University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
HORN POINT LABORATORY

UNIVERSITY OF MARYLAND EXTENSION
Solutions in your community

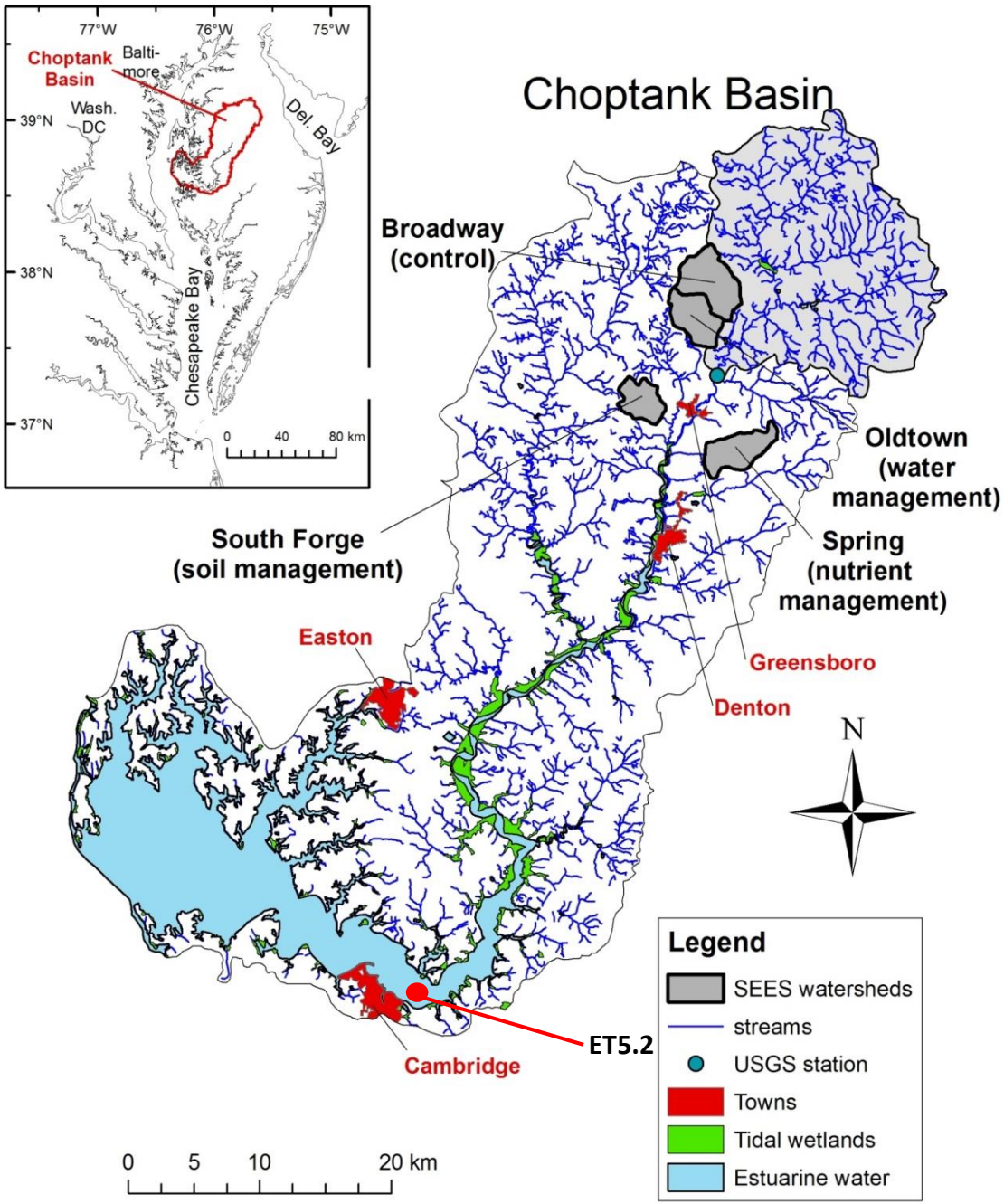
MARYLAND DEPARTMENT OF AGRICULTURE

WINROCK INTERNATIONAL

PEOPLE · LAND · WATER
Everyone Contributes to Water Quality

People Land Water

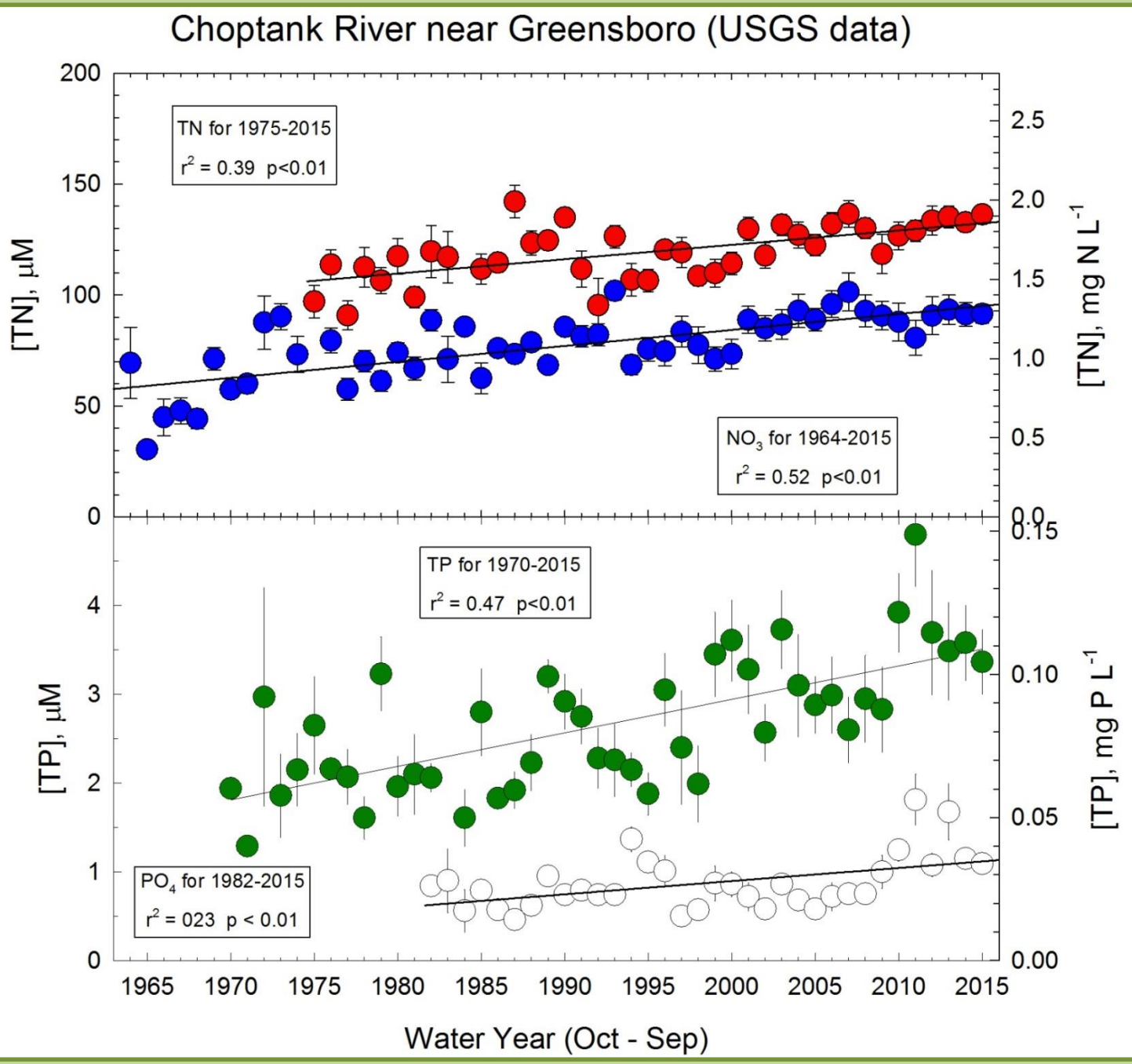
NSF

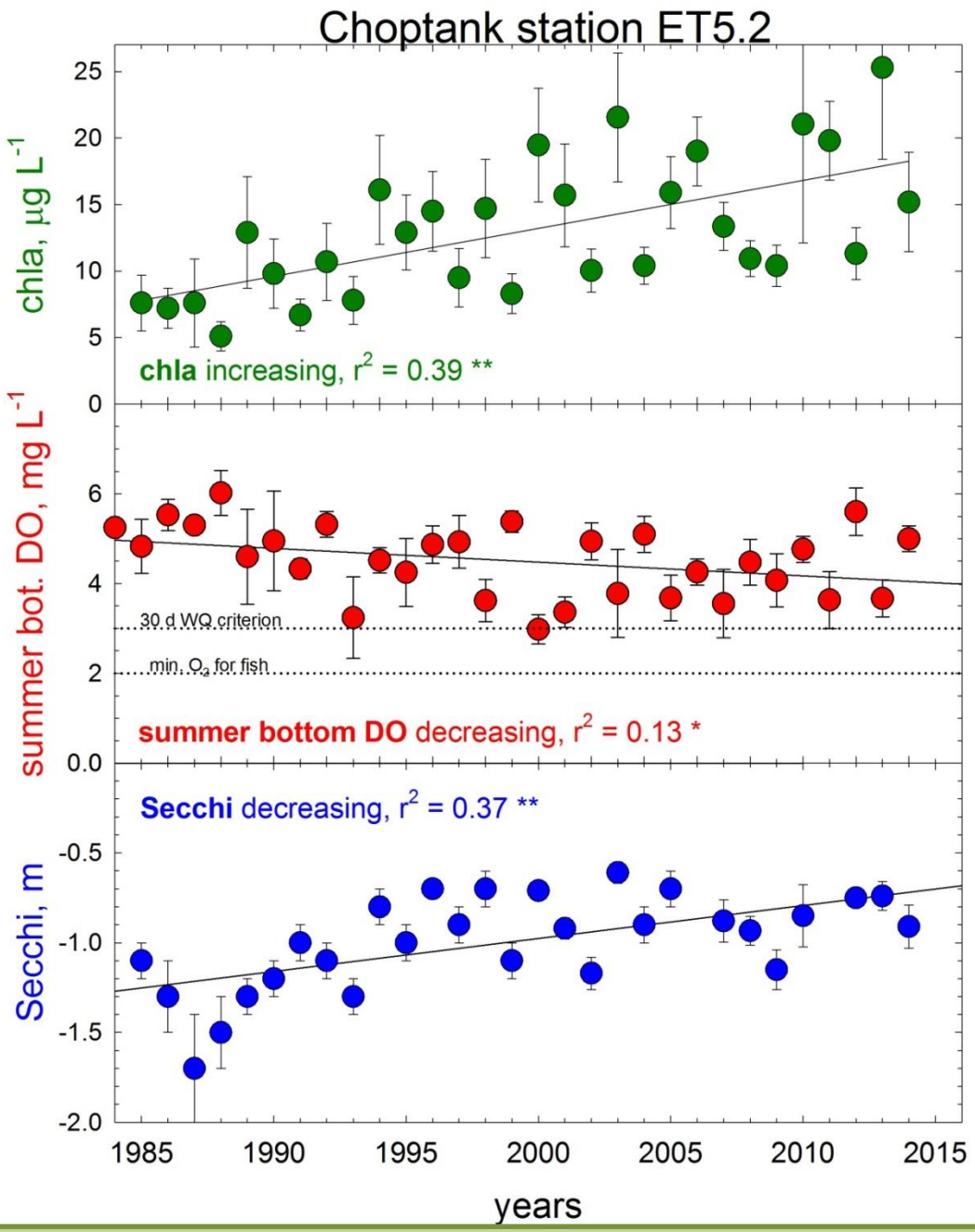


Water Quality Data:

<u>Watersheds</u>
USGS gauge at Greensboro
Broadway
South Forge
Oldtown
Spring

<u>Estuarine Station</u>
ET5.2


Choptank River near Greensboro (USGS data)
TN for 1975-2015
r2 = 0.39 p<0.01
NO3 for 1964-2015
r2 = 0.52 p<0.01
TP for 1970-2015
r2 = 0.47 p<0.01
PO4 for 1982-2015
r2 = 023 p < 0.01
[TN], µM
[TN], mg N L-1
[TP], µM
[TP], mg P L-1
Water Year (Oct - Sep)
0
50
100
150
200
0.0
0.5
1.0
1.5
2.0
2.5
1
2
3
4
0.00
0.05
0.10
0.15
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015



The estuary responds

Increasing annual average chla

Decreasing summer bottom dissolved O_2

Decreasing annual average Secchi depth

Water Quality in the Choptank Basin

- Increasing N and P in non-tidal streams
- Increasing annual average chlorophyll a in surface estuarine waters
- Decreasing water transparency in surface estuarine waters
- Decreasing summer dissolved oxygen in estuarine bottom waters
