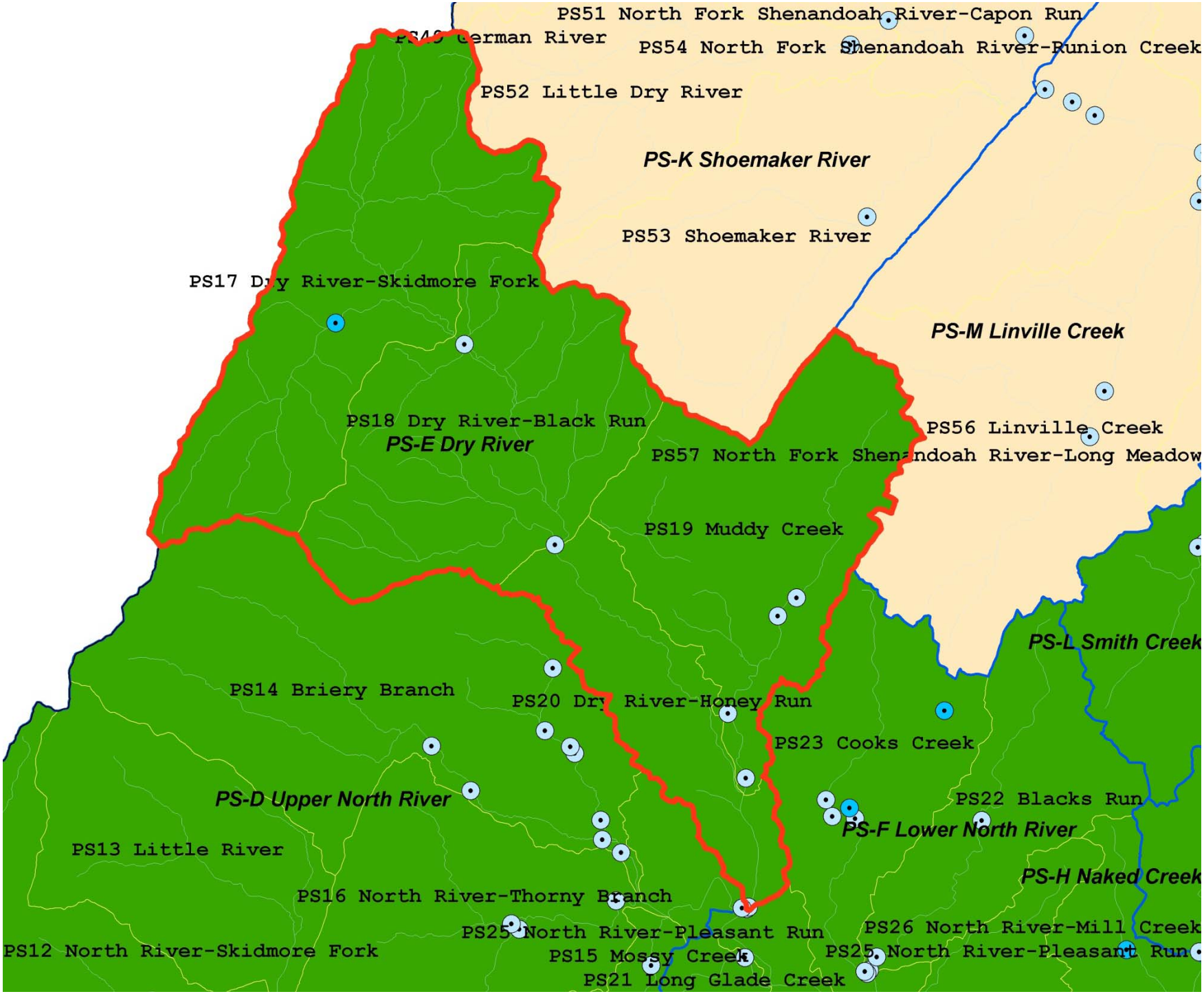
On Behalf of
The Commonwealth of Virginia:
Department of Conservation and Recreation

Prepared by

MapTech

June 26, 2001

http://www.deq.virginia.gov/export/sites/default/tmdl/implans/nriverip.pdf


PS51 North Fork Shenandoah River-Capon Run
PS54 North Fork Shenandoah River-Runion Creek
PS52 Little Dry River
PS-K Shoemaker River
PS53 Shoemaker River
PS17 Dry River-Skidmore Fork
PS-M Linville Creek
PS18 Dry River-Black Run
PS-E Dry River
PS56 Linville Creek
PS57 North Fork Shenandoah River-Long Meadow
PS19 Muddy Creek
PS-L Smith Creek
PS14 Briery Branch
PS20 Dry River-Honey Run
PS23 Cooks Creek
PS-D Upper North River
PS22 Blacks Run
PS-F Lower North River
PS13 Little River
PS-H Naked Creek
PS16 North River-Thorny Branch
PS25 North River-Pleasant Run
PS26 North River-Mill Creek
PS12 North River-Skidmore Fork
PS15 Mossy Creek
PS25 North River-Pleasant Run
PS21 Long Glade Creek

2005 VADEQ PROGRESS REPORT BY Robert Brent

Is Water Quality Improving in Muddy Creek and Dry River?

http://www.deq.virginia.gov/export/sites/default/tmdl/pdf/mcdrprog.pdf

2005 VADEQ PROGRESS REPORT BY Robert Brent

	Muddy Creek	Dry River
Bacteria	✓	✓
Nitrate	X	✓
Aquatic Life	✓	

http://www.deq.virginia.gov/export/sites/default/tmdl/pdf/mcdrprog.pdf

Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

Virginia

Conservation Stewardship Puts Muddy Creek and Lower Dry River Watersheds on Path to Recovery

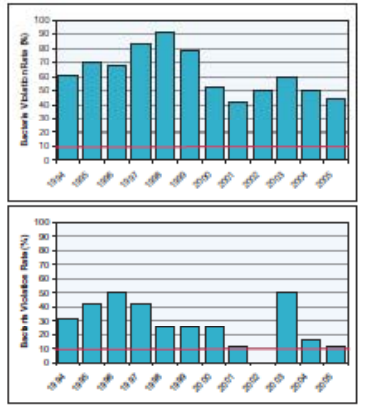
Waterbodies Improved

Runoff from agricultural and residential activities and livestock stream access contributed to water quality impairments to Virginia's Muddy Creek and Lower Dry River. Both waterbodies violated state water quality standards for fecal coliform bacteria and nitrate, and excess sediment and phosphorus loads further degraded aquatic life in Muddy Creek. These water quality problems caused the state to place Muddy Creek and the Lower Dry River on Virginia's 303(d) list of impaired waters.

project partners conducted numerous on-site tours, gave presentations to civic clubs, mailed postcards advertising the program, personally contacted farmers and residents, and held meetings to update the community on water quality improvements.

Results

Early results from the BMP implementation effort are encouraging. As shown in the accompanying graphs, fecal coliform counts in Muddy Creek and the Lower Dry River have declined overall. By 2005, the Lower Dry River showed an 11 percent violation rate of the state fecal coliform standard. This rate is down from a high of 50 percent and just above the state's 10 percent violation rate threshold for 303(d) listing.



Violation rate of the 1,000 colony-forming units/100 mL instantaneous standard for fecal coliform bacteria in Muddy Creek (top) and the Lower Dry River (bottom). To be delisted for impairments caused by fecal coliform bacteria, a waterbody may not have a bacteria violation rate greater than 10 percent (represented by the red line).

manure storage units. Religious beliefs preclude the community from accepting any financial assistance to implement BMPs. Community members refused any cost share assistance and assumed complete financial responsibility for 8.3 of the 10 miles of livestock exclusion fencing installed throughout the watershed.

Since 2002 more than $309,000 in section 319 funding has supported two full-time SVSWCD staff, who provide technical assistance to the Mennonite community and others in the project area. This support has generated nearly $839,000 in cost-share funds—approximately $200,000 of which came from farmers—to implement agricultural and residential BMPs. Finally, project partners used $130,000 in USDA/EQIP funds to install BMPs throughout the North River watershed.

