Patterns of Water Quality in Buffalo Creek – Links to Geology, Land Use, and Management

Report on BCWA Volunteer Monitoring Program (2005-2012)

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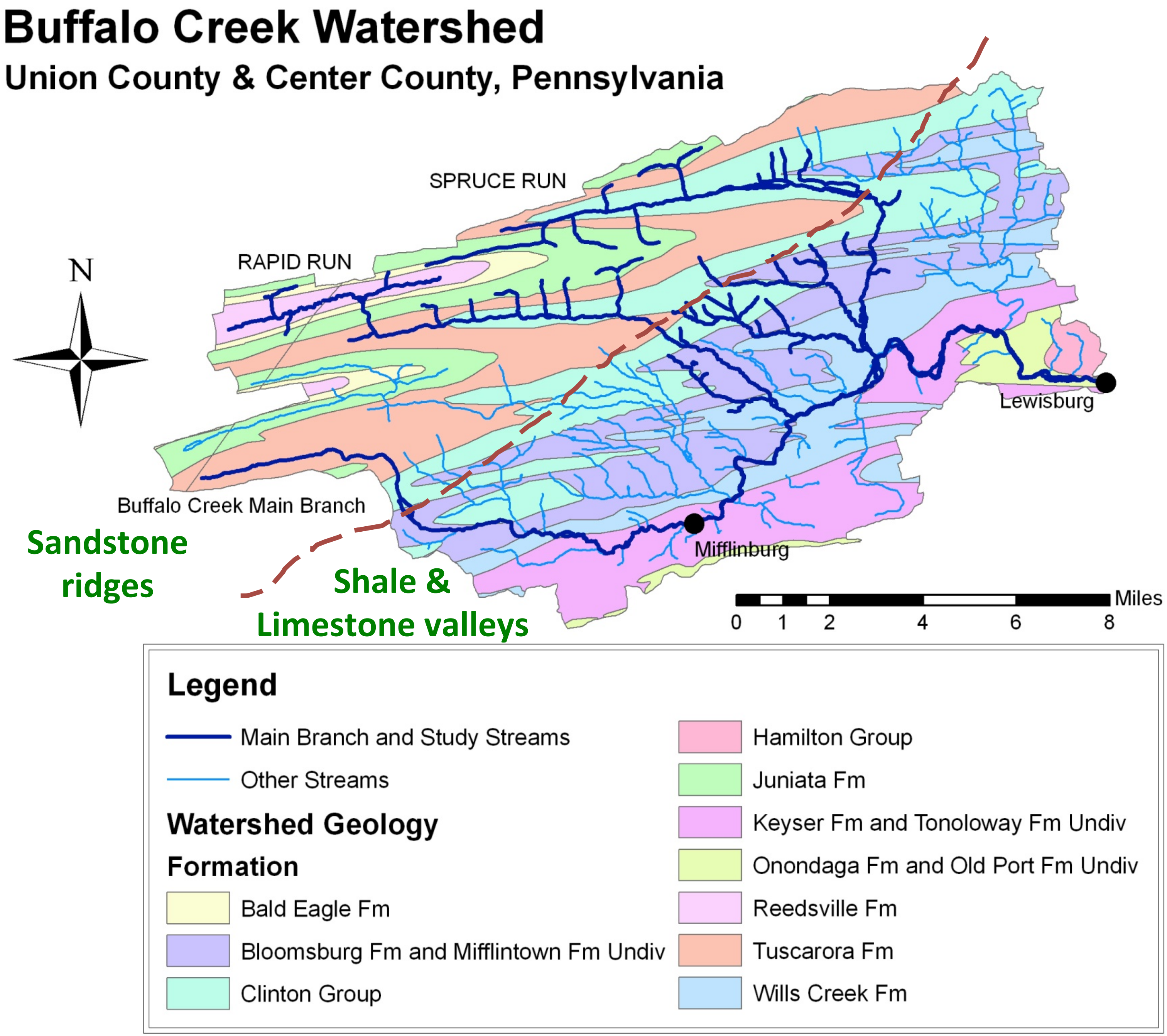
2 May 2013

Acknowledgments

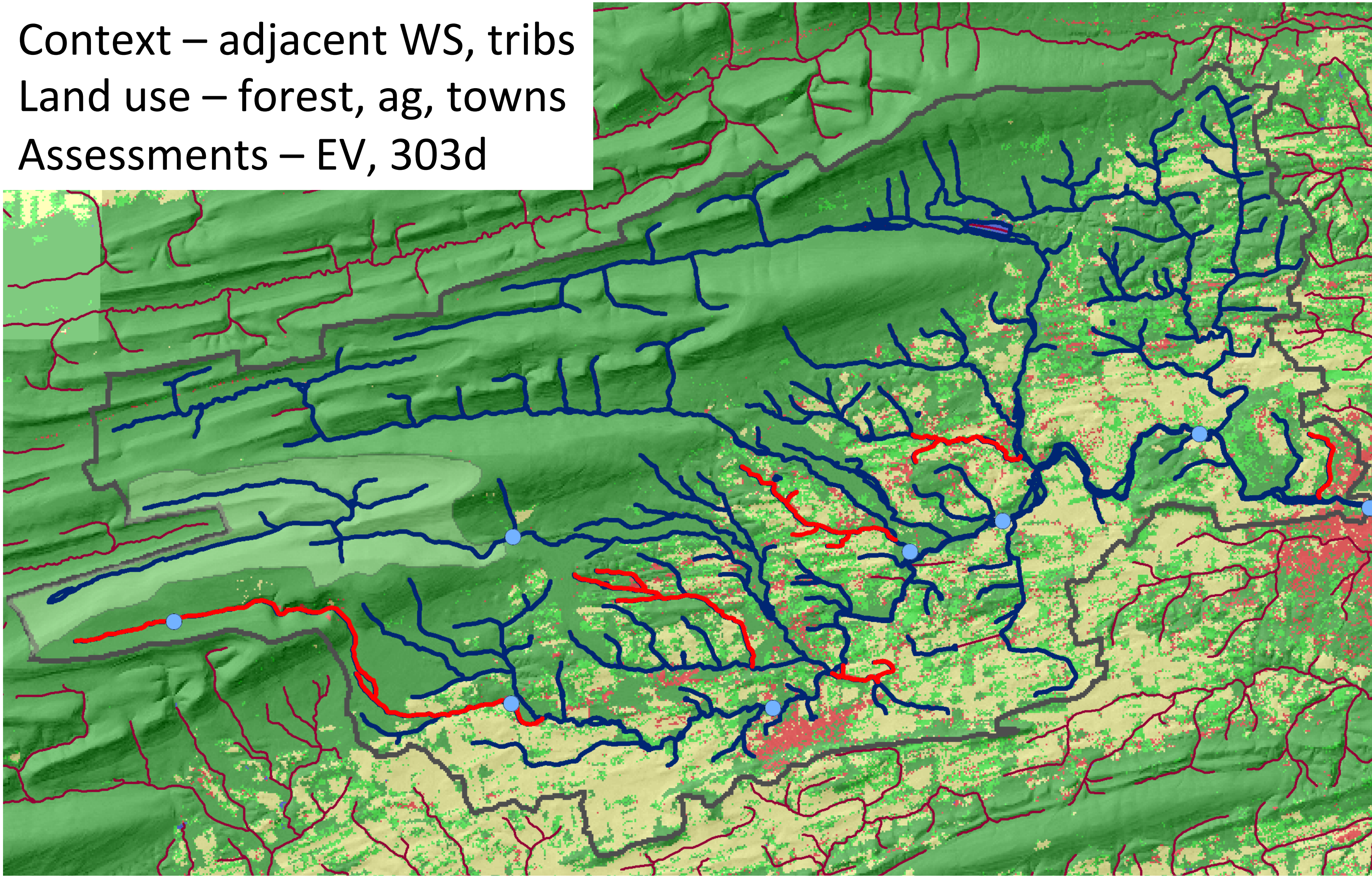
- Volunteer monitoring teams – you know who you are
- Monitoring program coordinators – Thom, David
- Chelsea Fischer – Bucknell Presidential Fellow and lab assistant extraordinaire
- Huan Vin Luong & Elaine Keithan – Directors of Bucknell's Environmental Science Laboratory



Buffalo Creek Watershed
Union County & Center County, Pennsylvania
SPRUCE RUN
RAPID RUN
N
Buffalo Creek Main Branch
Sandstone ridges
Shale & Limestone valleys
Lewisburg
Mifflinburg
Miles
0 1 2 4 6 8
Legend
Main Branch and Study Streams
Other Streams
Watershed Geology
Formation
Bald Eagle Fm
Bloomsburg Fm and Mifflintown Fm Undiv
Clinton Group
Hamilton Group
Juniata Fm
Keyser Fm and Tonoloway Fm Undiv
Onondaga Fm and Old Port Fm Undiv
Reedsville Fm
Tuscarora Fm
Wills Creek Fm