- Classic symptoms of cultural eutrophication
- Choptank is becoming similar to the Pax and mainstem Bay

Goal of our 5 year PLW project:

- Coastal SEES funding from NSF (2013-2018)
- Do Best Management Practices (BMPs) improve water quality?
- Do lots of BMPs measurably increase water quality?
- Direct Measurements.

NO MODELING

  - Watershed scale
  - Subwatershed scale (multiple farms)
  - Farm scale

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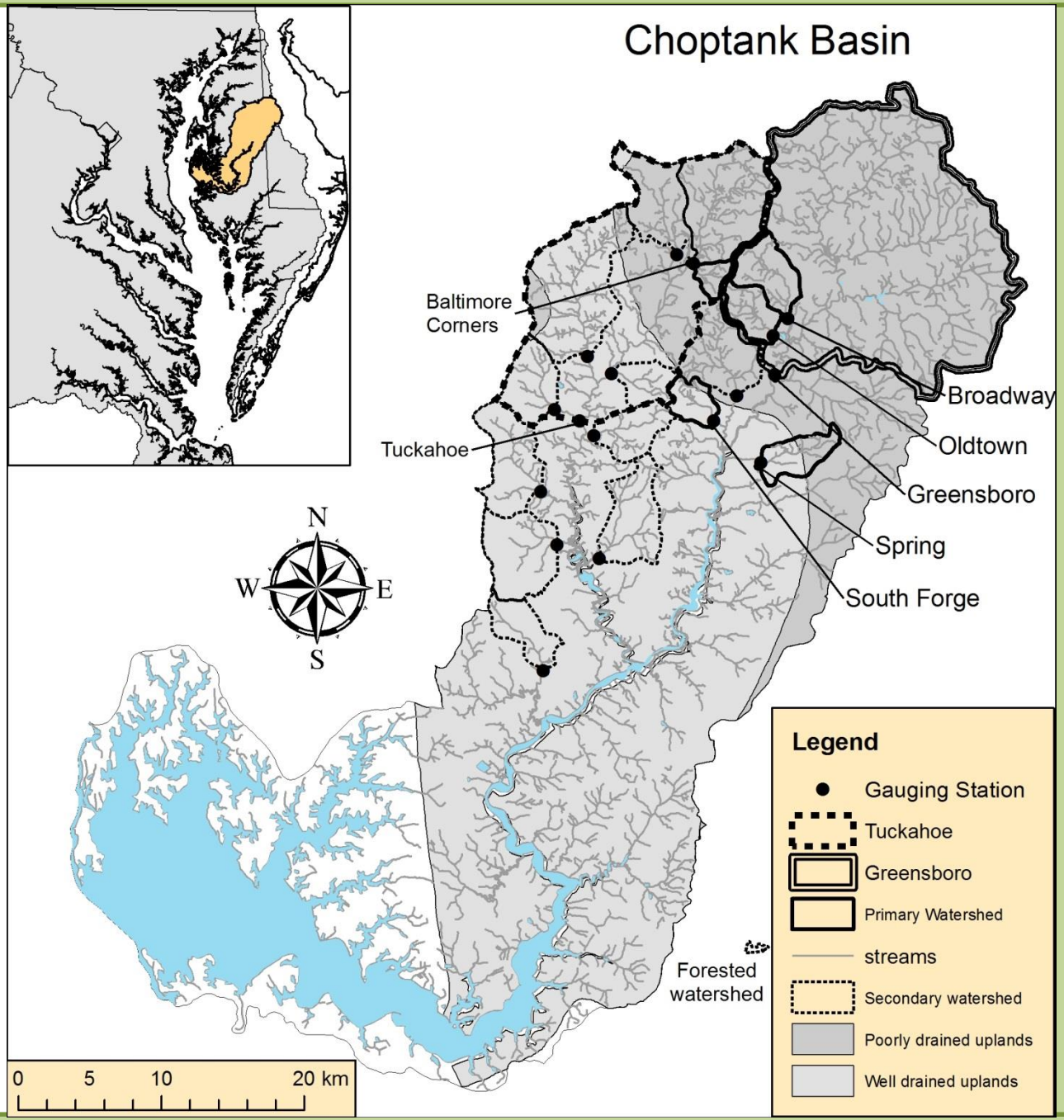
Experimental Design: monitoring

- 1 control watershed: WQ monitoring, but no push for BMPs
- 3 experimental watersheds with increased BMPs and WQ monitoring
  - Water management (drainage controls on tile lines and ditches, wetland creation)
  - Soil management (cover crops, buffers, sediment ponds)
  - Fertilizer management (precision ag, split side-dress, fertilizer reductions)

Watersheds:
control:
Broadway
experimental:
Oldtown
S. Forge
Spring



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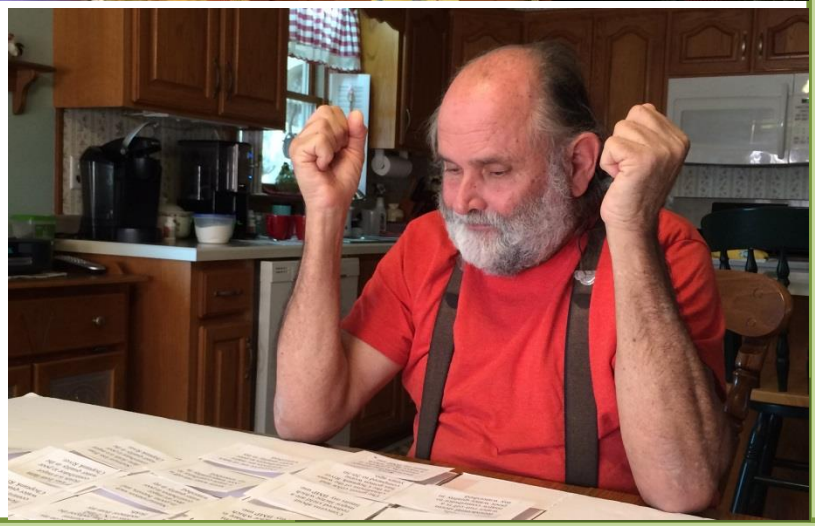
Experimental Design: sociology

- Annual surveys of farmers and residents
  - Farming/management practices
  - Obstacles to adding BMPs
  - All 4 watersheds
  - 5 control farmers who farm within the Choptank Basin
- Q-sort test for ranking of BMPS by farmers
- Does information on WQ change farmer opinions?