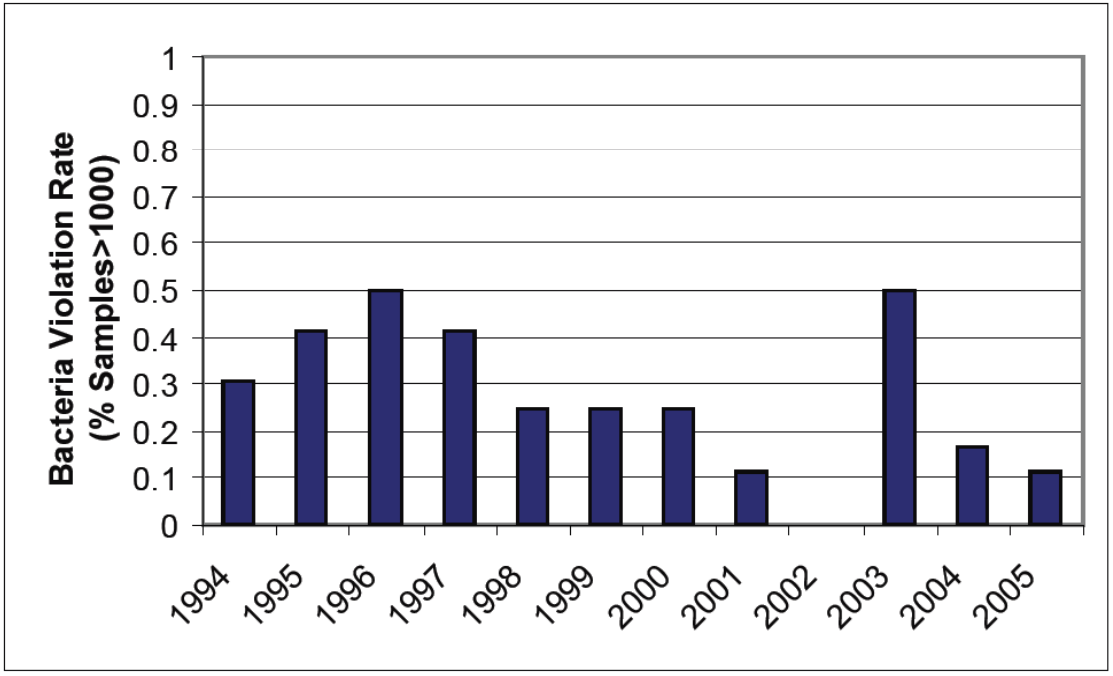


Figure 5. Violation rate of the 1,000 colony forming units/100 mL instantaneous standard for fecal coliform in Lower Dry River.

For additional information contact:

Mike Phillips
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540-433-2853 • mike.phillips@va.nacdnet.net

Megan O'Gorek
Shenandoah Valley Soil and Water Conservation District
540-433-2853 • megan.ogorek@va.nacdnet.net

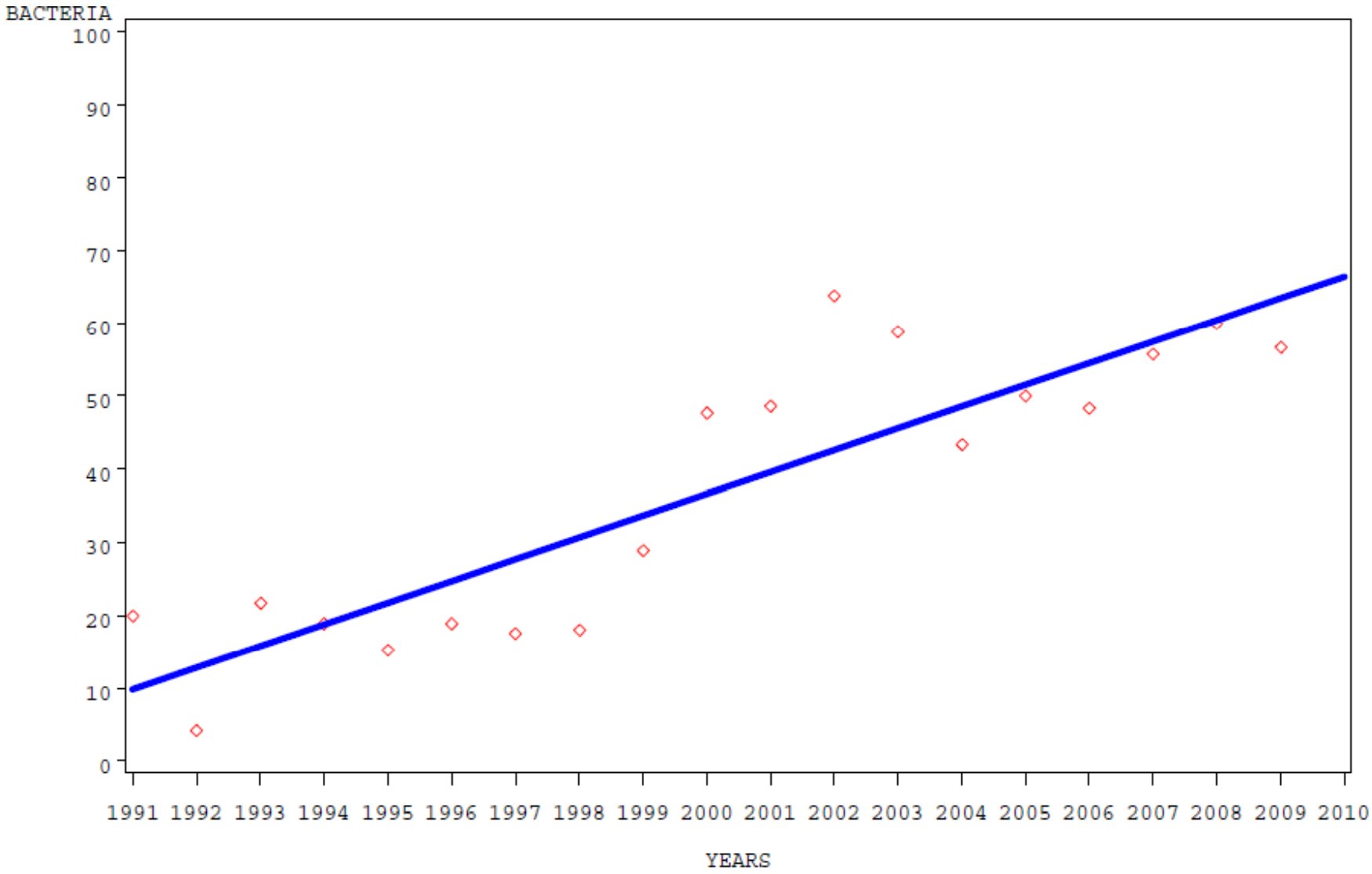
Nesha Mizel
Virginia Department of Conservation and Recreation
540-332-9238 • nesha.mizel@dcr.virginia.gov

Ann Carkhuff
U.S. Environmental Protection Agency, Region 3
215-814-5735 • carkhuff.ann@epa.gov

http://www.epa.gov/owow/nps/Success319/state/pdf/va_muddy.pdf

IWQ SCORES – REFERENCE PERIOD 2001 TO 2010

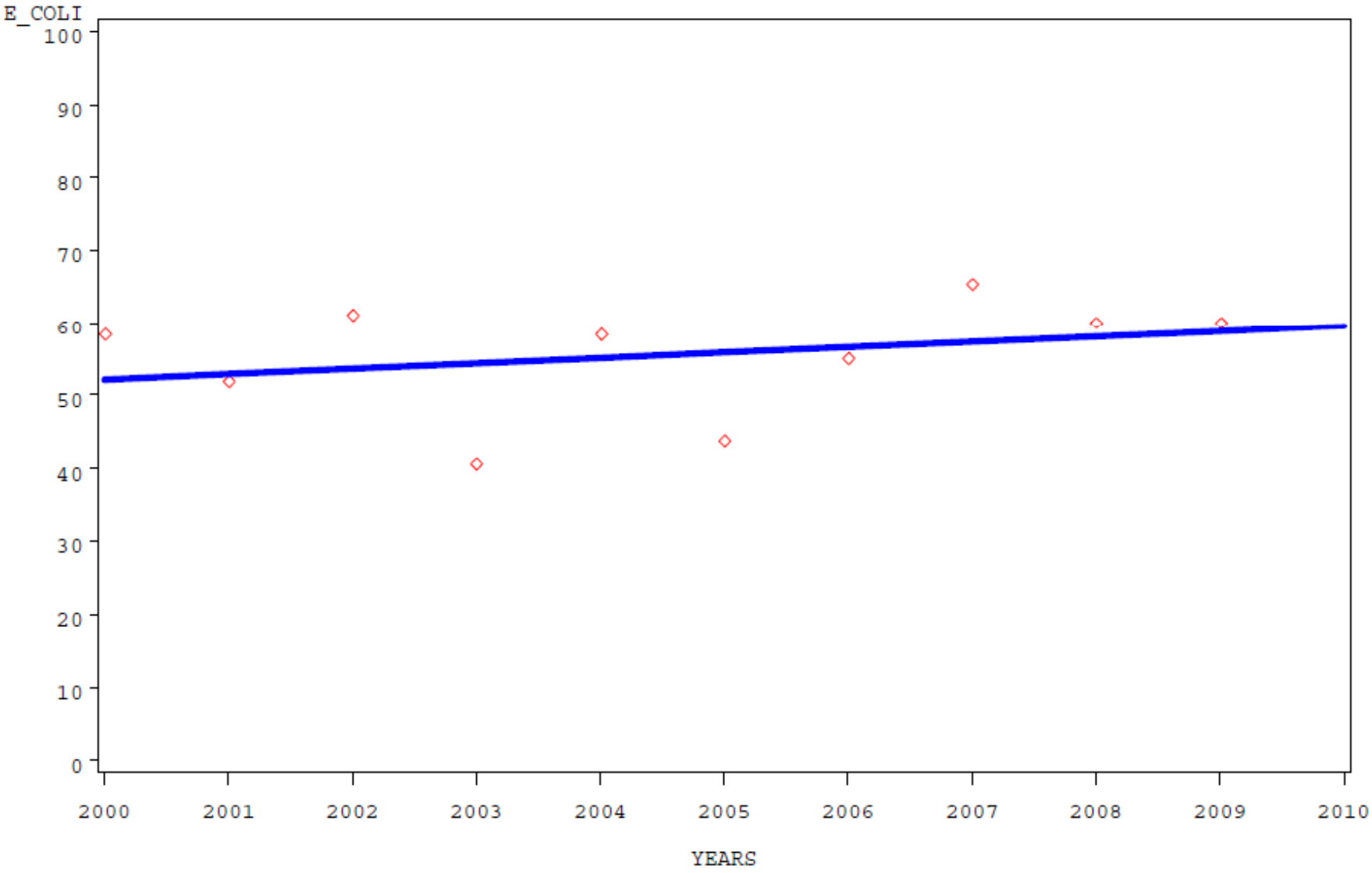
VAHU5=PS-E ON5=Dry River STA_LV1_CODE=STREAM