Buffalo Creek Watershed

Context – adjacent WS, tribs
Land use – forest, ag, towns
Assessments – EV, 303d



Outline of Presentation

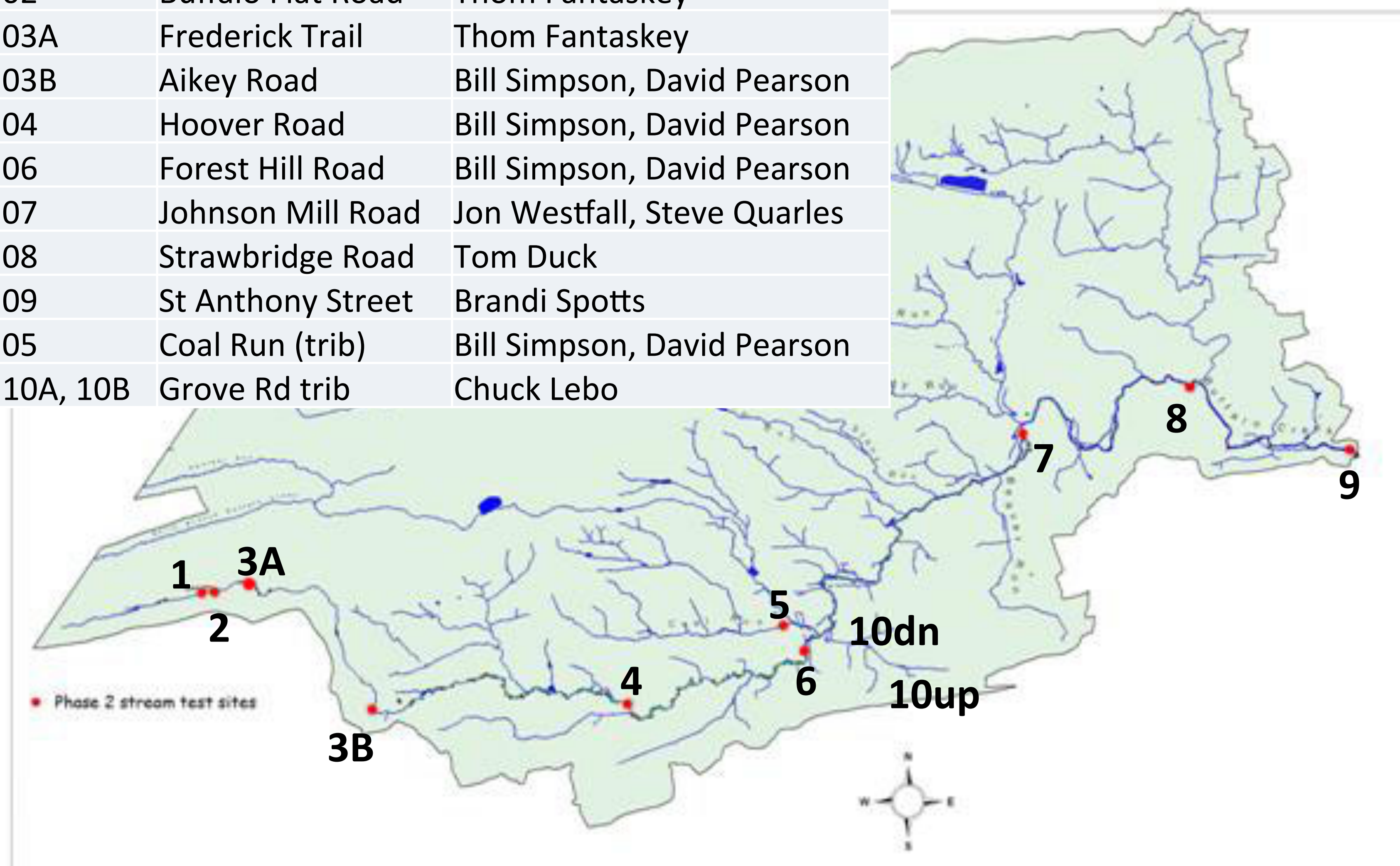
- Description of monitoring program
- Water quality trends
  - Longitudinal patterns and influences
  - Long-term patterns in water quality
  - Acid remediation project in headwaters
  - Temporal variability and human impacts
- Future directions for monitoring

Monitoring Goals

- **What value is the monitoring program?**
  - Critical baseline profile of water quality
  - Educational outreach, public awareness
- ***Assessment*** – ecological, potential problems, solutions, recovery
- ***Reporting & documenting*** – enforcement, grant proposals, long-term record
- ***Planning*** – future projects, land owner contacts

BCWA Monitoring Sites

Site 01	Hayes Lane Camp	Thom Fantaskey
Site 02	Buffalo Flat Road	Thom Fantaskey
Site 03A	Frederick Trail	Thom Fantaskey
Site 03B	Aikey Road	Bill Simpson, David Pearson
Site 04	Hoover Road	Bill Simpson, David Pearson
Site 06	Forest Hill Road	Bill Simpson, David Pearson
Site 07	Johnson Mill Road	Jon Westfall, Steve Quarles
Site 08	Strawbridge Road	Tom Duck
Site 09	St Anthony Street	Brandi Spotts
Site 05	Coal Run (trib)	Bill Simpson, David Pearson
Site 10A, 10B	Grove Rd trib	Chuck Lebo

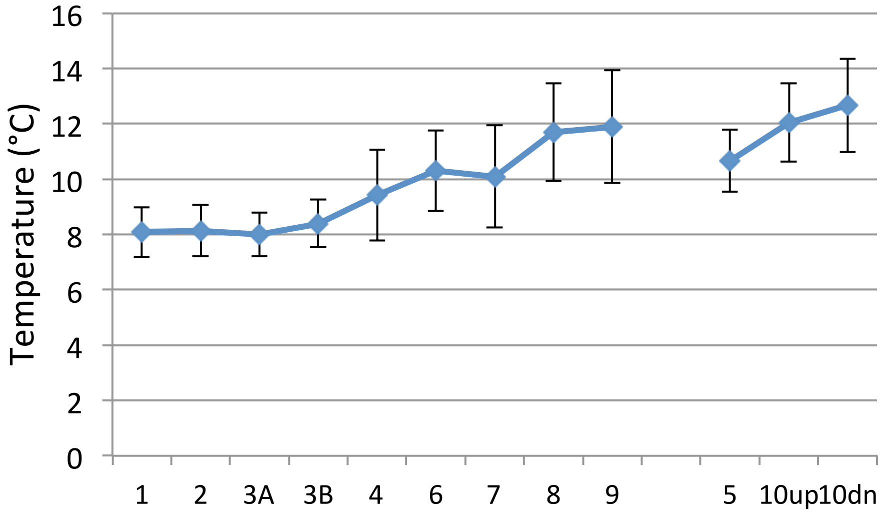


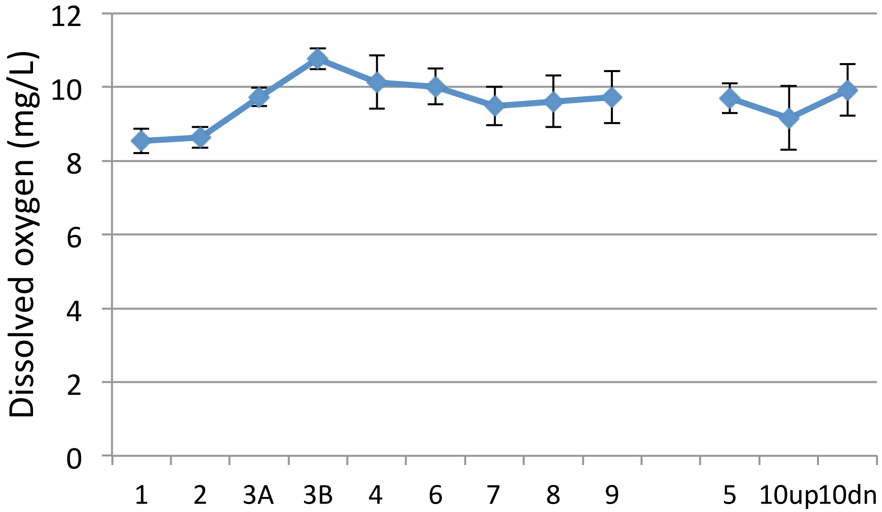
BCWA Monitoring Program

- Phase 1
  - 8 sites (6 mainstem, 2 tribs), April 2005-March 2007
  - Monthly sampling
  - All field data – date, time, weather, air temp, water temp, water color and odor, dissolved oxygen, alkalinity, pH, turbidity, nitrate, phosphate
- Phase 2
  - Originally 10 sites (9 mainstem, 1 trib), 2nd trib (2 locations) added March 2011, December 2007-present
  - Quarterly sampling at "regular" sites, monthly sampling at "project sites" or new sites for 3 years, quarterly after
  - Augmented field data (date, time, weather, water temp, dissolved oxygen, alkalinity, pH) with lab analysis (total suspended solids; nutrients – ammonium, phosphorus; cations – sodium, potassium, magnesium, calcium; anions – chloride, nitrate, sulfate)