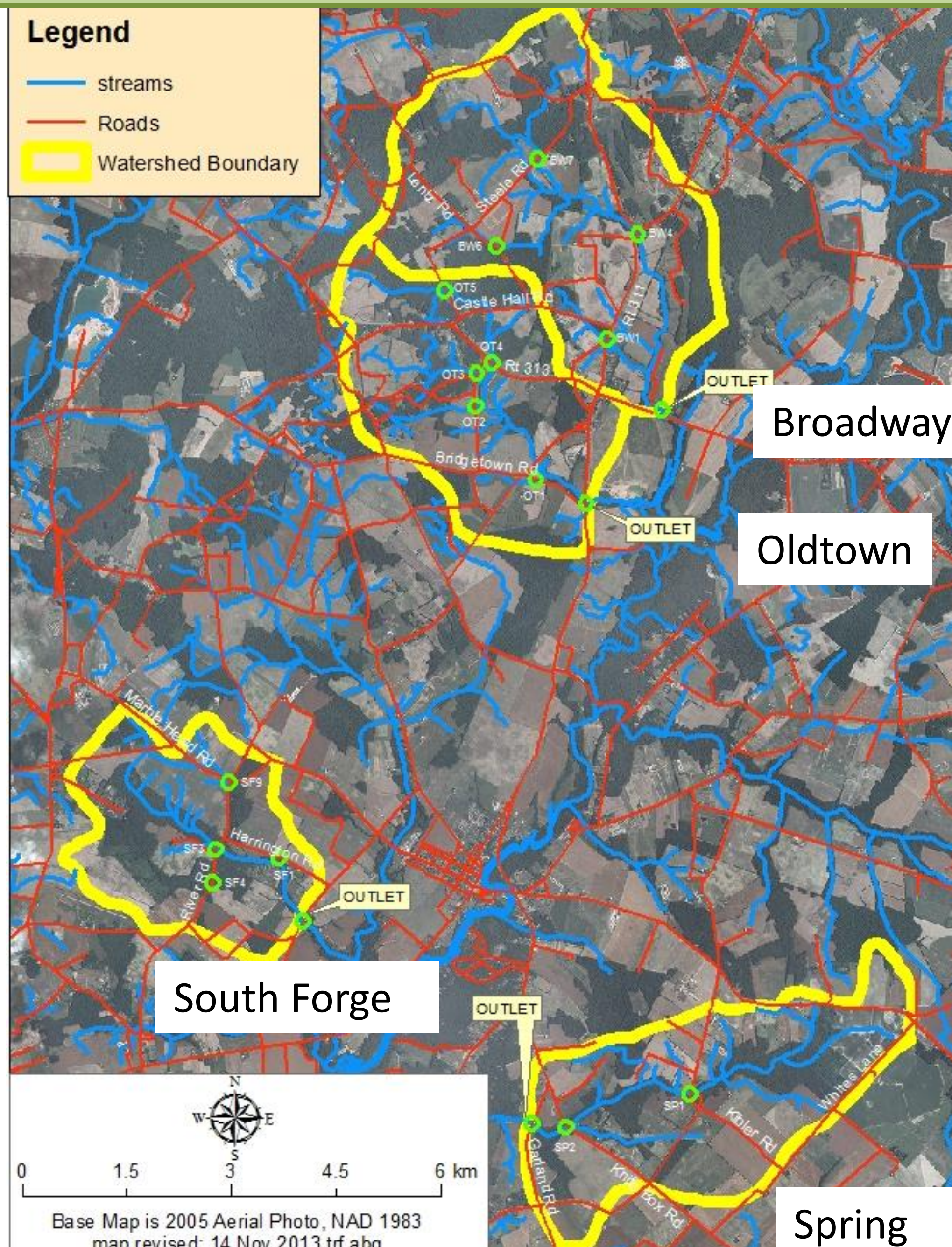


Funding for new BMPs

- We have raised funds to help pay for BMPS
  - Bioreactors & P traps (slag, gypsum) – Midshore Riverkeepers
  - Solar-powered pond aerators – NFWF
  - Cost shared BMPs – MACS, RCPP funding accessed via NRCS
- Cost benefit analysis by Winrock

Natural Resources Conservation Service

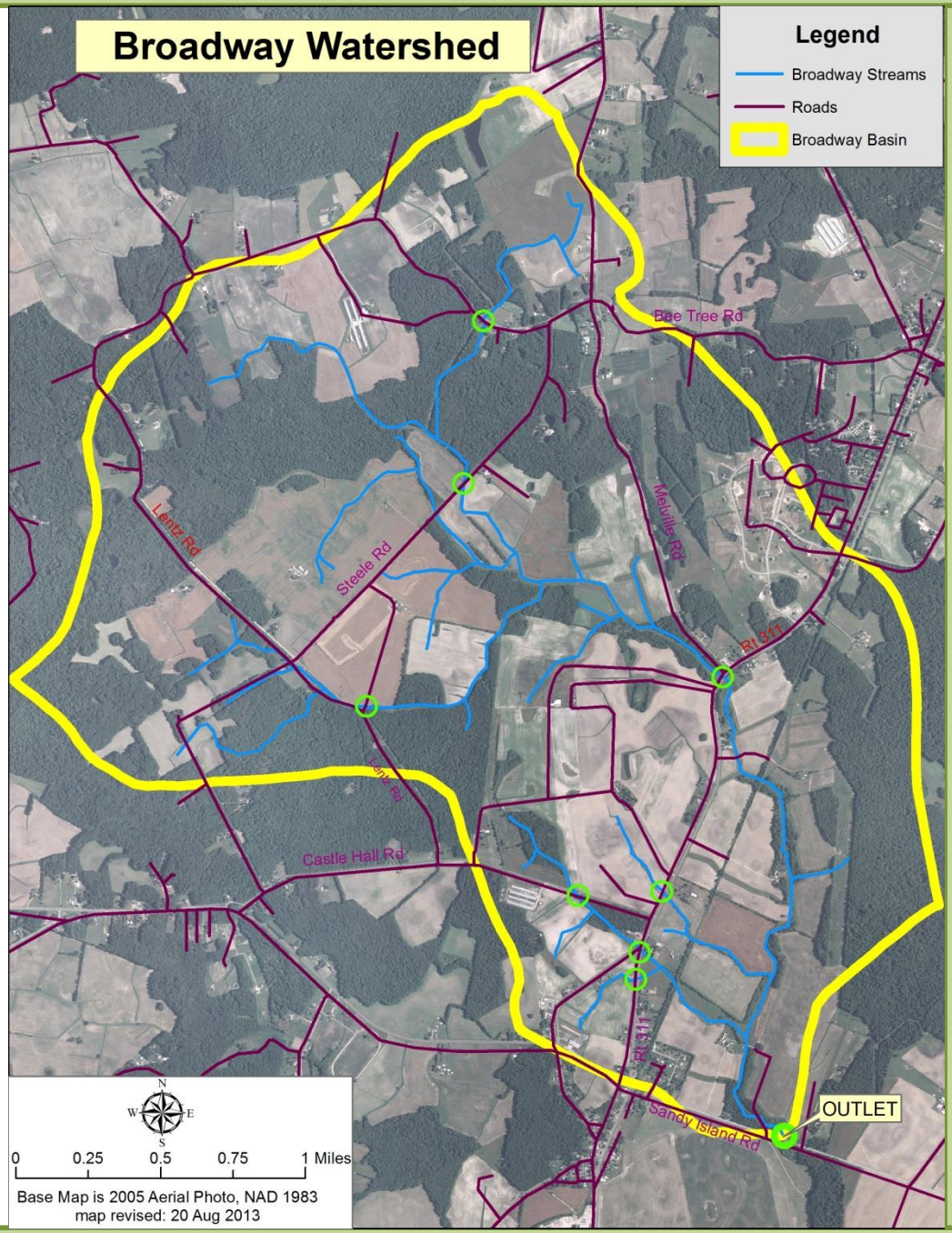
WINROCK INTERNATIONAL



Legend
streams
Roads
Watershed Boundary
Broadway
Oldtown
South Forge
Spring
OUTLET
OUTLET
OUTLET
OUTLET
Steele Rd
Lenz Rd
Castle Hall Rd
Rt 311
Rt 313
Bridgetown Rd
BW7
BW6
BW4
BW1
OT5
OT4
OT3
OT2
OT1
SF9
SF3
SF4
SF1
SP1
SP2
Marble Head Rd
Harrington Rd
River Rd
Garland Rd
Kibler Rd
Whites Lane
Knife Box Rd
N
S
E
W
0
1.5
3
4.5
6 km
Base Map is 2005 Aerial Photo, NAD 1983
map revised: 14 Nov 2013 trf abg

Broadway (control)

area: 6.3 sq mi
agriculture: 62 %
forest: 35 %
developed: 3 %
hydric soils: 58 %
no. farmers: 12
no. septics: 206
no. CAFOs: 2
no. old BMPs: ?
no. new BMPs: 0



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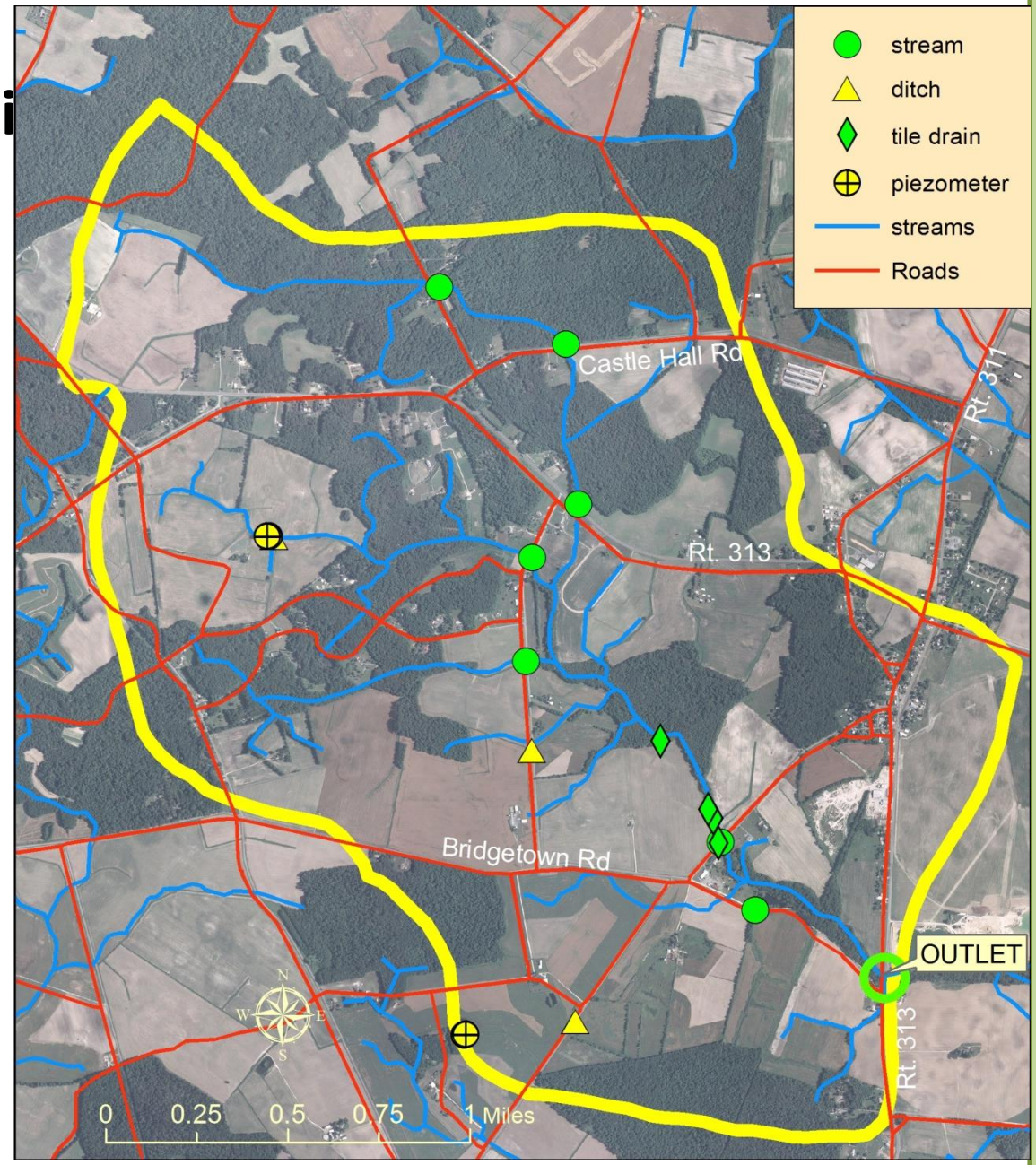
Oldtown