Regression Equation:
BACTERIA = -82.45191 + 0.008152*YEARS

IWQ SCORES – REFERENCE PERIOD 2001 TO 2010

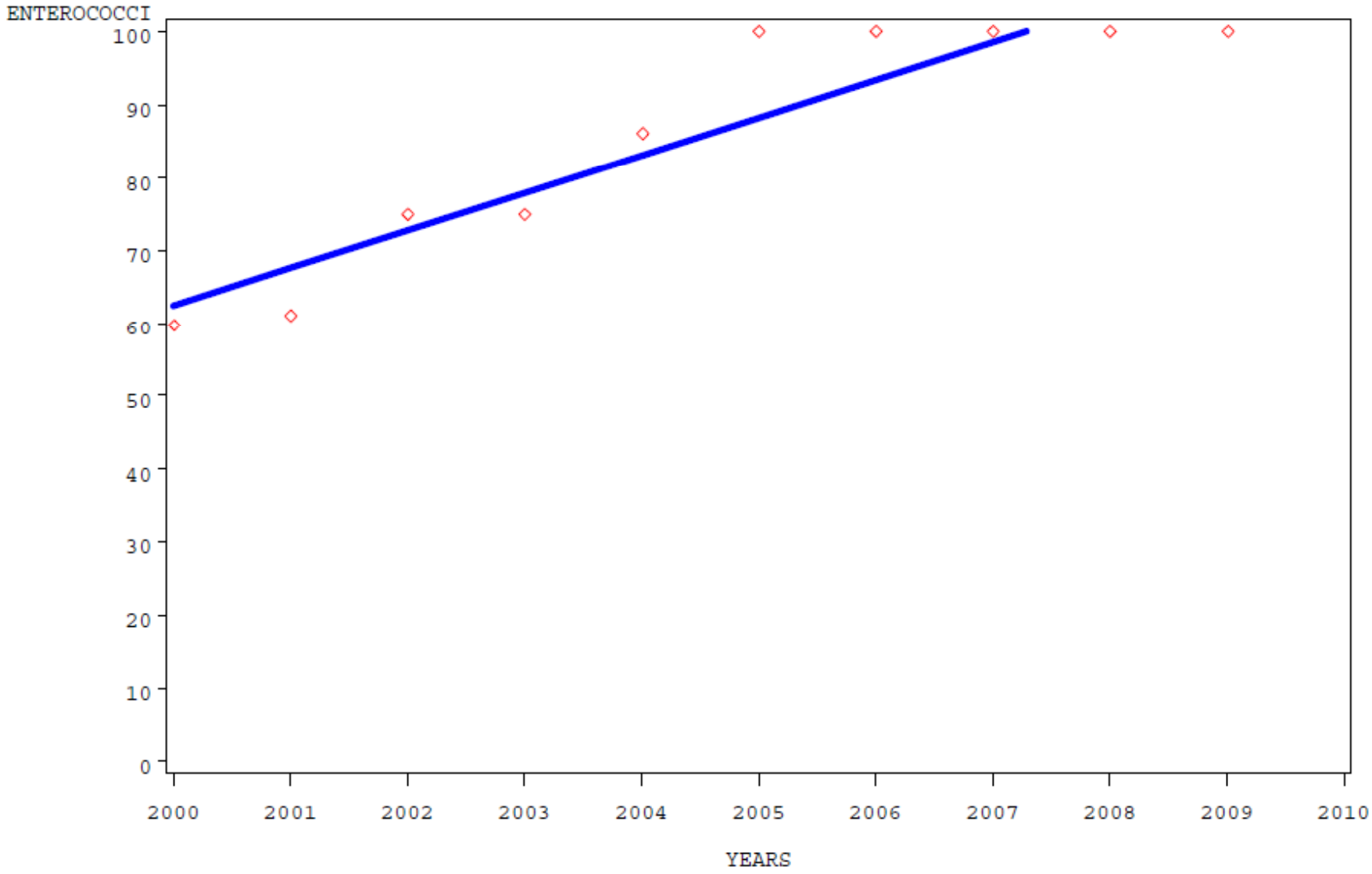
VAHU5=PS-E ON5=Dry River STA_LV1_CODE=STREAM



Regression Equation:
E COLI = 22.51857 + 0.002025*YEARS

IWQ SCORES – REFERENCE PERIOD 2001 TO 2010

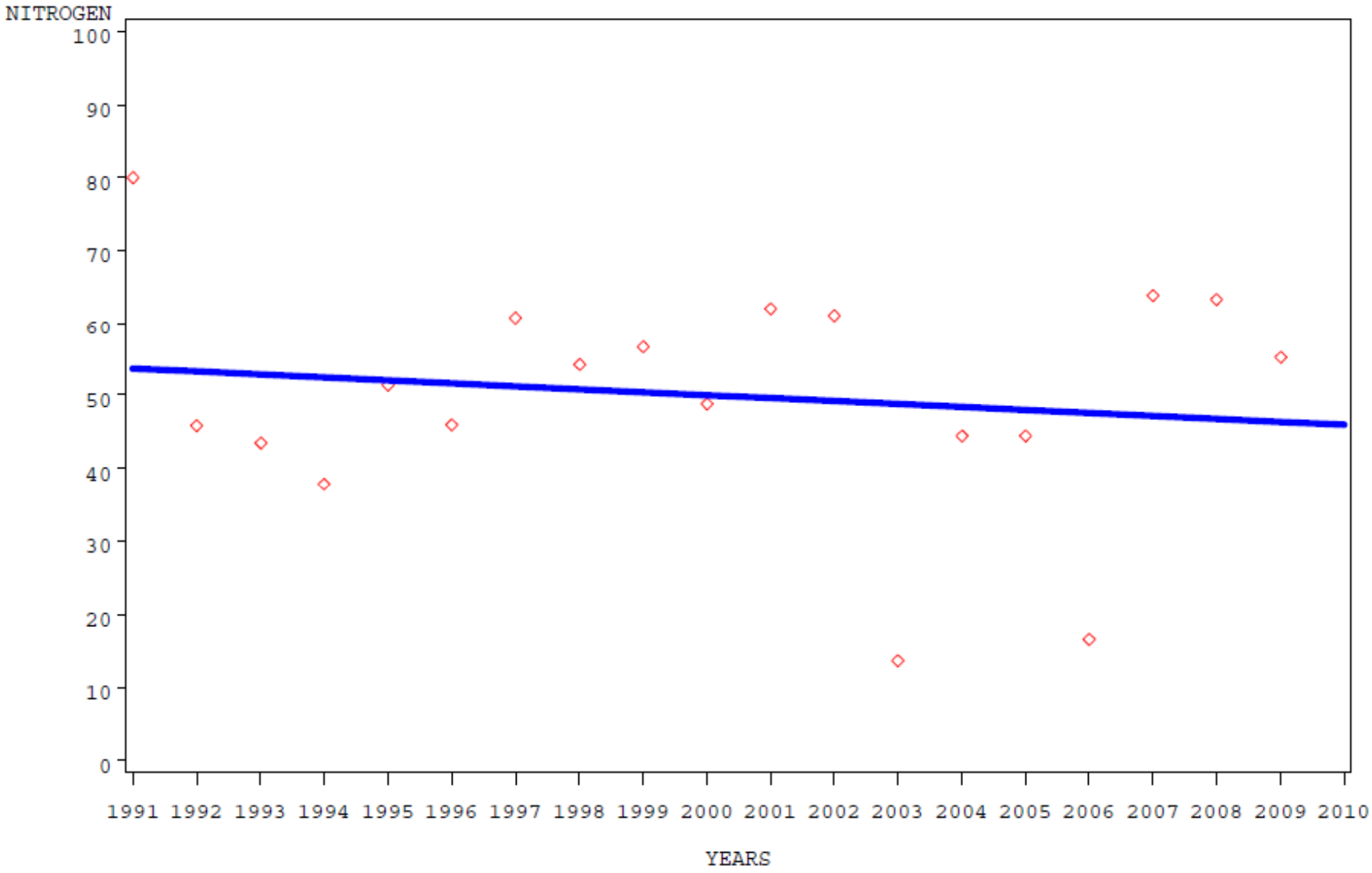
VAHU5=PS-E ON5=Dry River STA_LV1_CODE=STREAM