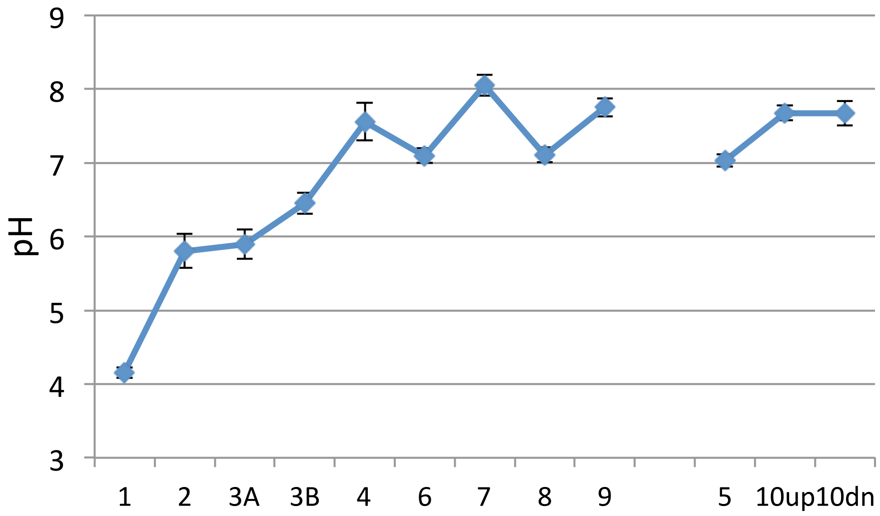
Downstream Trends

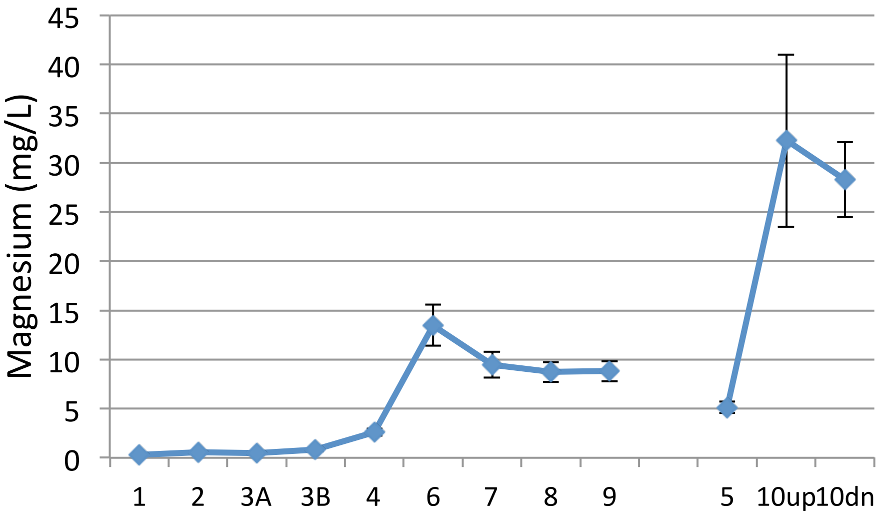
Changes that occur as you go downstream from the headwaters (site 1) to the confluence with the Susquehanna River (site 9) along with 2 tributaries in the valley near Mifflinburg. Values are means +/- 1 SE.