area: 4.6 sq mi
agriculture: 58 %
forest: 33 %
developed: 8 %
hydric soils: 60 %
no. farmers: 10
no. septics: 261
no. CAFOs: 0
no. old BMPs: ?
no. new BMPs: 5



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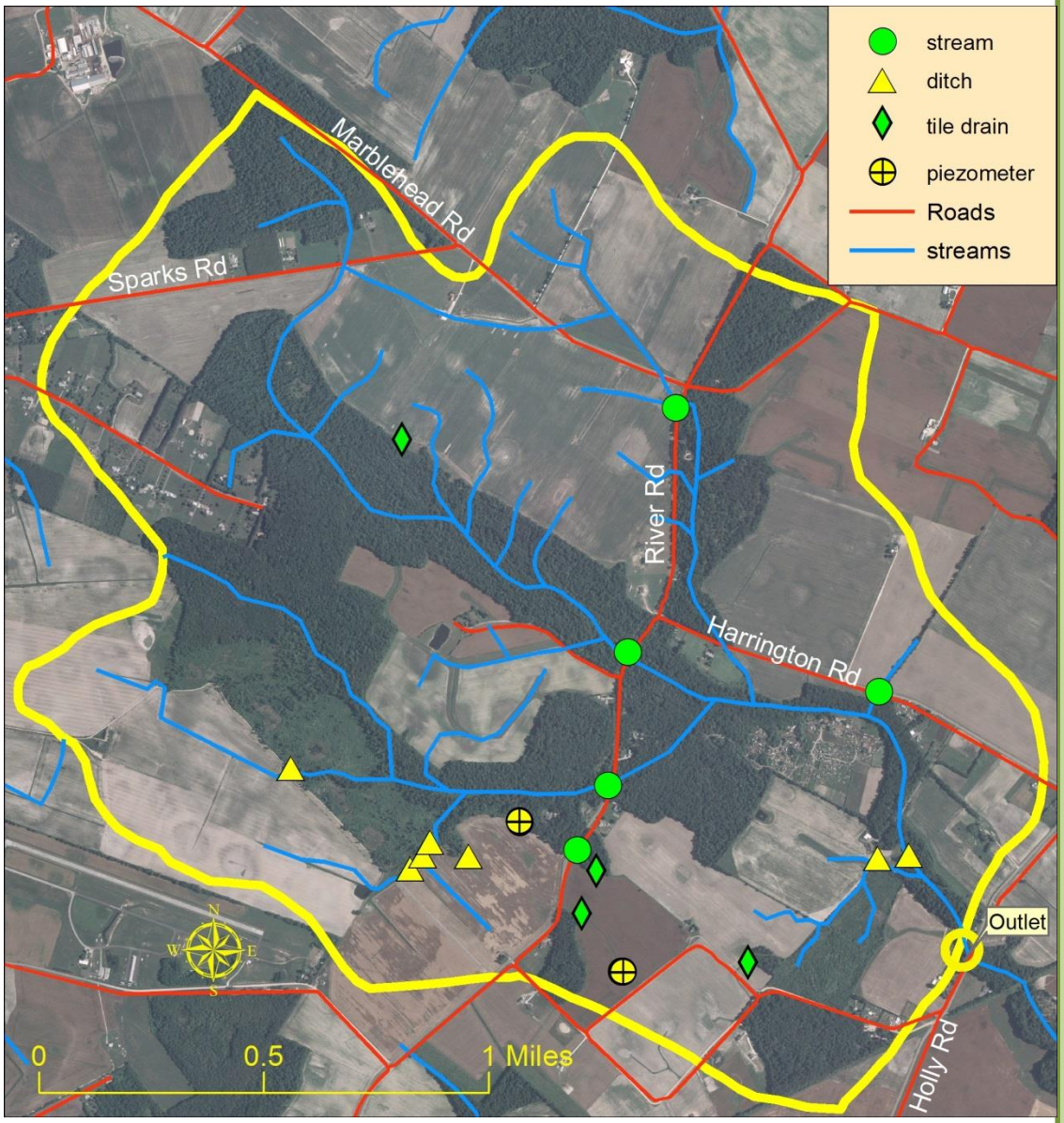
S. Forge

area: 3.2 sq mi
agriculture: 65 %
forest: 28 %
developed: 5 %
hydric soils: 34 %
no. farmers: 6
no. septics: 70
no. CAFOs: 1*
no old BMPs: ?
no new BMPs: 11



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Spring

area: 4.7 sq mi

agriculture: 78 %

forest: 22 %

developed: <1 %

hydric soils: 32 %

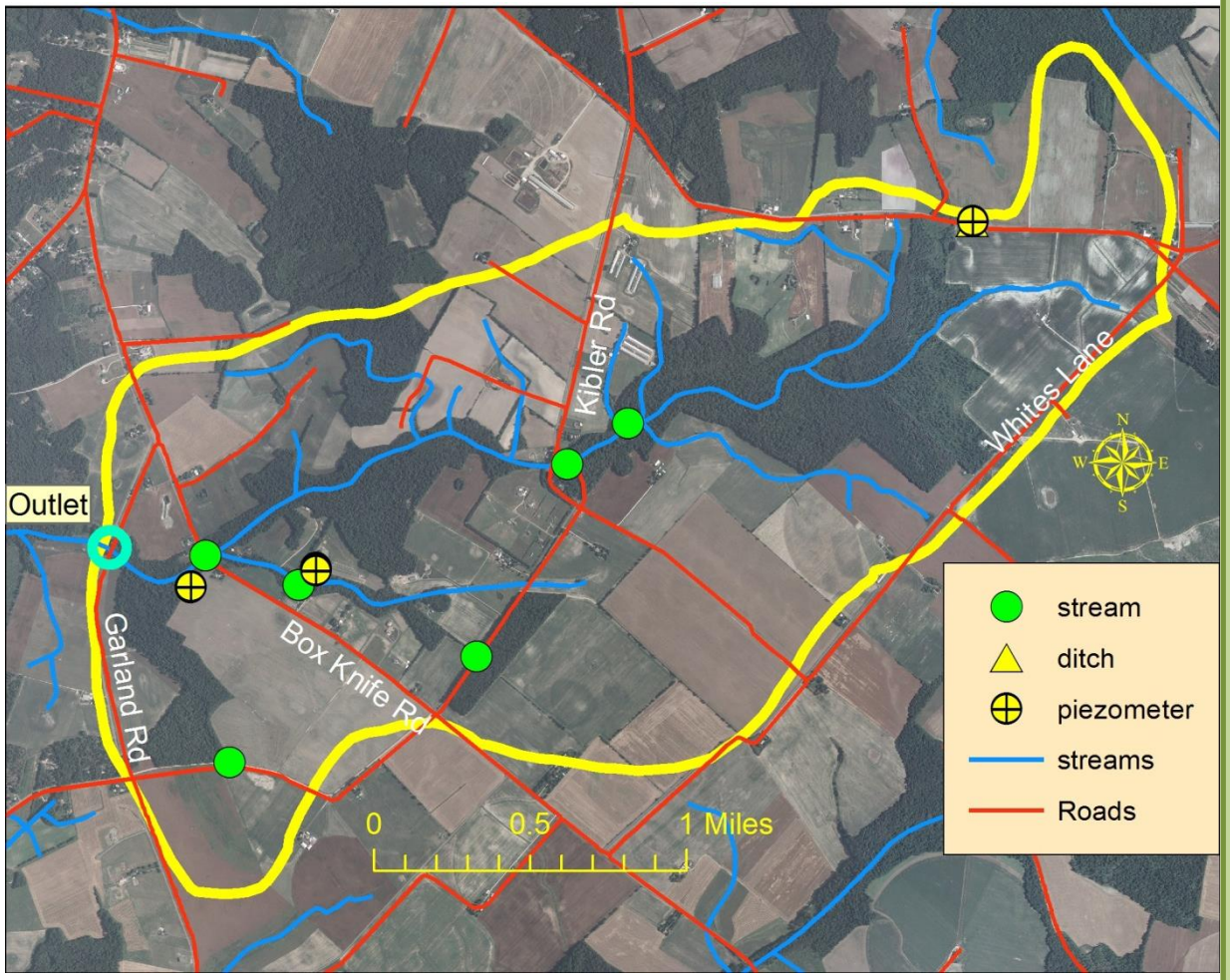
no. farmers: 16

no. septics: 72

no. CAFOs: 5

no. old BMPs: ?