Regression Equation:
ENTEROCOCCI = -143.183 + 0.014079*YEARS

IWQ SCORES – REFERENCE PERIOD 2001 TO 2010

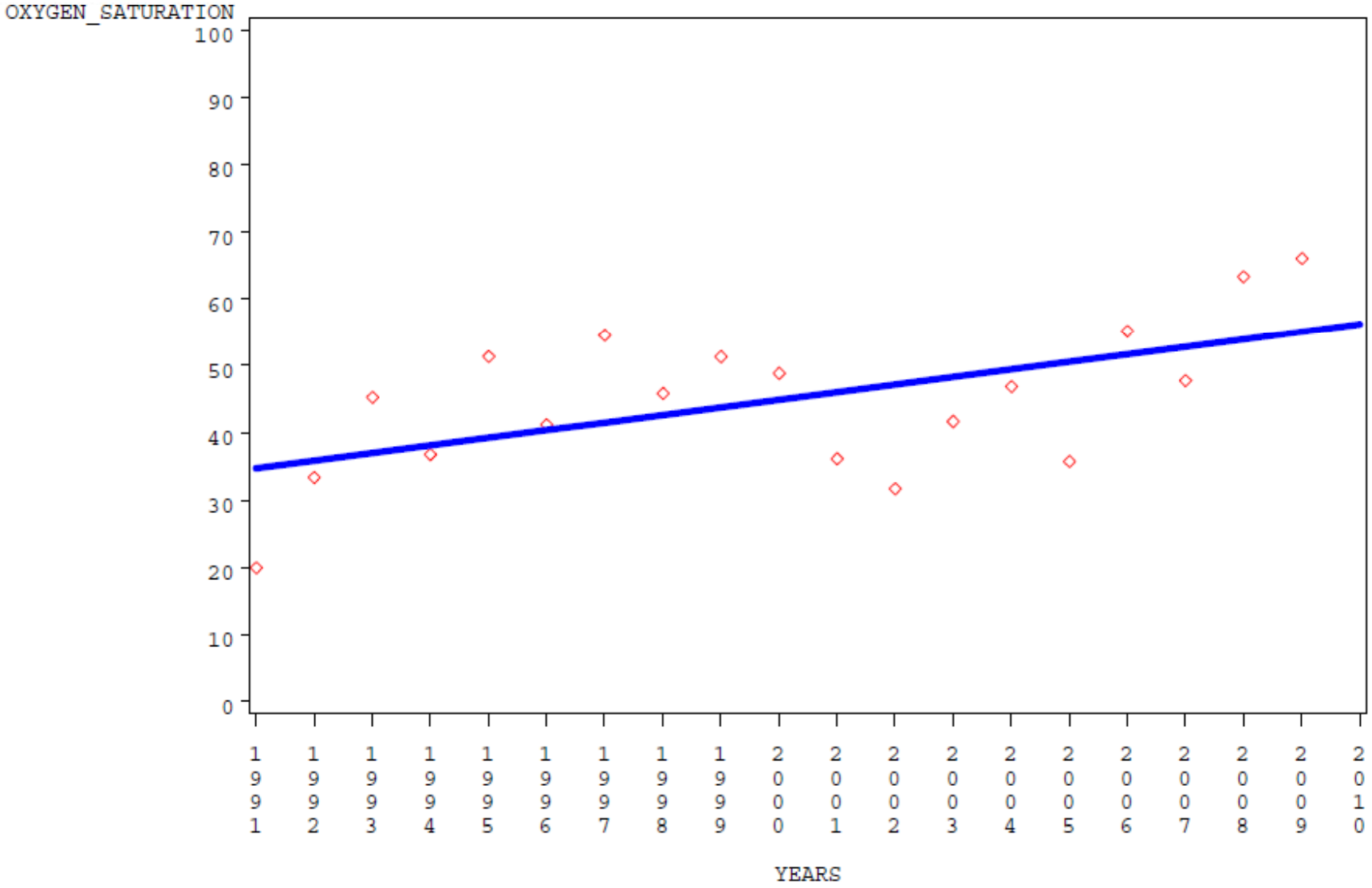
VAHU5=PS-E ON5=Dry River STA_LV1_CODE=STREAM



Regression Equation:
NITROGEN = 66.13025 - 0.001105*YEARS

IWQ SCORES – REFERENCE PERIOD 1999 TO 2008

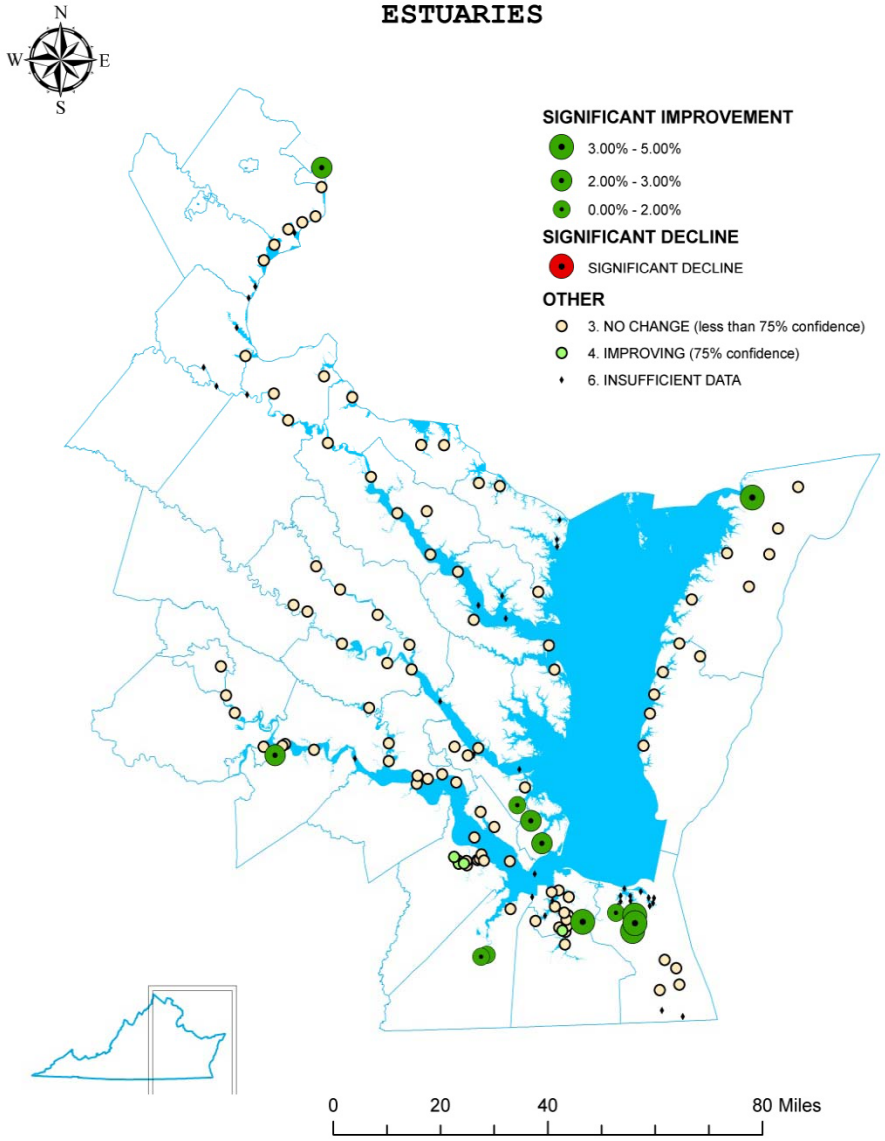
VAHU5=PS-E ON5=Dry River STA_LV1_CODE=STREAM