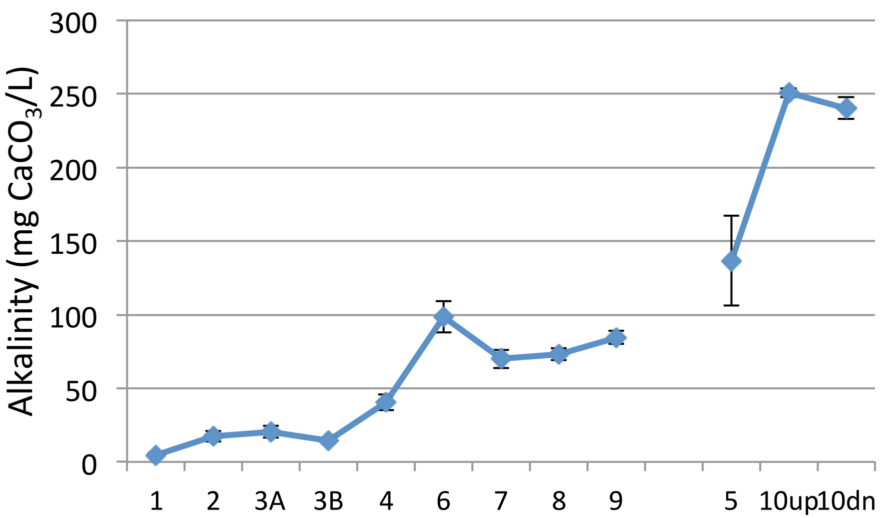


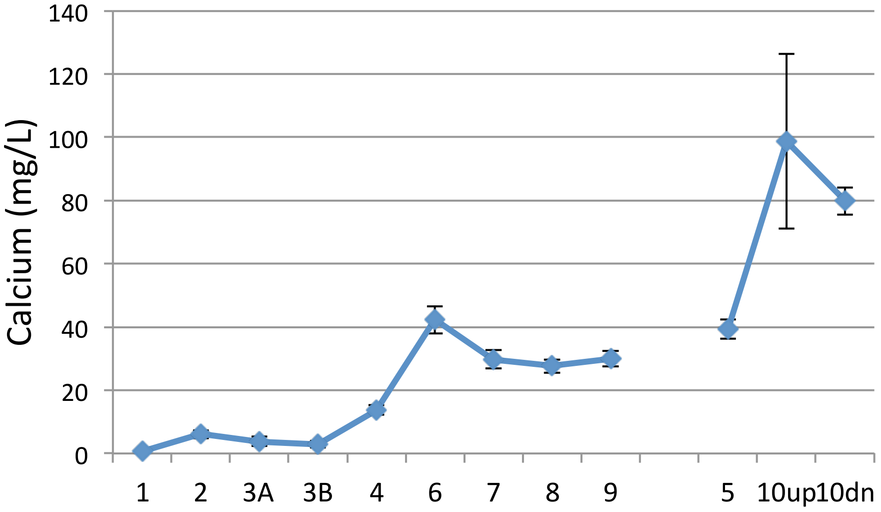


Downstream Trends – Geology

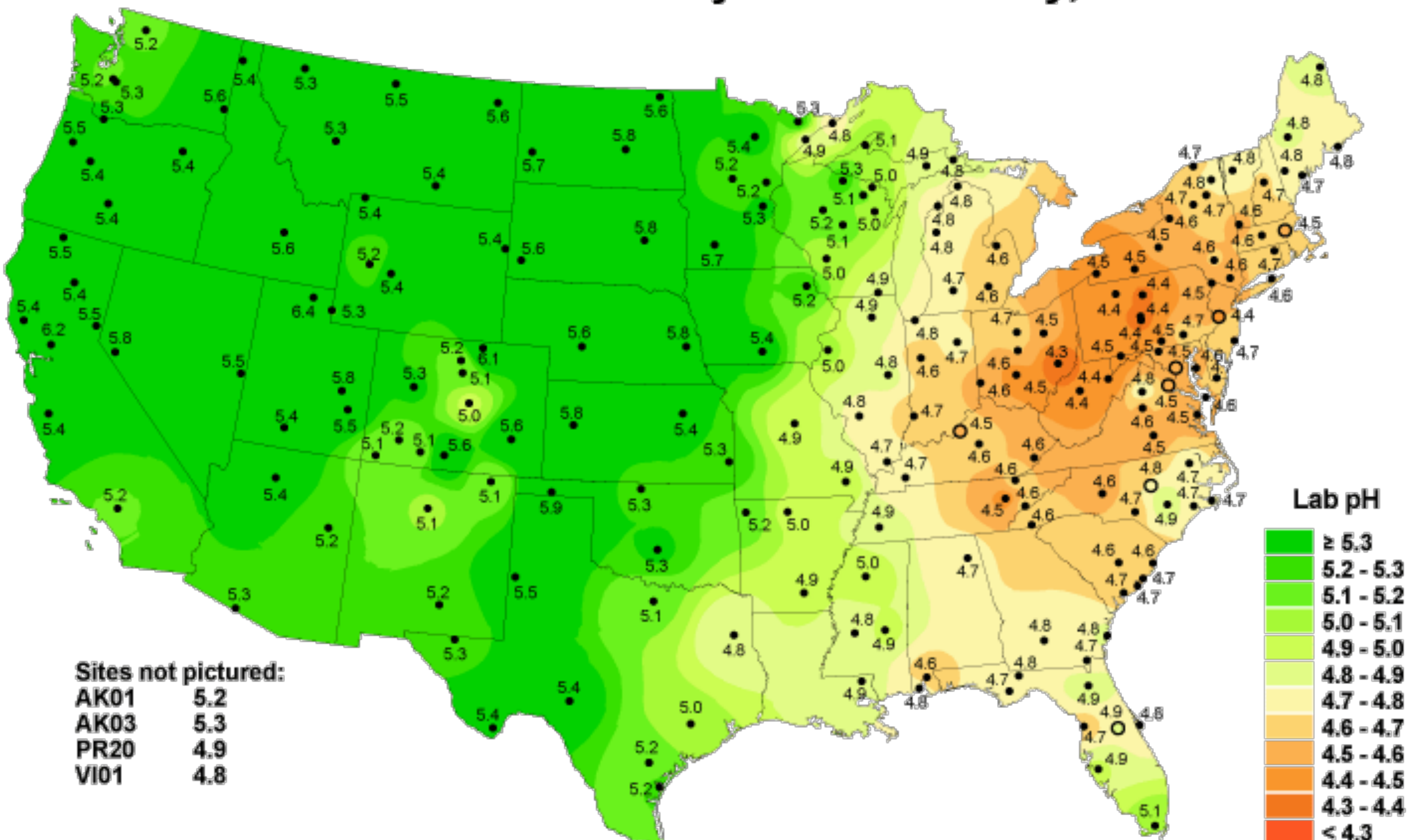






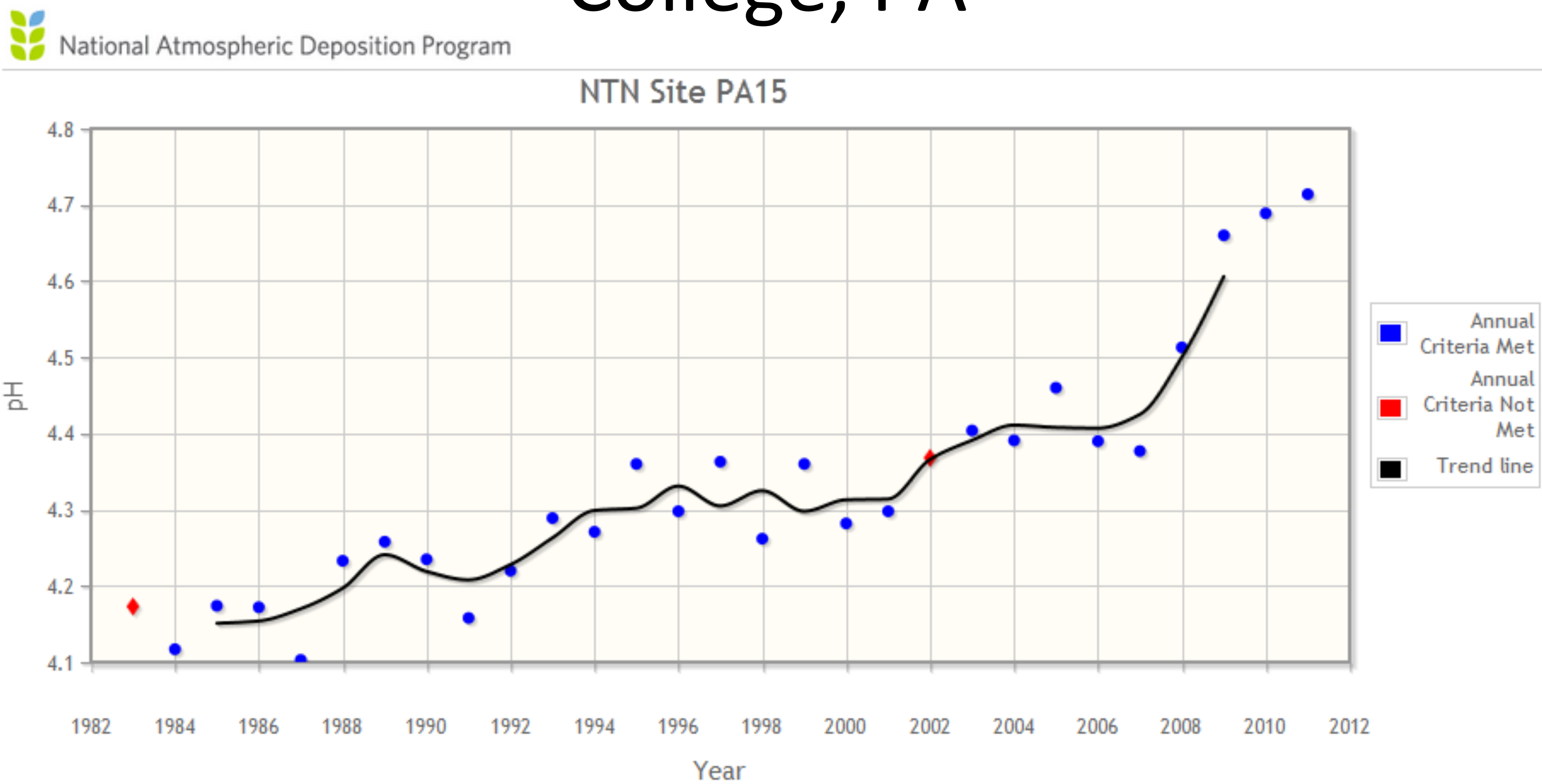