no. new BMPs: 5



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Water Quality Data

Three kinds of data

1. Samples at watershed outlet during baseflow conditions
    - groundwater only in the stream
    - no rain for 3 days
    - collected monthly
2. Samples at outlet during rain events
    - 8 storms per year
3. Samples taken monthly within the watersheds during baseflow conditions

    1st -2nd order streams

    Farm ditches, tile lines, groundwater

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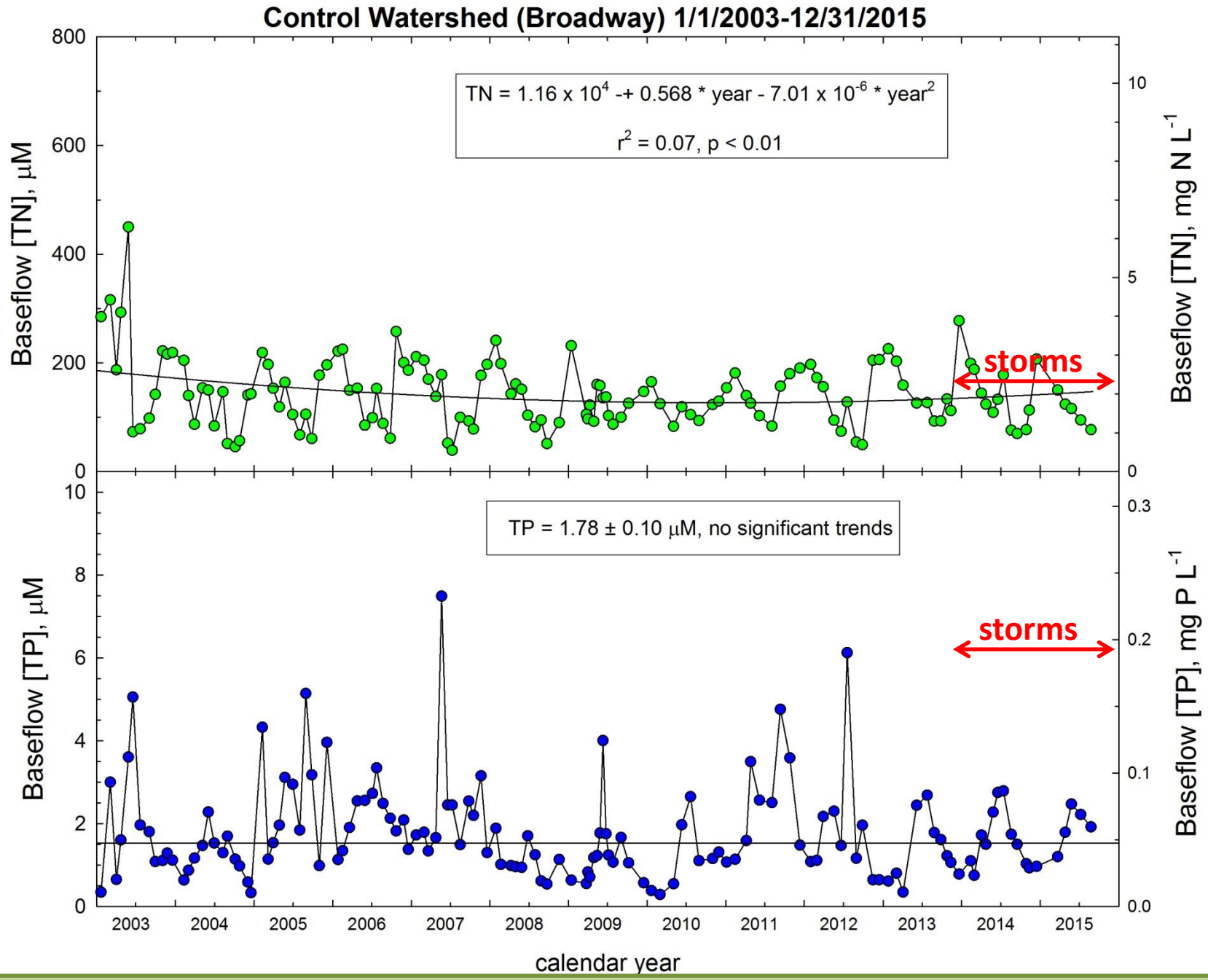
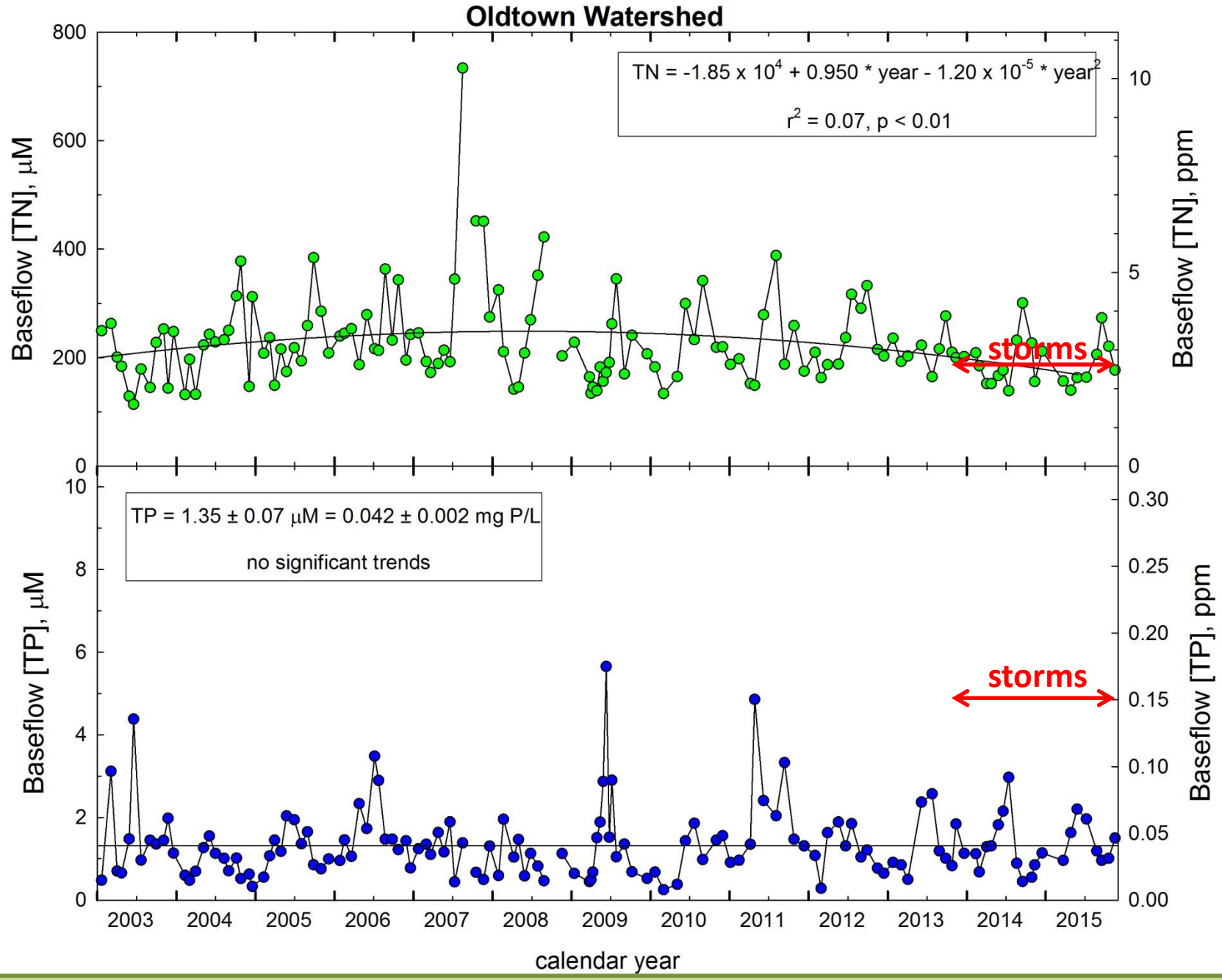
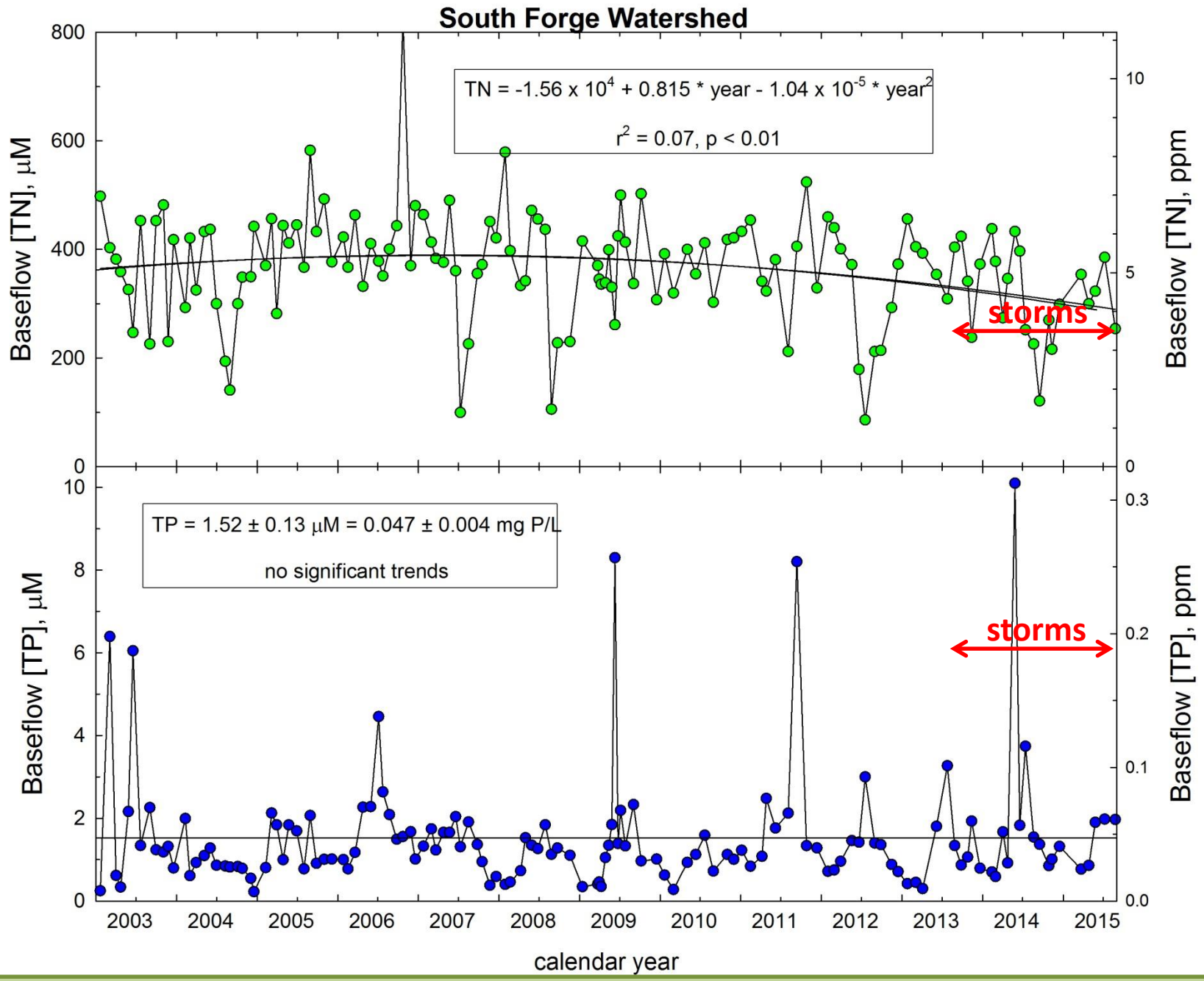
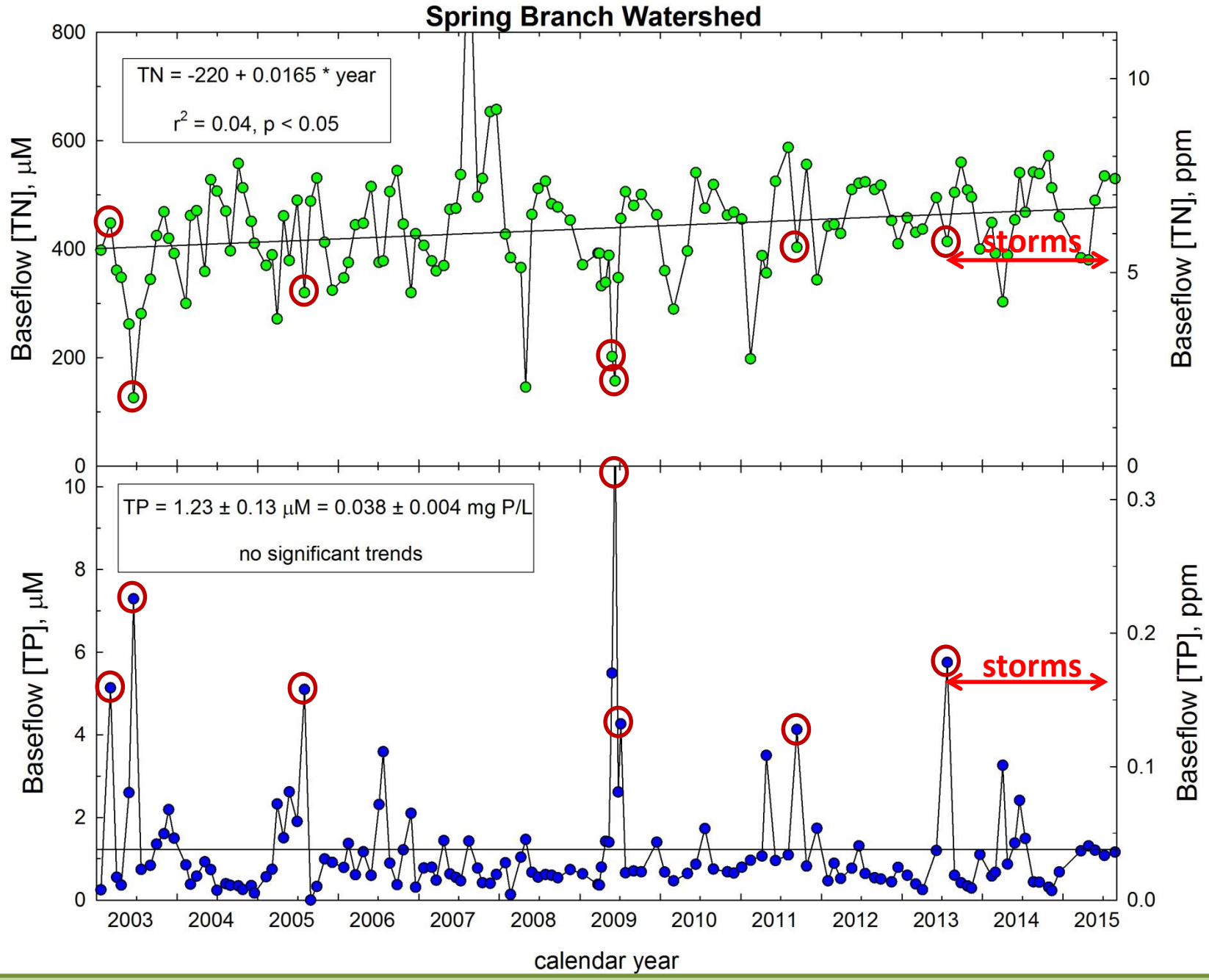