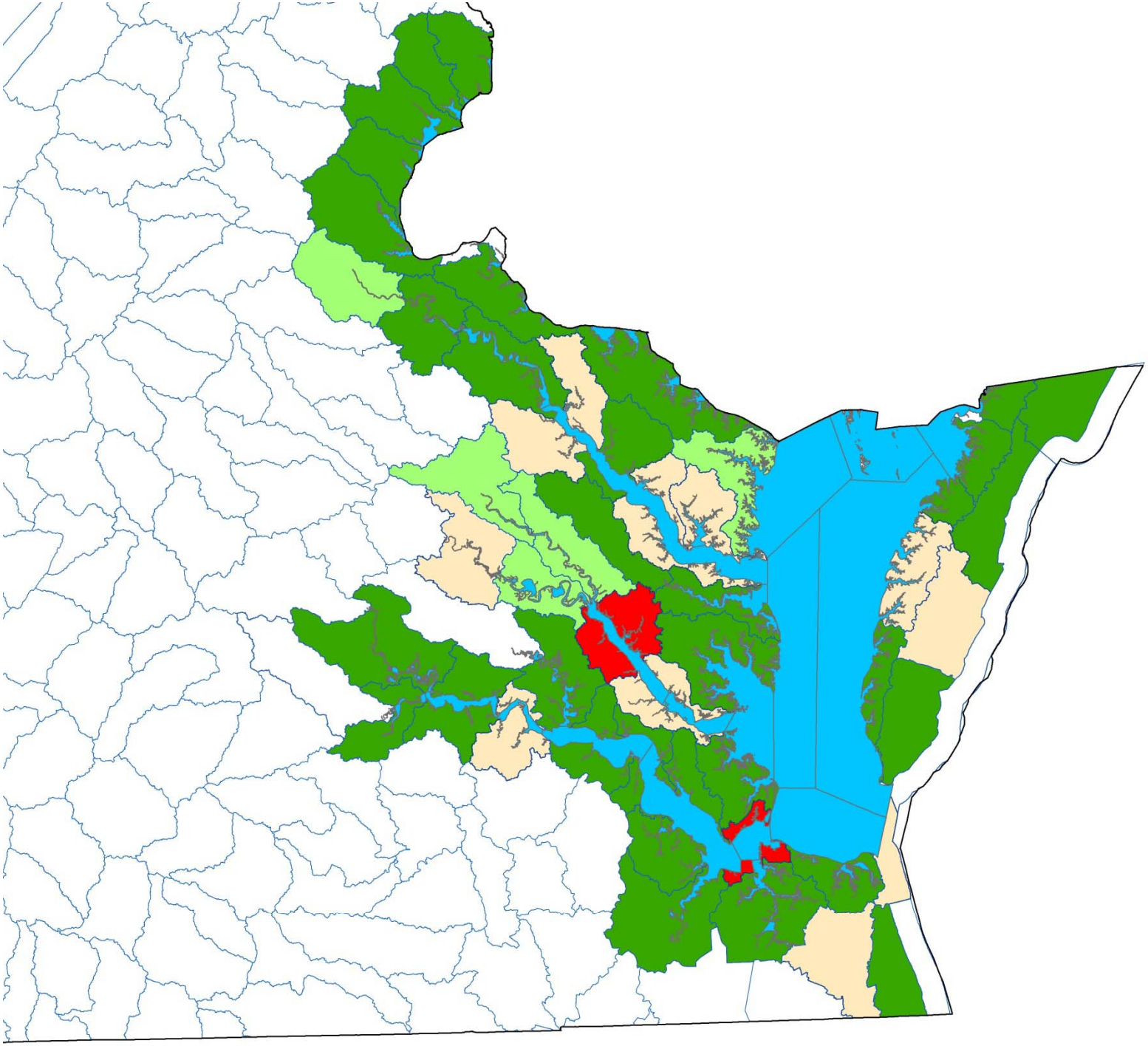
Regression Equation:
OXYGEN SATURATION = -0.385935 + 0.003098*YEARS

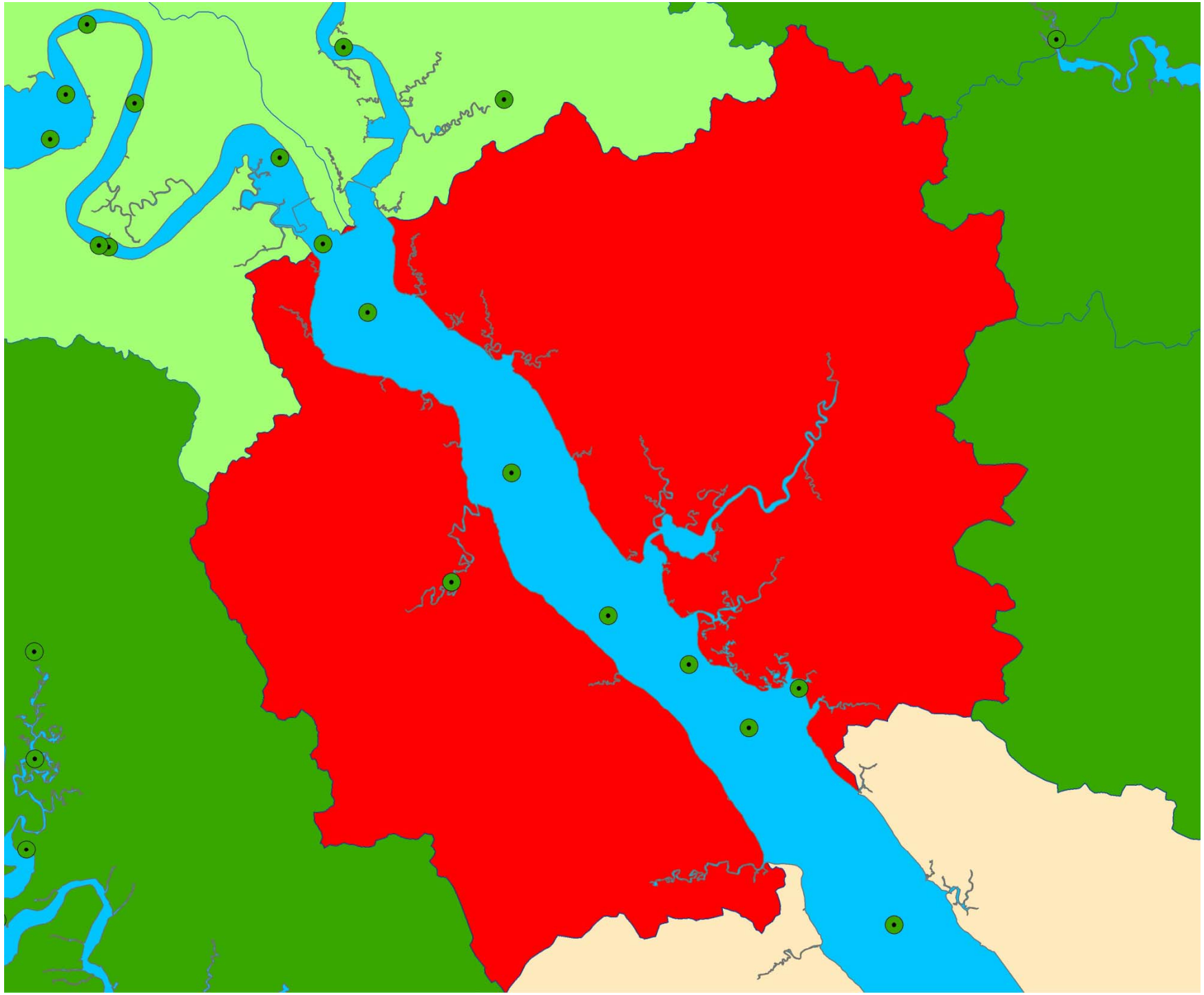
“Since 2002 more than $309,000 in section 319 funding has supported two full-time SVSWCD staff, who provide technical assistance to the Mennonite community and others in the project area. This support has generated nearly $839,000 in cost-share funds—approximately $200,000 of which came from farmers—to implement agricultural and residential BMPs. Finally, project partners used $130,000 in USDA/EQIP funds to install BMPs throughout the North River watershed.”