Hydrogen ion concentration as pH from measurements made at the Central Analytical Laboratory, 2006

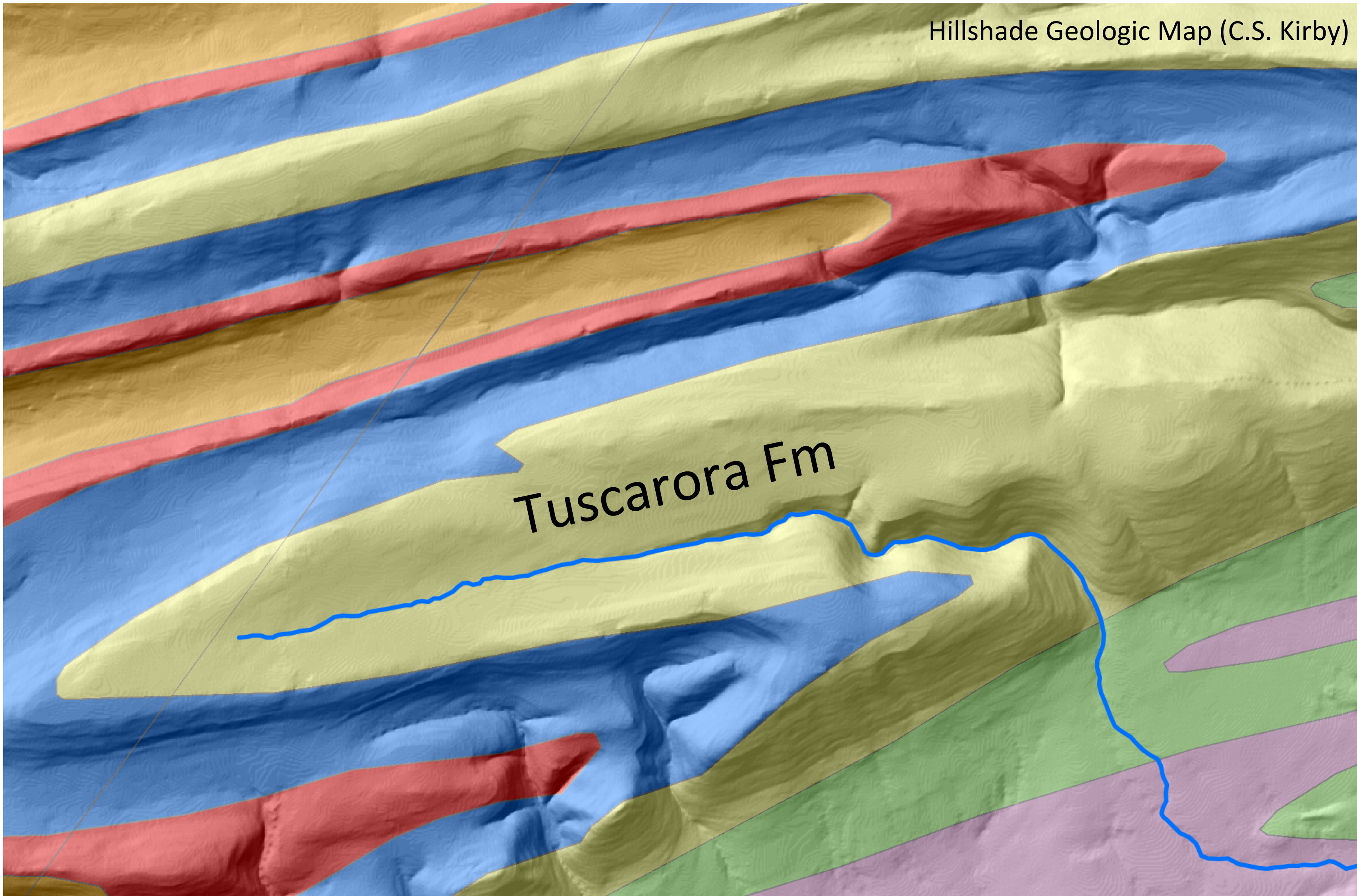


National Atmospheric Deposition Program/National Trends Network
http://nadp.sws.uiuc.edu