Control Watershed (Broadway) 1/1/2003-12/31/2015
TN = 1.16 x 10^4 -+ 0.568 * year - 7.01 x 10^-6 * year^2
r^2 = 0.07, p < 0.01
Baseflow [TN], µM
Baseflow [TN], mg N L^-1
storms
TP = 1.78 ± 0.10 µM, no significant trends
Baseflow [TP], µM
Baseflow [TP], mg P L^-1
storms
calendar year


Oldtown Watershed
TN = -1.85 x 10^4 + 0.950 * year - 1.20 x 10^-5 * year^2
r^2 = 0.07, p < 0.01
Baseflow [TN], µM
Baseflow [TN], ppm
storms
TP = 1.35 ± 0.07 µM = 0.042 ± 0.002 mg P/L
no significant trends
Baseflow [TP], µM
Baseflow [TP], ppm
storms
calendar year


South Forge Watershed
TN = -1.56 x 10^4 + 0.815 * year - 1.04 x 10^-5 * year^2
r^2 = 0.07, p < 0.01
Baseflow [TN], µM
Baseflow [TN], ppm
storms
TP = 1.52 ± 0.13 µM = 0.047 ± 0.004 mg P/L
no significant trends
Baseflow [TP], µM
Baseflow [TP], ppm
storms
calendar year

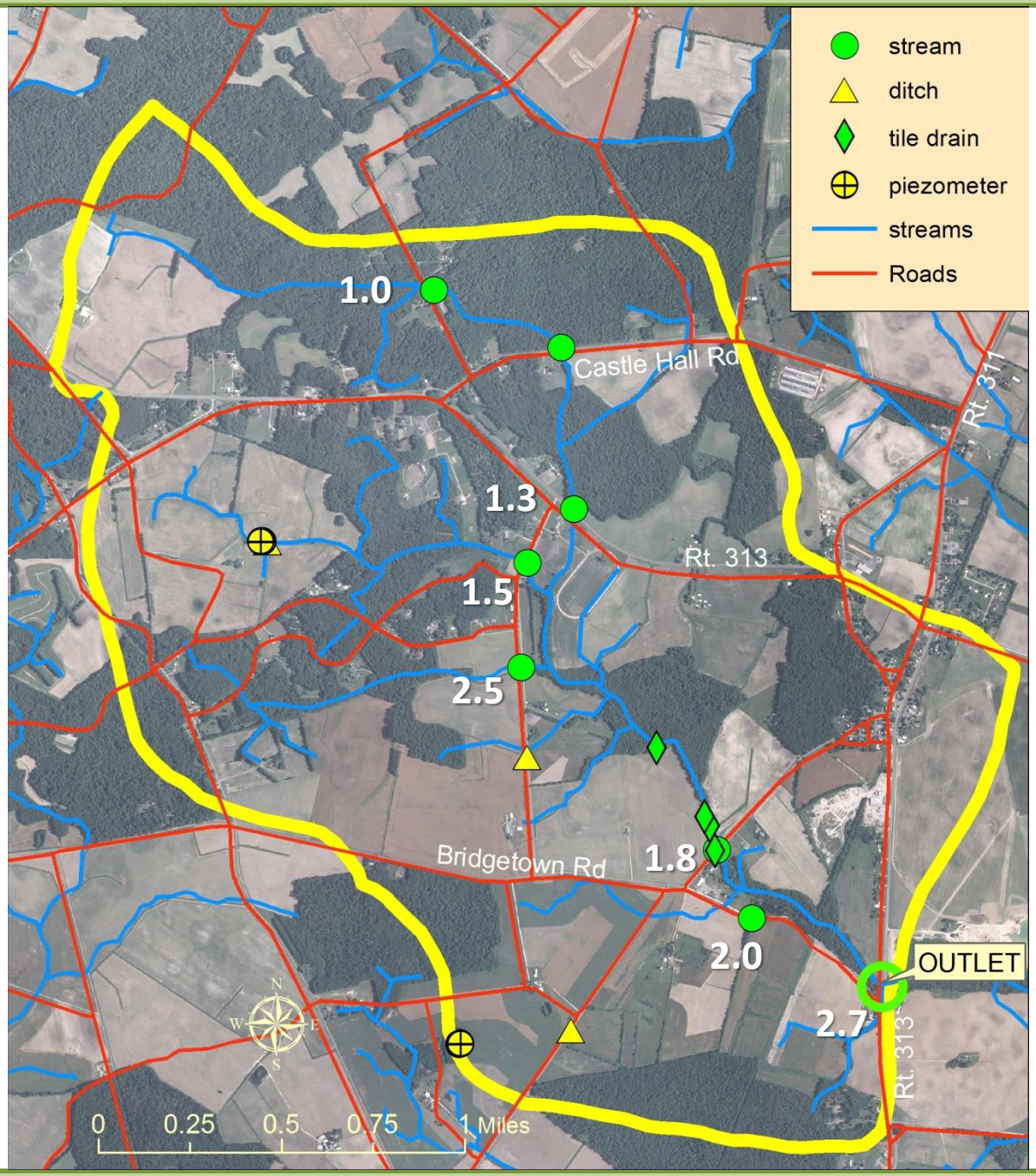

Spring Branch Watershed
TN = -220 + 0.0165 * year
r2 = 0.04, p < 0.05
Baseflow [TN], µM
Baseflow [TN], ppm
storms
TP = 1.23 ± 0.13 µM = 0.038 ± 0.004 mg P/L
no significant trends
Baseflow [TP], µM
Baseflow [TP], ppm
storms
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
calendar year