WATER QUALITY TRENDS 1991 TO 2010
BACTERIA ANNUAL PERCENT CHANGE
ESTUARIES



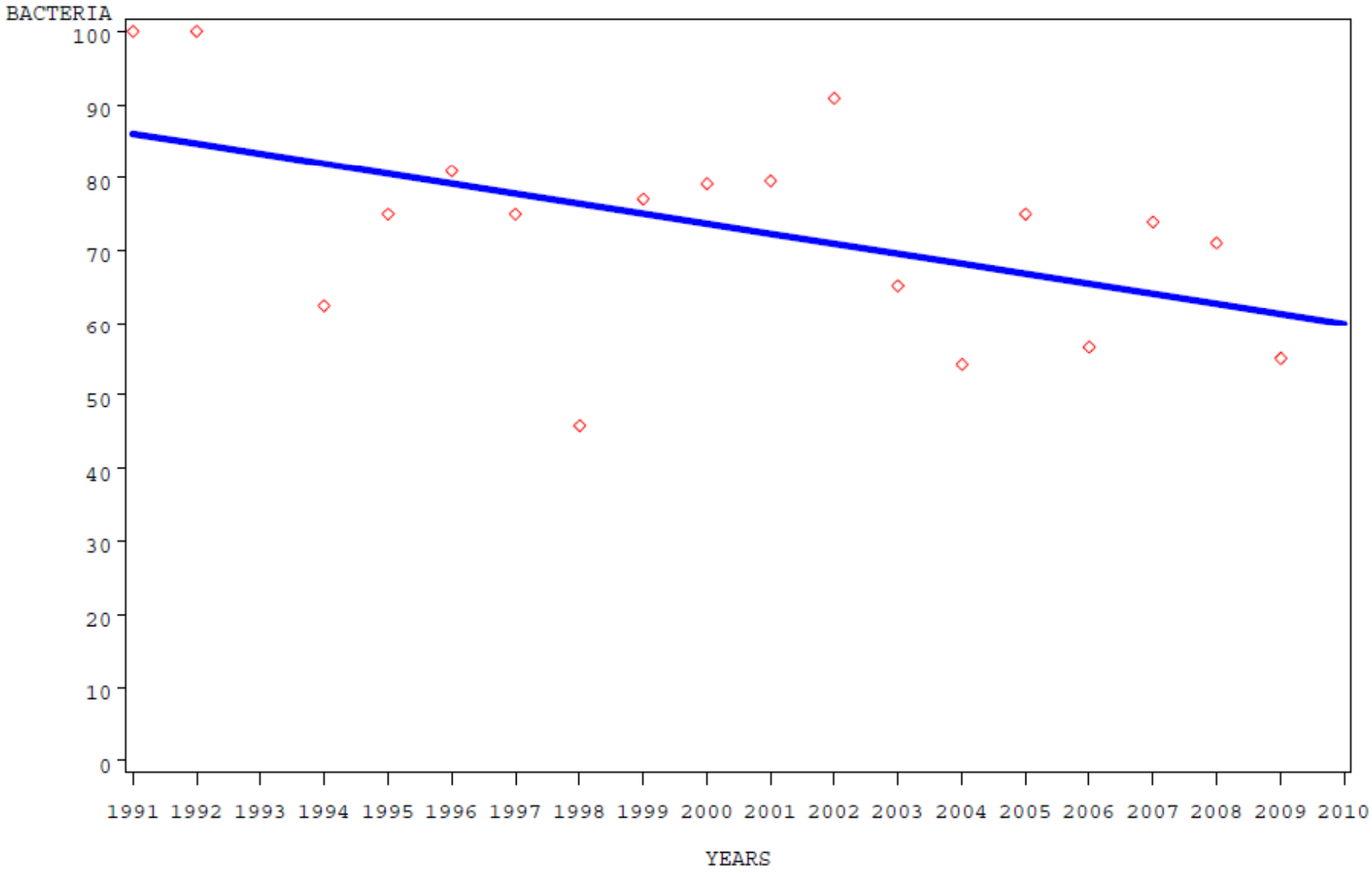
Sources:
1. Virginia Department of Environmental Quality Comprehensive Environmental Data System.
2. National Hydrography Data Center.
3. Virginia Depatment of Transportation.
4. U.S. Department of Commerce, U.U. Census Bureau, Geography Division, 2008.
5. U.S. Geological Survey Stream Gage Network.





IWQ SCORES – REFERENCE PERIOD 2001 TO 2010

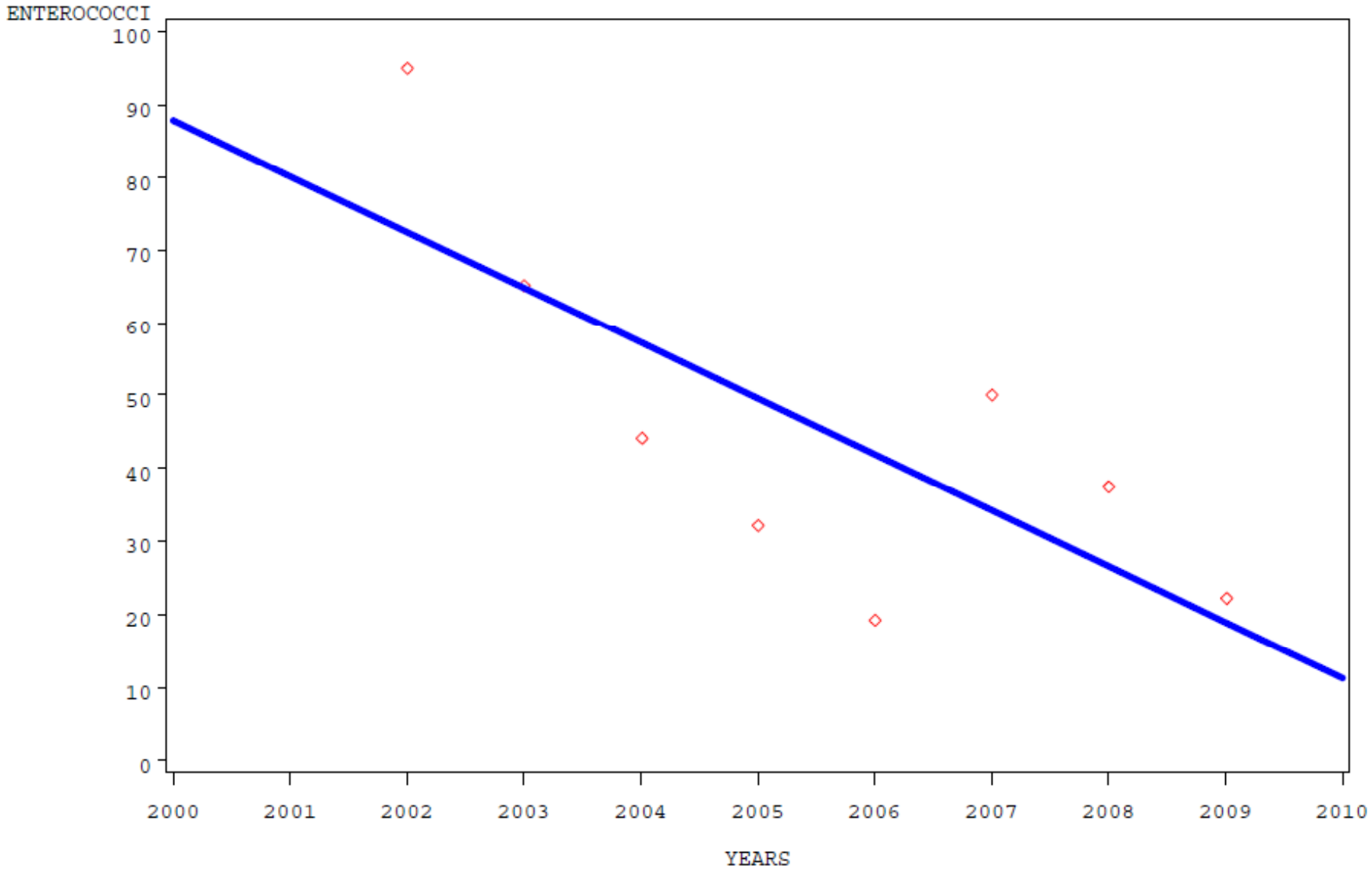
VAHU5=YO-R ON5=Upper York River STA_LV1_CODE=ESTURY