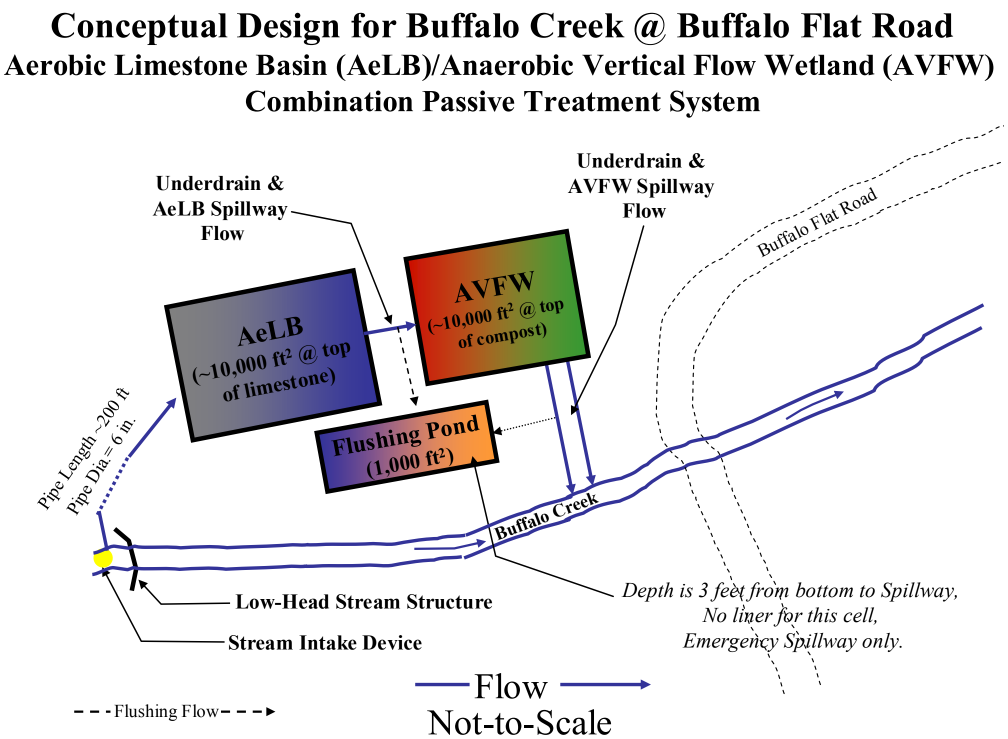
pH Trend for Precipitation in State College, PA



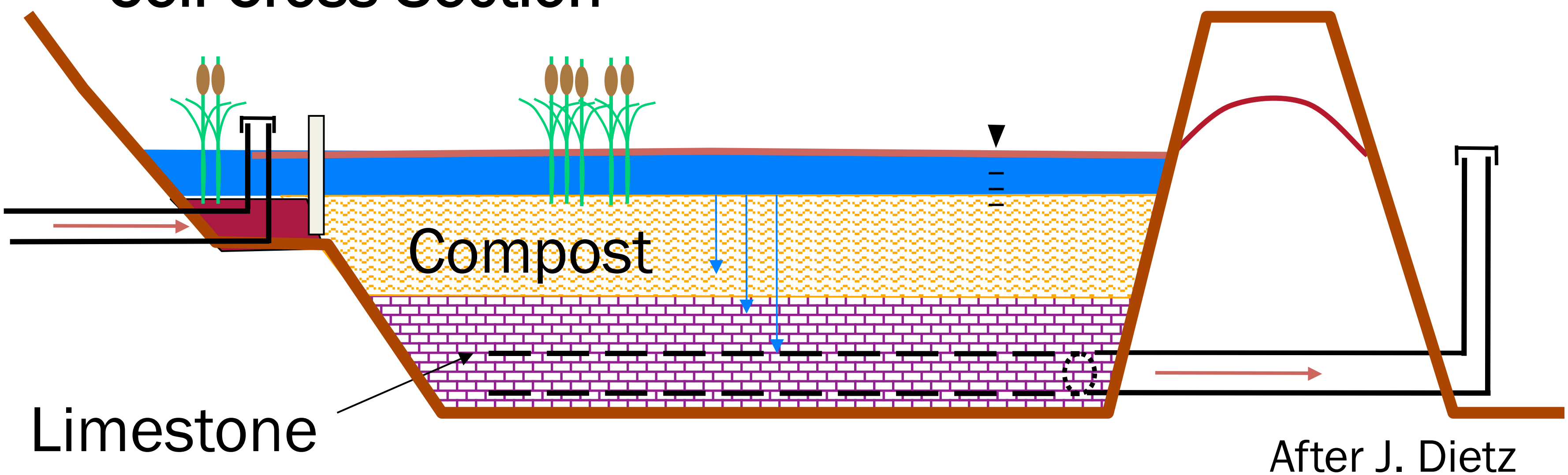
Geology of Buffalo Creek Headwaters



Passive Treatment Acid Remediation System

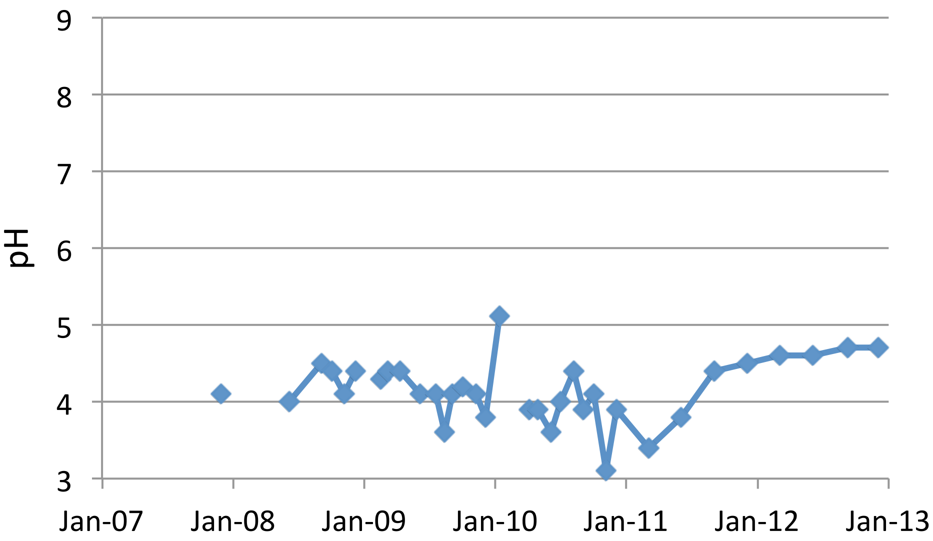


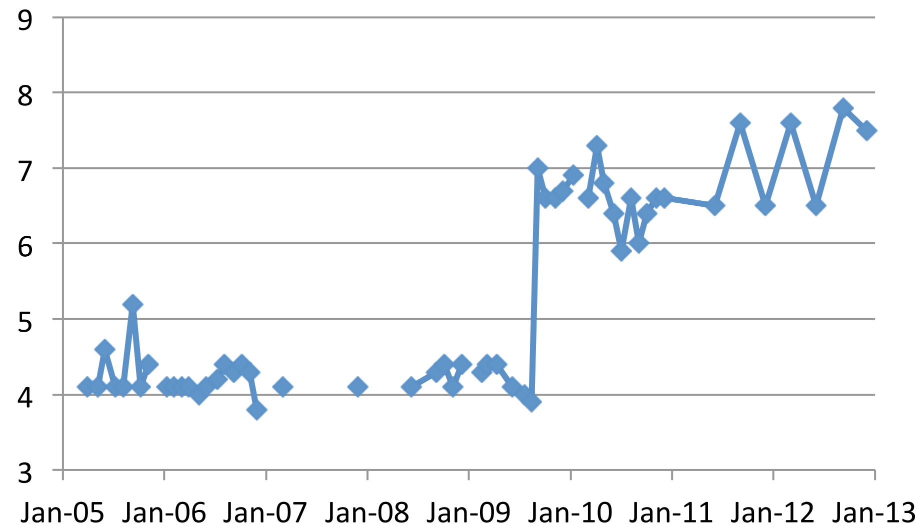
Vertical Flow Wetland Cell Cross Section