Summary: Water Quality Reports (outlets)

watershed	Flow type	Total N ppm	Total P ppm	TSS ppm
Oldtown	base	3.2	0.042	3.5
	storm	2.5	0.150	59.4
South Forge	base	5.1	0.047	4.0
	storm	3.4	0.177	30.3
Spring	base	6.1	0.038	3.2
	storm	5.4	0.149	28.4
		↓ -15-30%	↑ x 3-4	↑ x 10

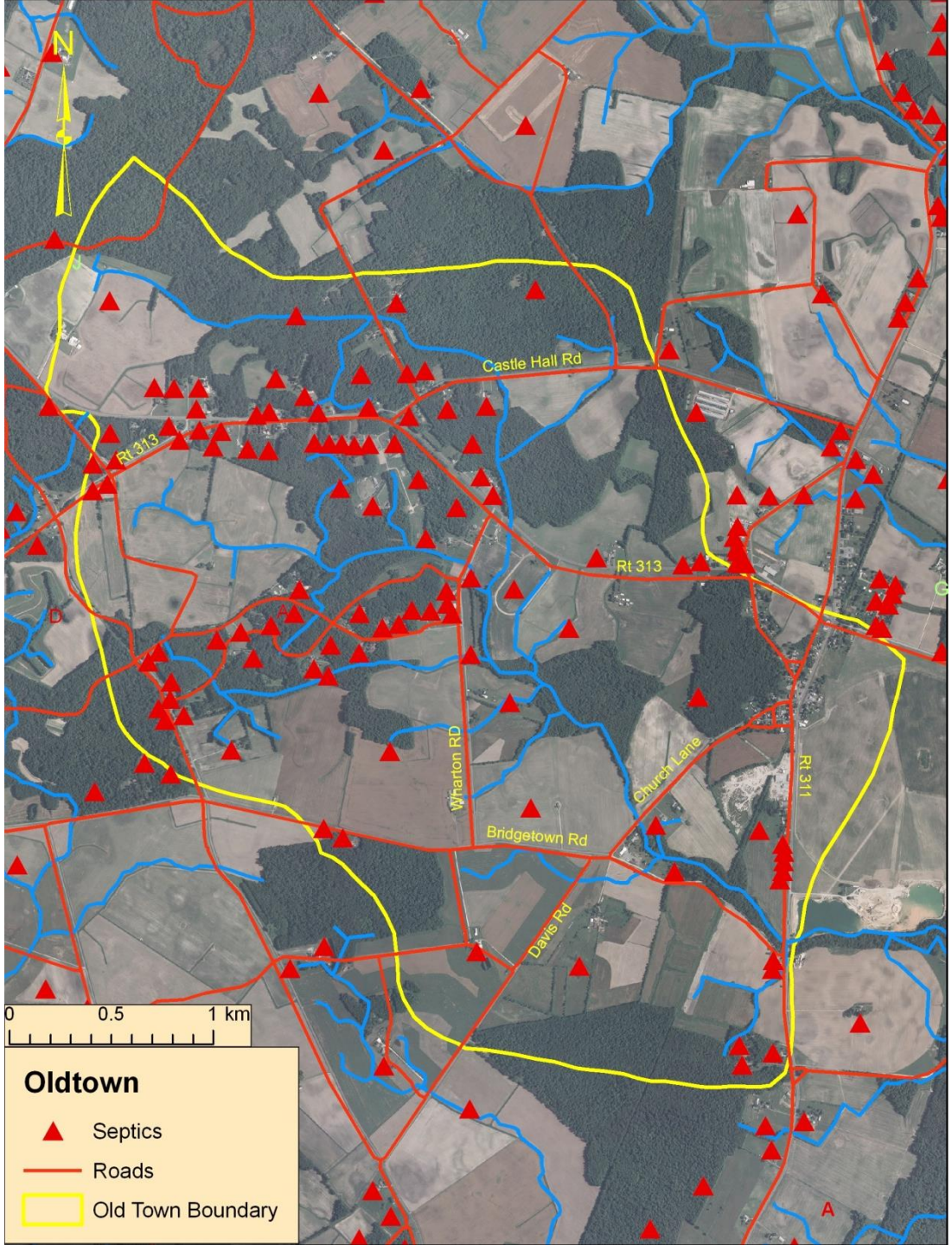
Oldtown Watershed

Total N, ppm



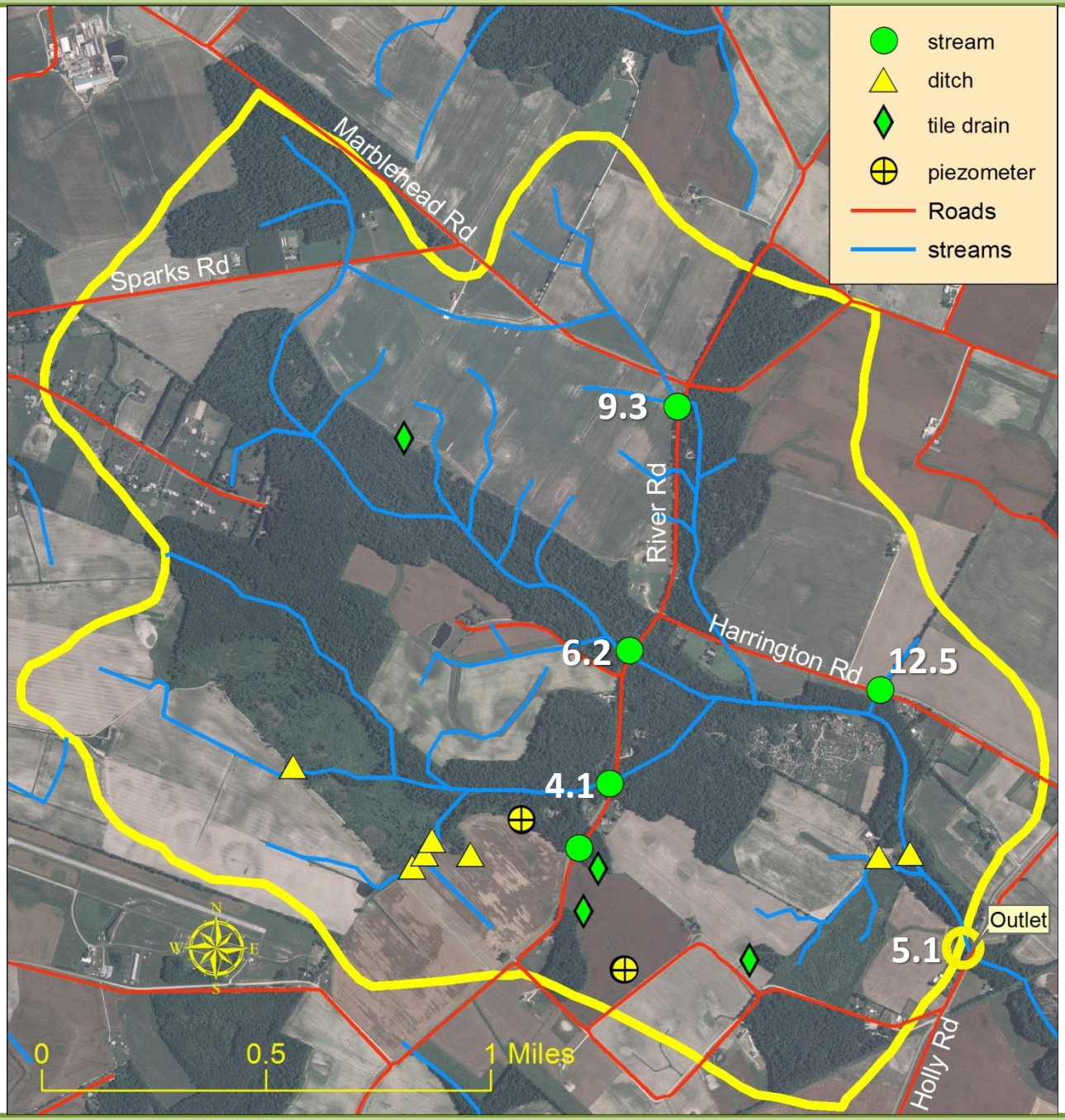
Oldtown Watershed

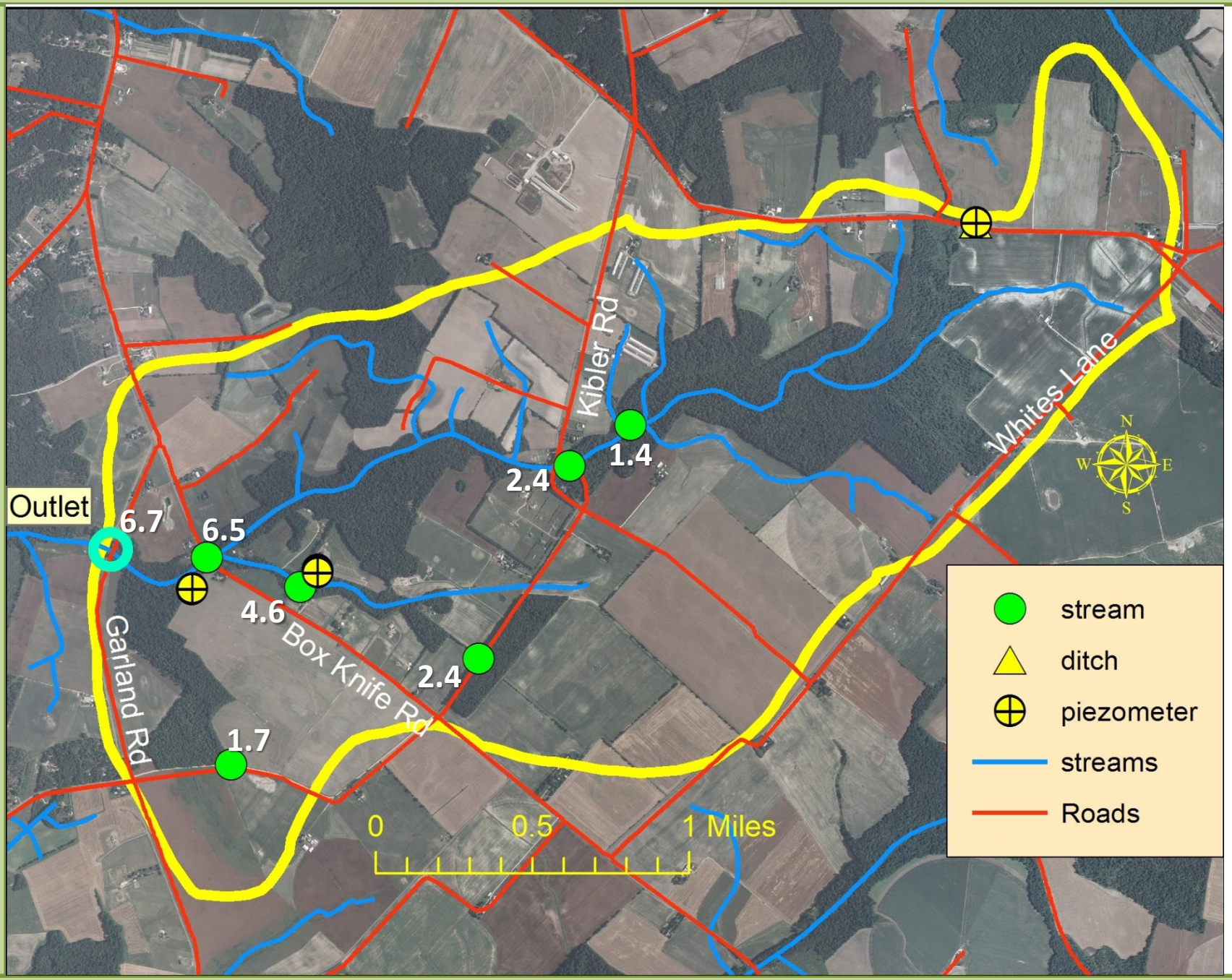
Septics



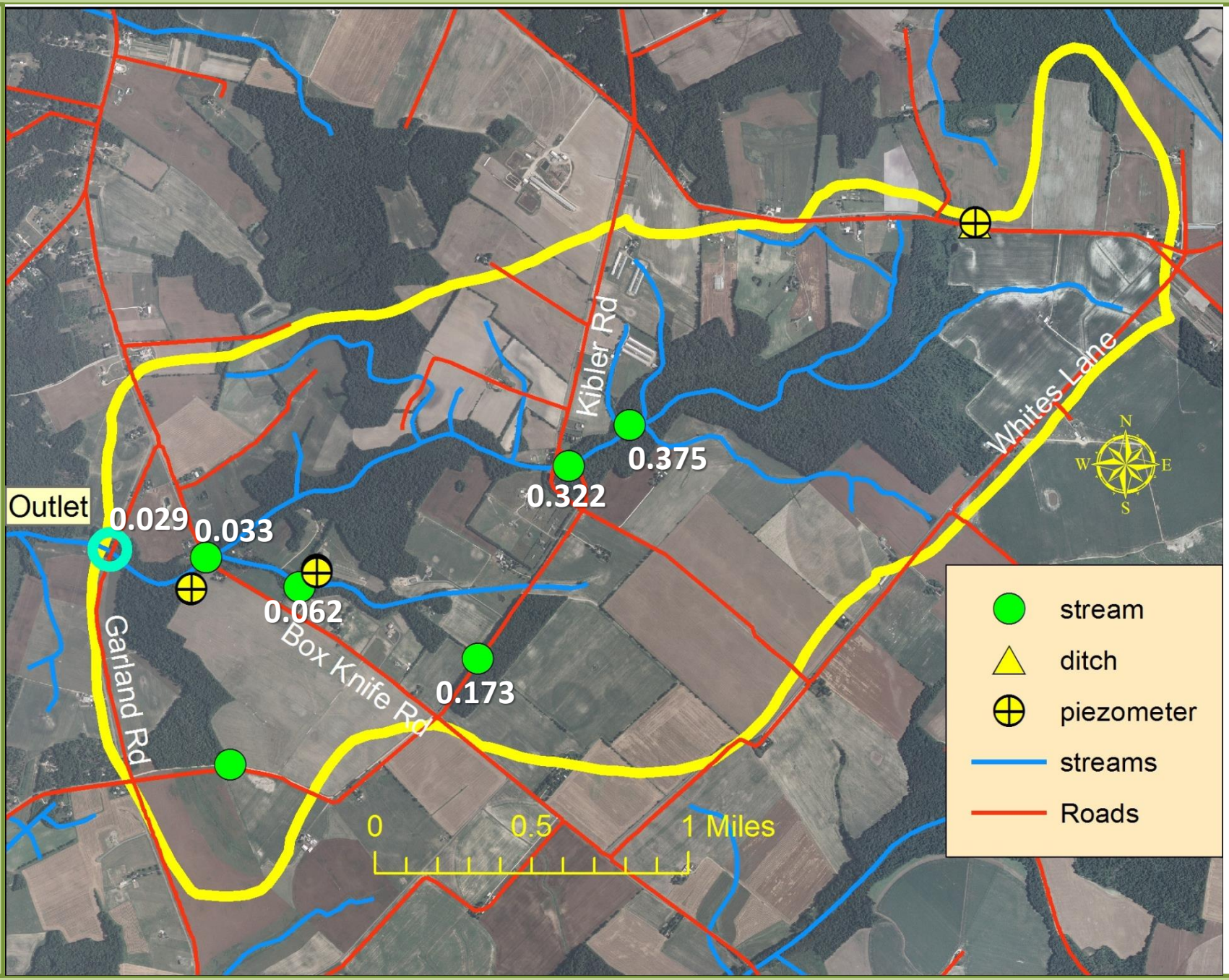
South Forge Watershed

Total N, ppm





Spring Watershed Total N, ppm



Spring Watershed Total P, ppm

New BMPs in the Experimental Watersheds (implemented or planned, little data available yet)

BMP	watershed	no.	efficiency
Agri-drains (ditches)	Oldtown	1	90%
Agri-drains (tile lines)	Oldtown, S. Forge	5	70-90% *
Bioreactors	S. Forge	3	98%
P traps	S. Forge	2	60-80%
Cover crops after soy beans	S. Forge	2	??%
sediment ponds	S. Forge	1	??%
Split sidedress	Spring	1	??%
Greenseeker	Spring	1	??%
Pond aerator	Spring	1	??%

We are monitoring these new BMPs at the three spatial scales to detect their effects on water quality.

Lessons learned related to engagement

- Farmers are small businessmen (and women)
- They feel singled out by the TMDLs, with their financial solvency threatened
  - BMPs cost them money, in general, despite cost-shares
  - Economic headwinds for BMP adoption
- Many don't trust government agencies and most riverkeepers, sometimes not Universities
- We have worked very hard over 2 years to get 2/3 of the farmers to work with us and allow us to sample on their farms (early and mid adopters)
- You need a trusted person to open doors.
  - In our case it was a UMD extension agent, a coPI

Lessons learned regarding which BMPs work best

- This is what we are currently testing
- Some BMPs have been tested at the farm scale by us or by others
  - Winter cover crops
  - Drainage control structures
  - Bioreactors