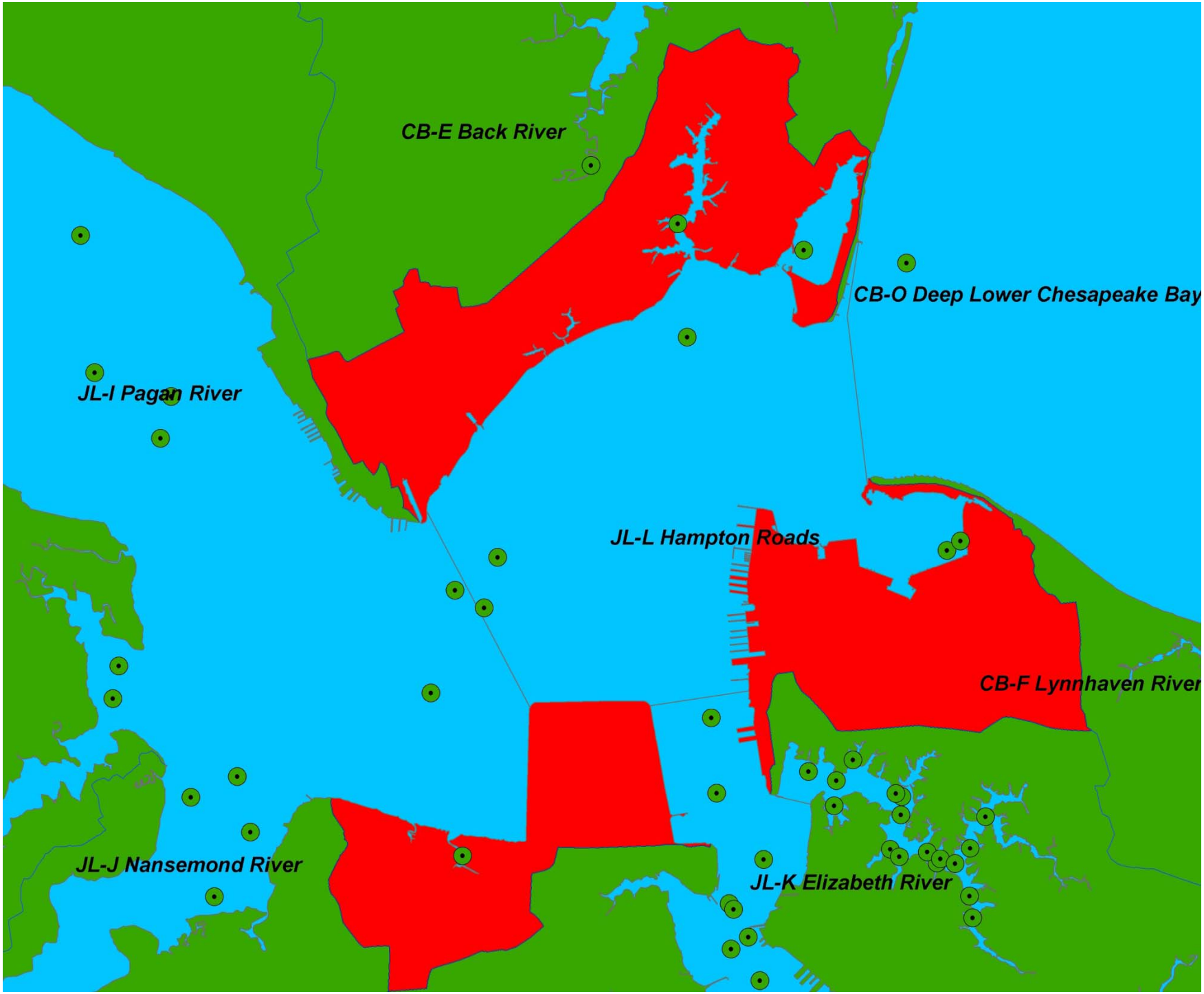
Regression Equation:
BACTERIA = 128.585 - 0.003757*YEARS

IWQ SCORES – REFERENCE PERIOD 2001 TO 2010

VAHU5=YO-R ON5=Upper York River STA_LV1_CODE=ESTURY

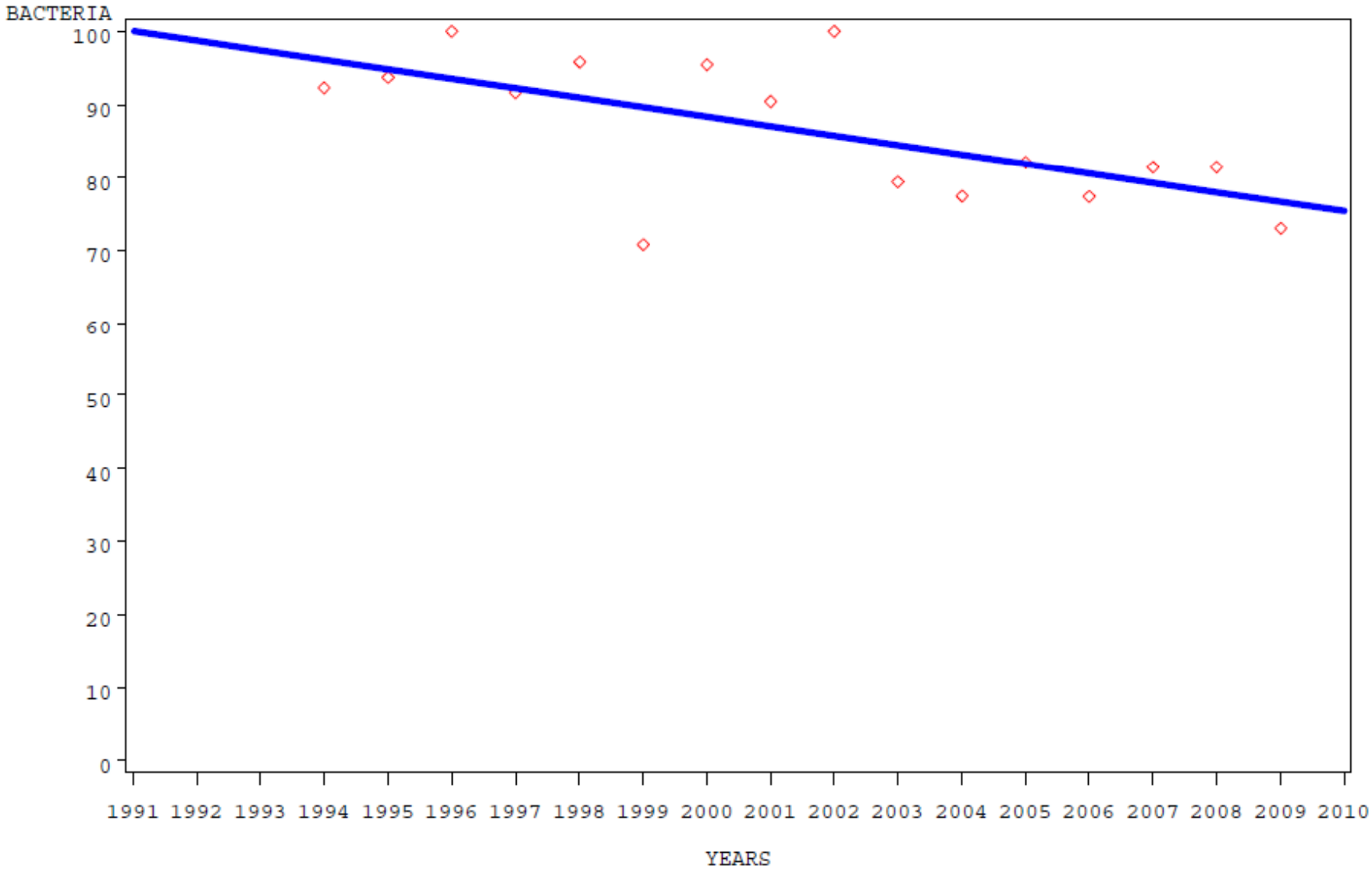


Regression Equation:
ENTEROCOCCI = 394.1938 - 0.020968*YEARS


CB-E Back River
CB-O Deep Lower Chesapeake Bay
JL-I Pagan River
JL-L Hampton Roads
CB-F Lynnhaven River
JL-J Nansemond River
JL-K Elizabeth River