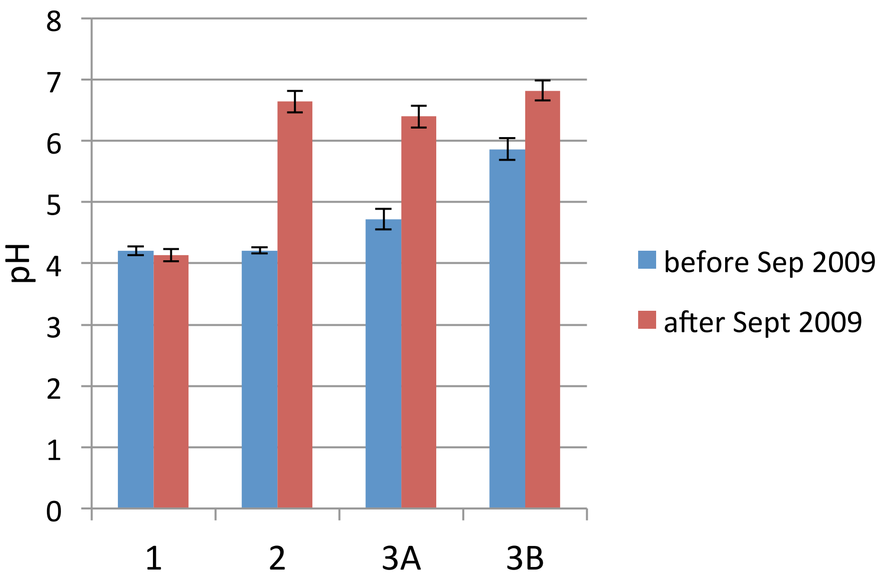


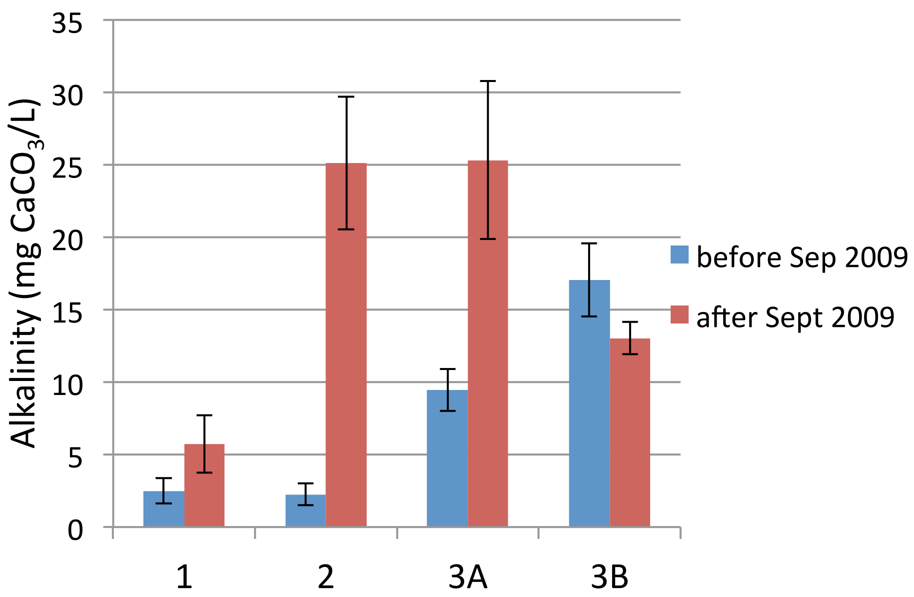
After J. Dietz

Acid Remediation Effects









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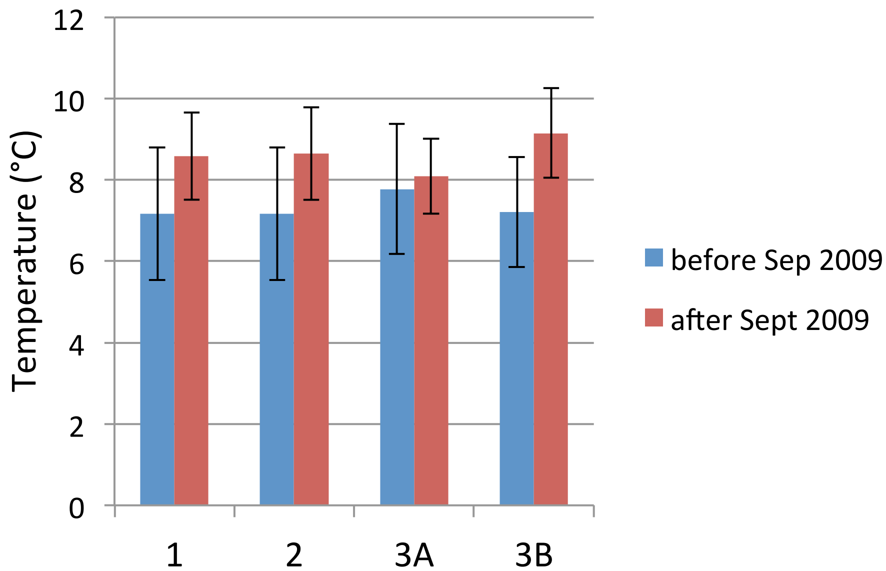
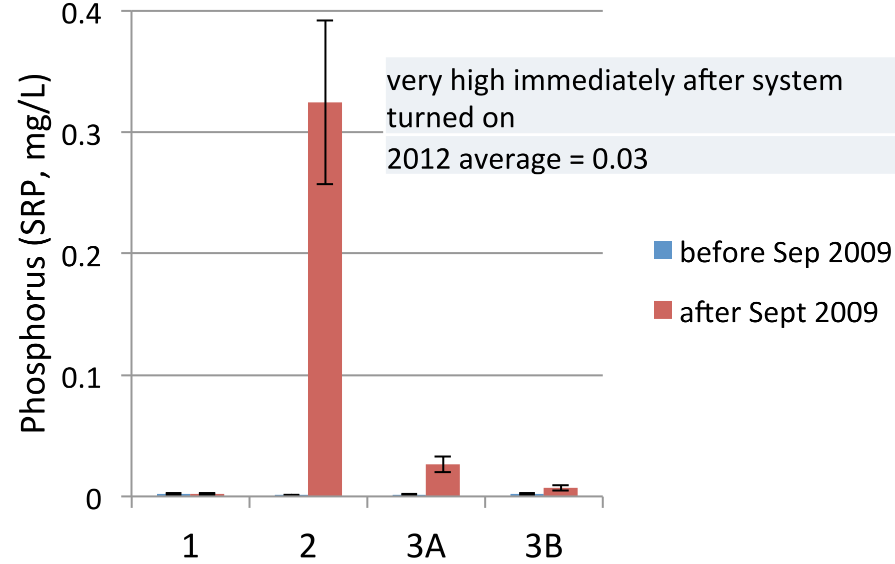
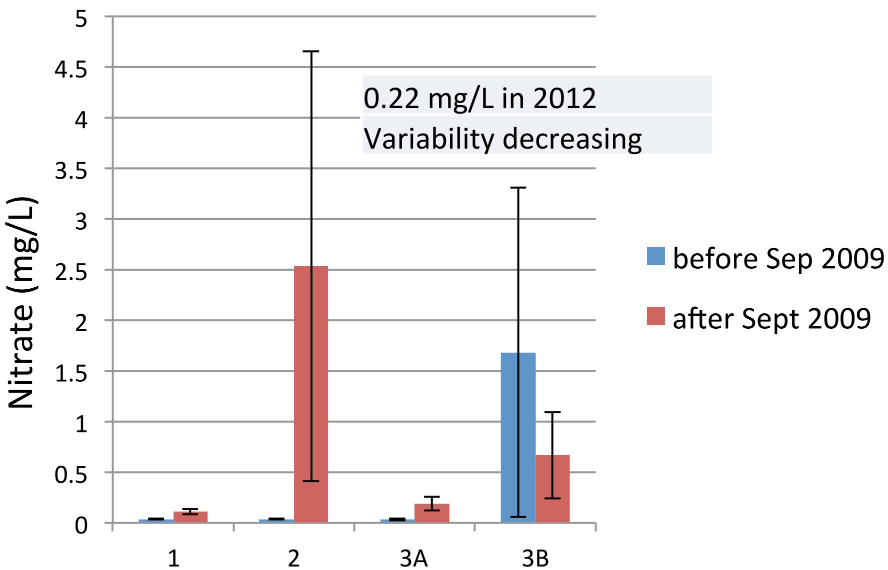
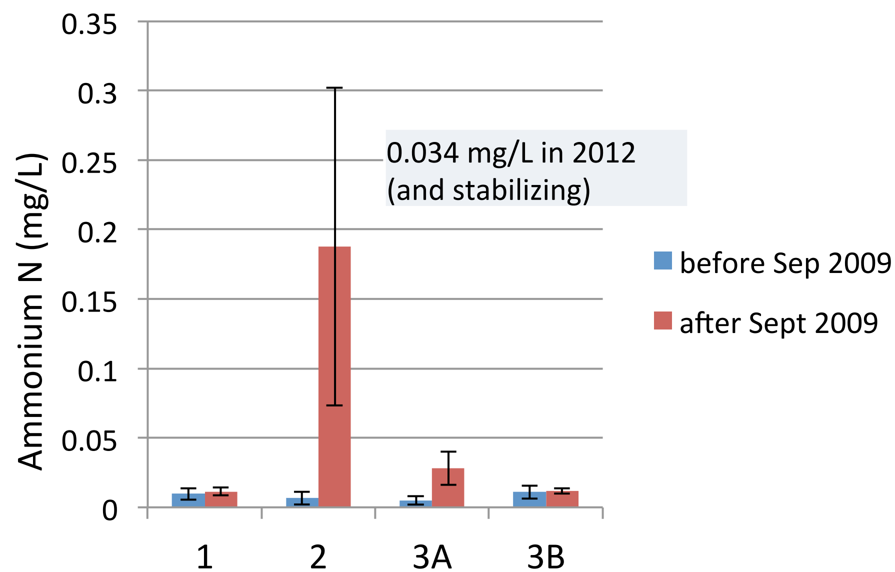
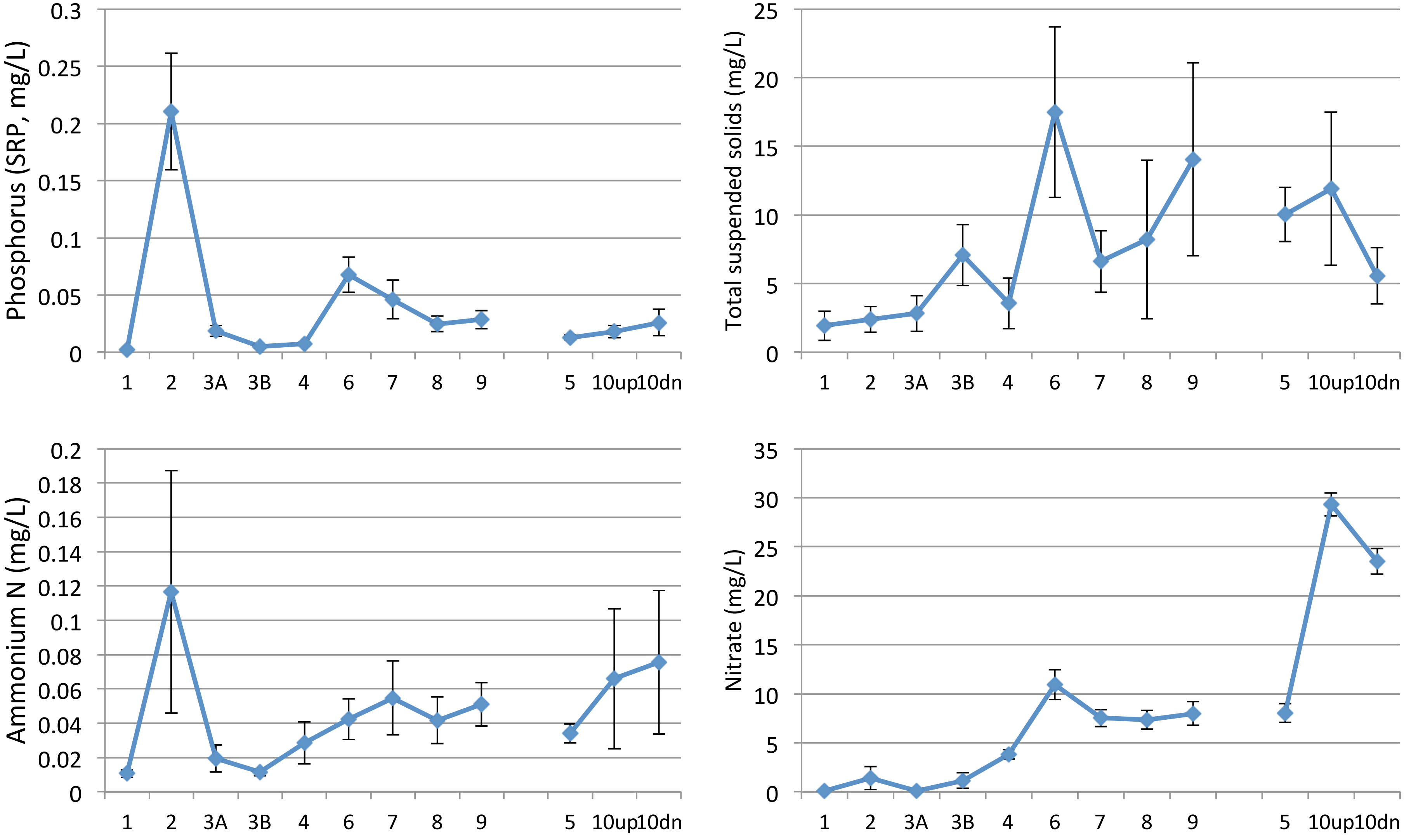