- In this project we won't have answers for at least another year at the farm scale
- The watershed scale may take longer

What type of work is needed most to improve water quality?

- Building trust with farmers and residents to get cooperation
  - Fallout from Hudson case about 2 years ago
- Careful monitoring of current BMPs and testing of new ones
- Apply higher densities of BMP implementation
  - Too few have been applied in most cases
  - Cover crops are typically applied only after corn, not after soybeans (50% winter cover max)
  - Only ~1/3 of stream sides have buffers, despite CREP
    - CREP payments are too low compared to grain prices

What challenges have arisen to completing this work?

- The late adopters, the 1/3 of farmers not cooperating with us, require extra time and effort to gain their trust and cooperation
- NSF funded us for monitoring, but not to help pay for BMPs. We are constantly applying for funds to help farmers pay for BMPs or to test new BMPs
- Residents contribute small amounts of N, P, and sediments in our watersheds, but are VERY difficult to reach (<10% success for us)
- Challenging statistical analysis of separating effects of pre-existing and new BMPs

What are the opportunities for working collaboratively with the group?

- Recognize that cleaner estuarine waters require cleaner inflowing freshwaters
- Partner with USDA, MDA, or CB Trust to cover ag BMP expenses that are not cost-shared. For example,
  - A drainage control on a ditch may cost $10-20k
  - USDA cost share is 87.5%
  - Farmer has to pay $1,250-2,500 per ditch
- Partner with EPA, MDE or Riverkeepers to increase funds for residential denitrifying septic systems
  - Waiting lists of residents to get access to MDE funding
  - Cost is $15-25k each + $5-25/month in electricity
- Partner with research projects like ours to provide funds for current or novel BMPs that need testing


Best Management Practices
Test Farm