IWQ SCORES – REFERENCE PERIOD 2001 TO 2010

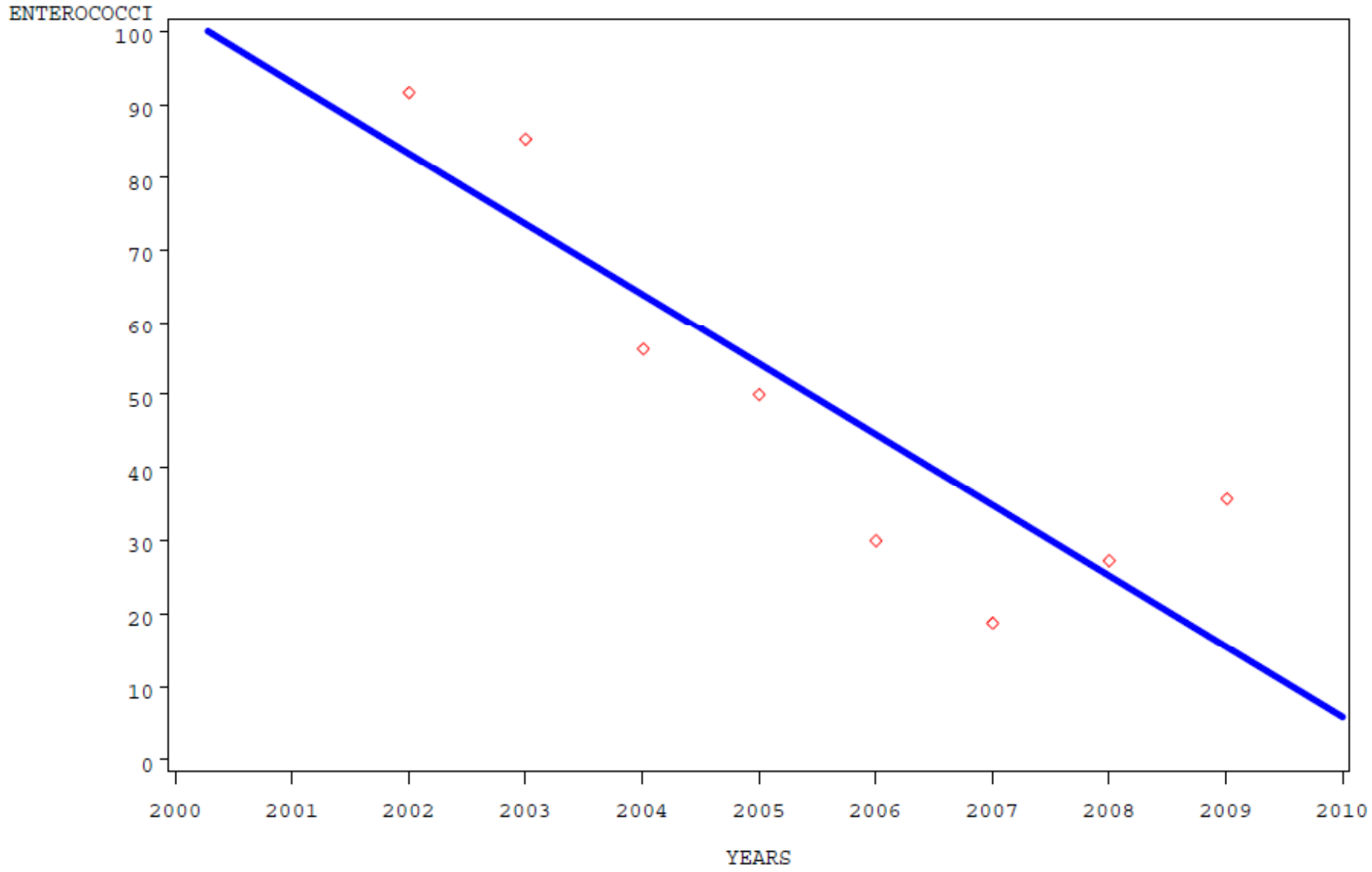
VAHU5=JL-L ON5=Hampton Roads STA_LV1_CODE=ESTURY



Regression Equation:
BACTERIA = 140.1962 - 0.003547*YEARS

IWQ SCORES – REFERENCE PERIOD 2001 TO 2010

VAHU5=JL-L ON5=Hampton Roads STA_LV1_CODE=ESTURY



Regression Equation:
ENTEROCOCCI = 490.3157 - 0.026529*YEARS

MEASURES OF PROGRESS

Traditional water quality assessments have reported on numbers of impaired waters.

- **Each year we add more and more dirty waters to the list.**

Past measures of progress enumerated delisted waters.

- **There has been no interim measure available to document progress between these two endpoints.**

What is needed is an interim measure of progress.

We need to better account for the intermediate effects of efforts to improve our waters, independent of impairment status.

It's time to improve our message by emphasizing water quality improvements over time, rather than a simple count of delistings.

Such indicators of progress have been referred to as "Interim Measures."

Progress infers change over time…i.e. Trend

Traditional analyses of time series data often use a nonparametric seasonal Kendal or similar statistic.

- Performed on individual stations.
- Generally limited to long-term trend stations only.
- But… TMDL implementation is usually at the watershed scale.

What is needed is a measure of incremental progress at the watershed level.

Classification of Watersheds

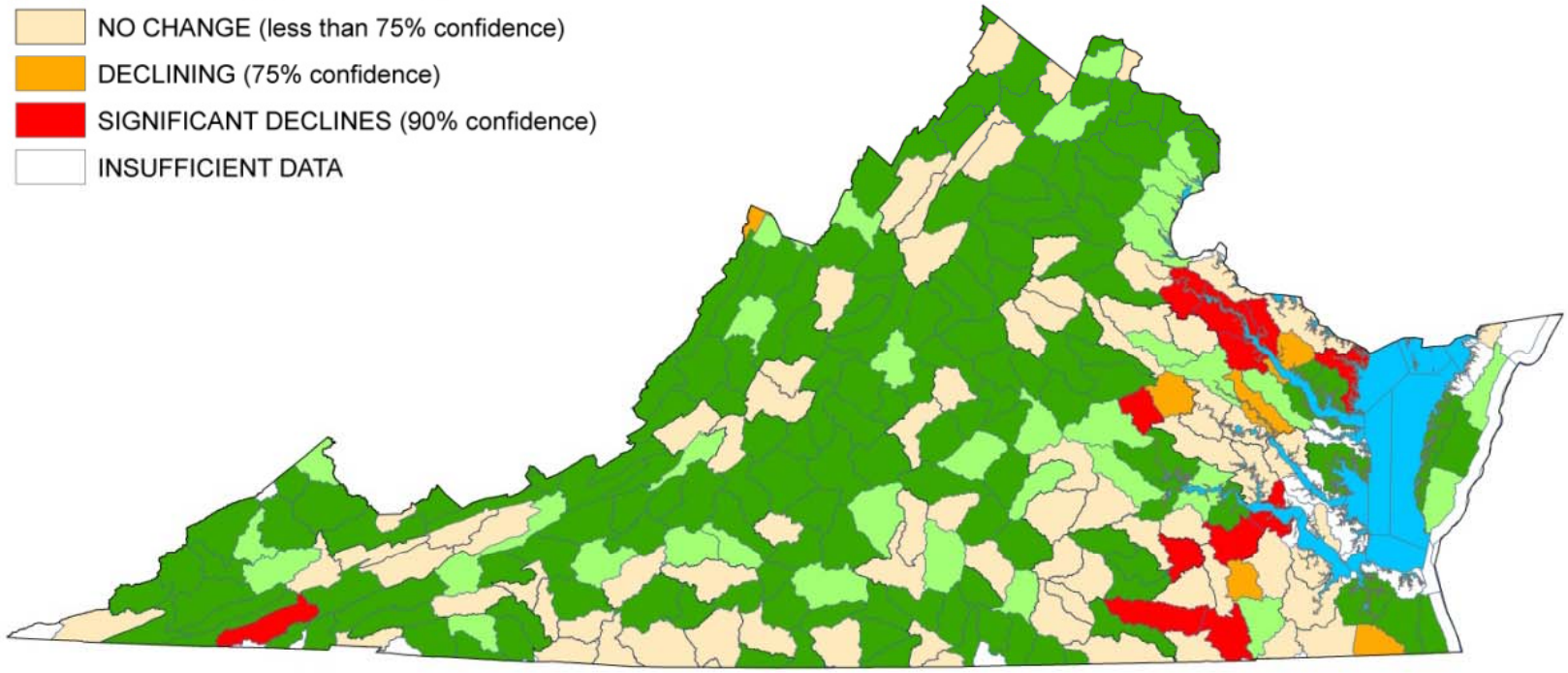
Watersheds can be classified and mapped based upon the significance of the linear regressions of their annual IWQ scores:

1. **Watersheds with IWQ regressions of positive slope and confidence levels ≥ 90% are classified as significantly improving in water quality.**
2. **Watersheds with IWQ regressions of positive slope and confidence levels 75% ≥ 90% are classified as moderately improving in water quality.**
3. **Watersheds with IWQ regressions of confidence levels < 75% are classified as showing no significant change in water quality.**
4. **Watersheds with IWQ regressions of negative slope and confidence levels 75% ≥ 90% are classified as moderately declining in water quality.**
5. **Watersheds with IWQ regressions of negative slope and confidence levels ≥ 90% are classified as significantly declining in water quality.**

Integrated Water Quality Trends 1991 to 2010
Suspended Solids in Rivers and Streams

STREAM SOLIDS

- SIGNIFICANT IMPROVEMENTS (90% confidence)
- IMPROVING (75% confidence)
- NO CHANGE (less than 75% confidence)
- DECLINING (75% confidence)
- SIGNIFICANT DECLINES (90% confidence)
- INSUFFICIENT DATA



DEQ
Virginia Department of Environmental Quality

N
W E
S

Miles
0 5 10 20 30 40

Virginia Department of Environmental Quality
Comprehensive Environmental Data System
IWQ analysis developed by R.E.Stewart and D.H.Smith.

NWBD 5th order layer provided by the Virginia Department of Conservation and Recreation

Map created on 14 July 2010.

For more information please read the Trend and IWQ Chapters in the 2012 Integrated Report, available now!
http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments/2012305b303dIntegratedReport.aspx