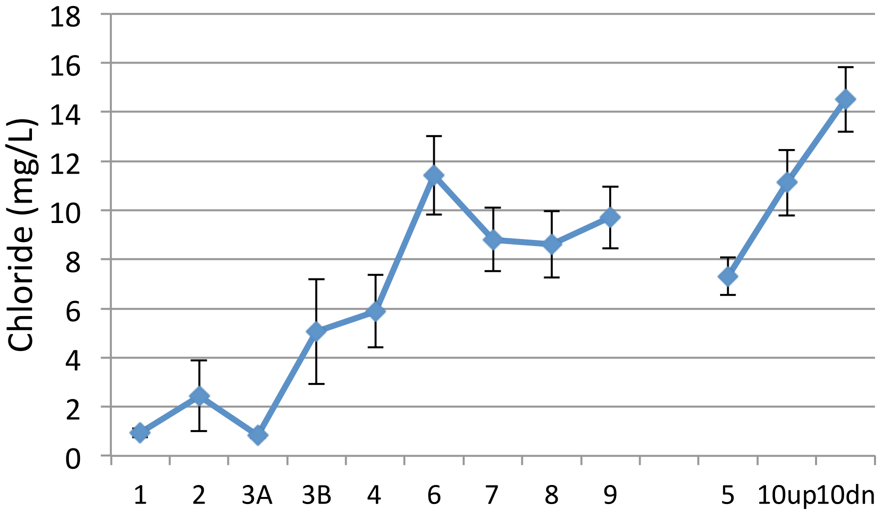


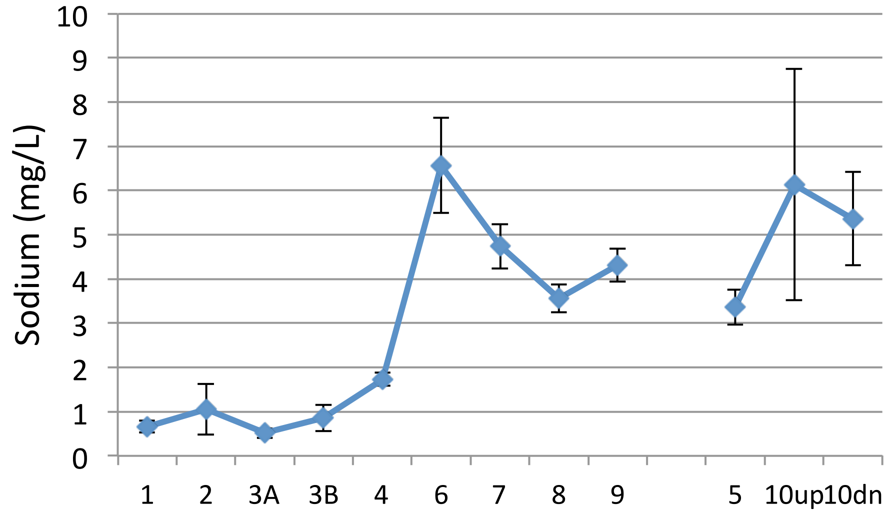


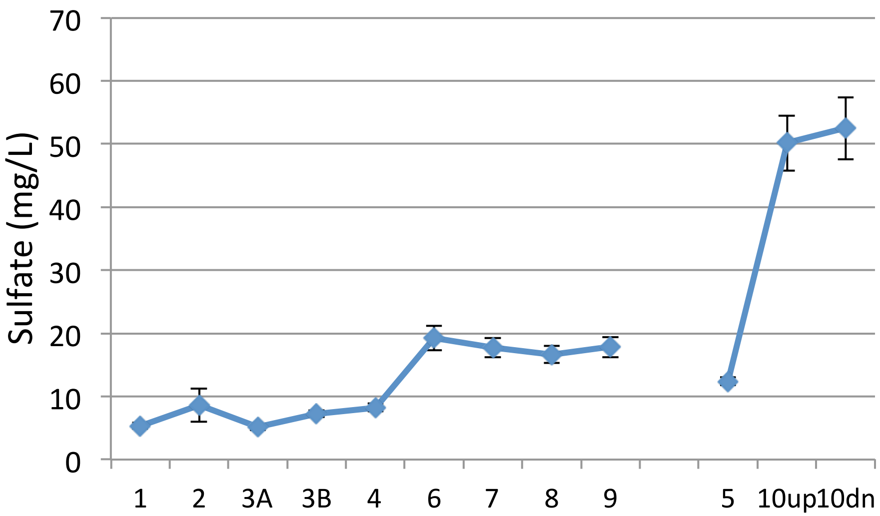
Downstream Trends – Land Use

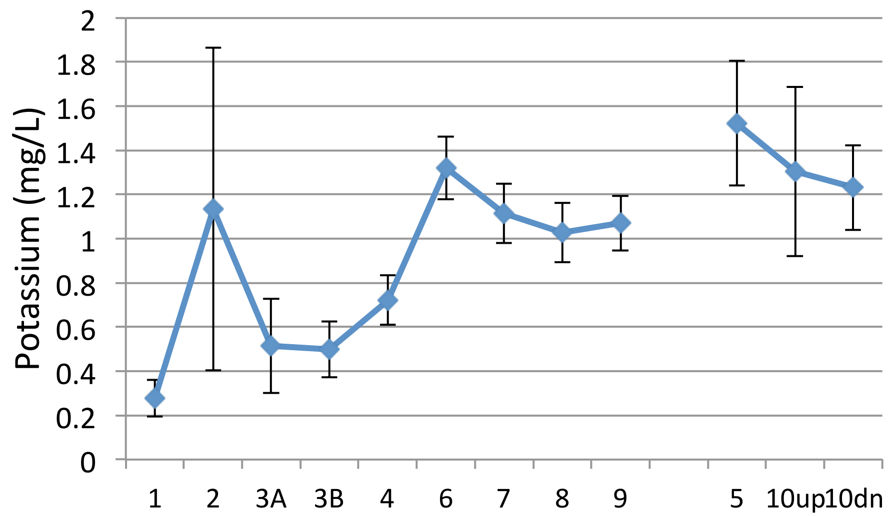


Downstream Trends – Human Development



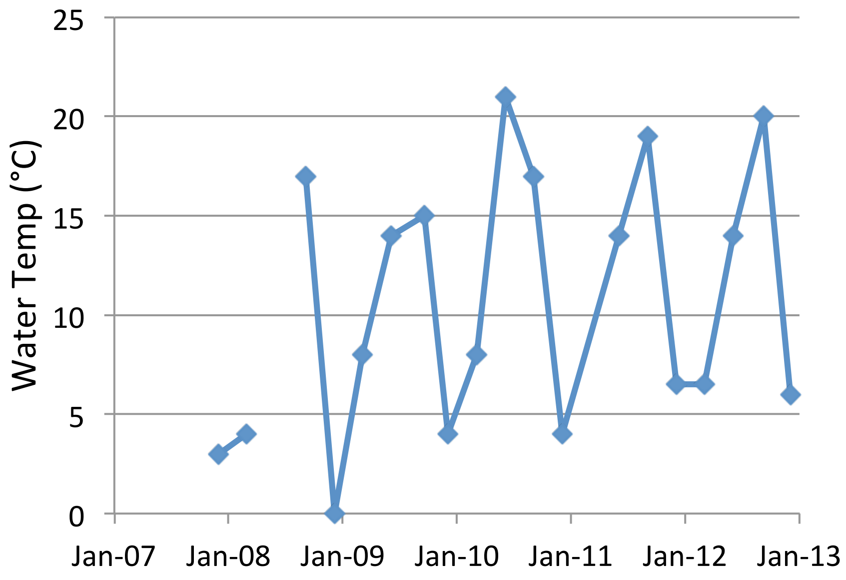


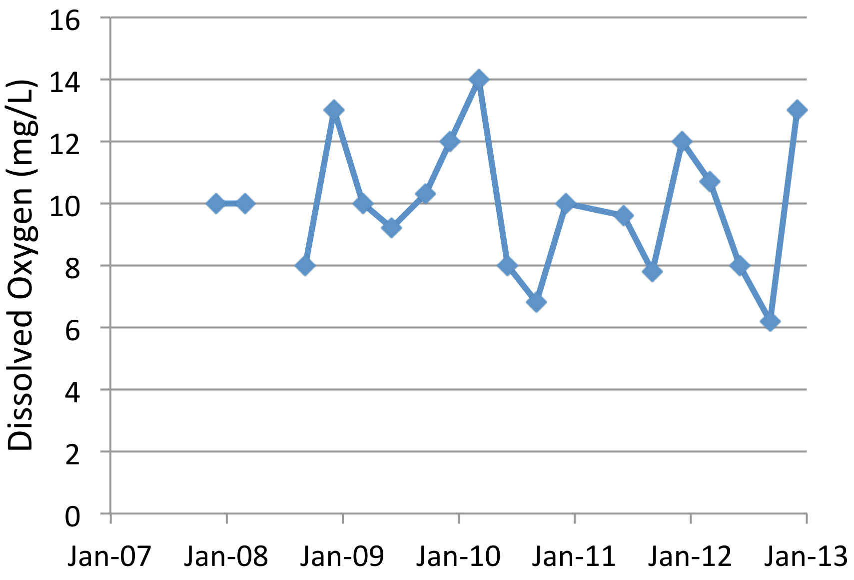




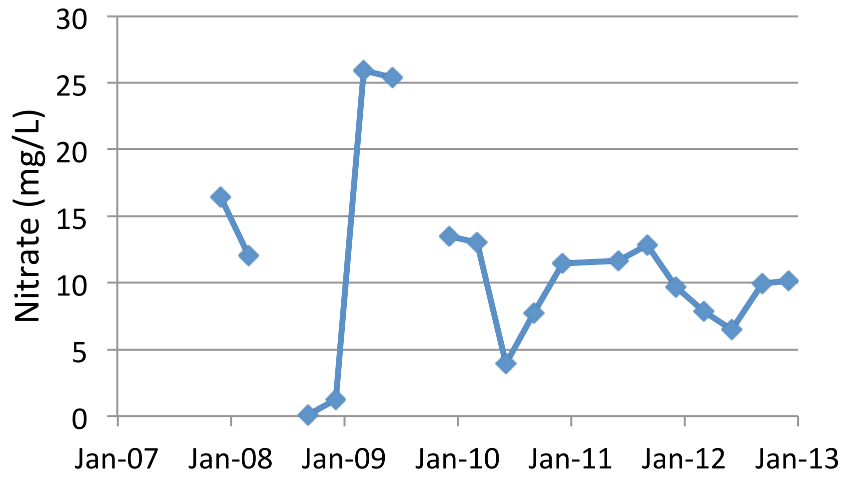
Temporal Variability – Site 6

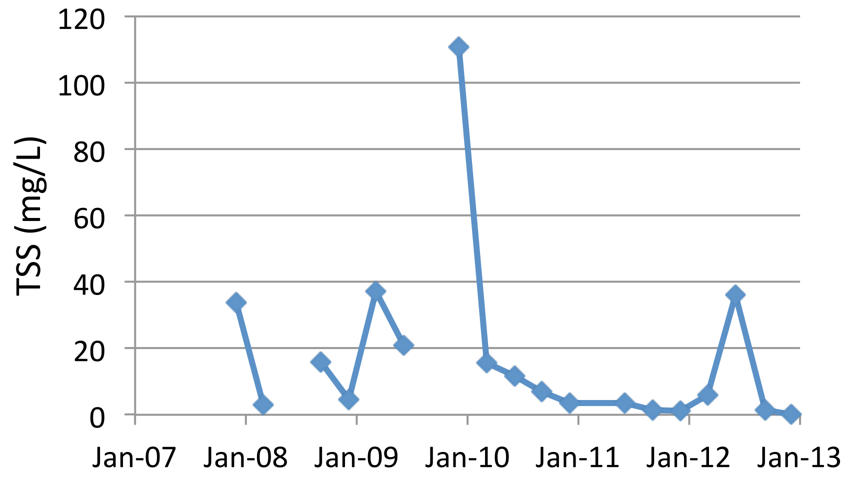
Example of variability in water quality over time (seasonality)

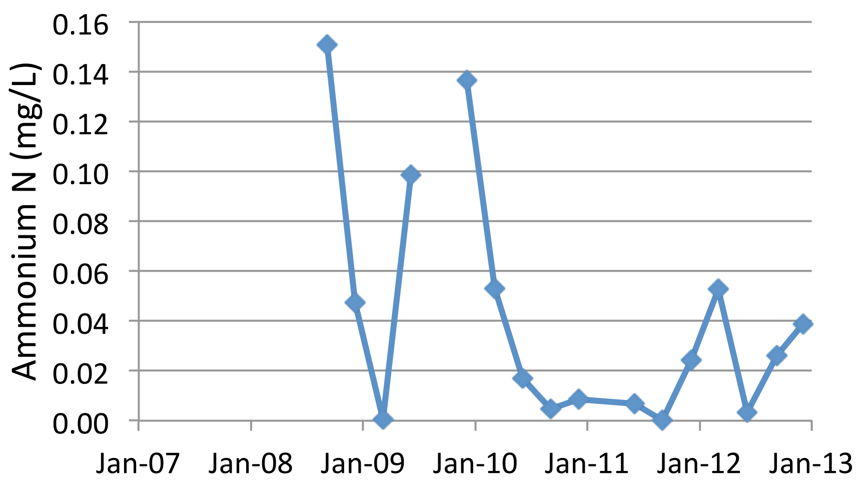


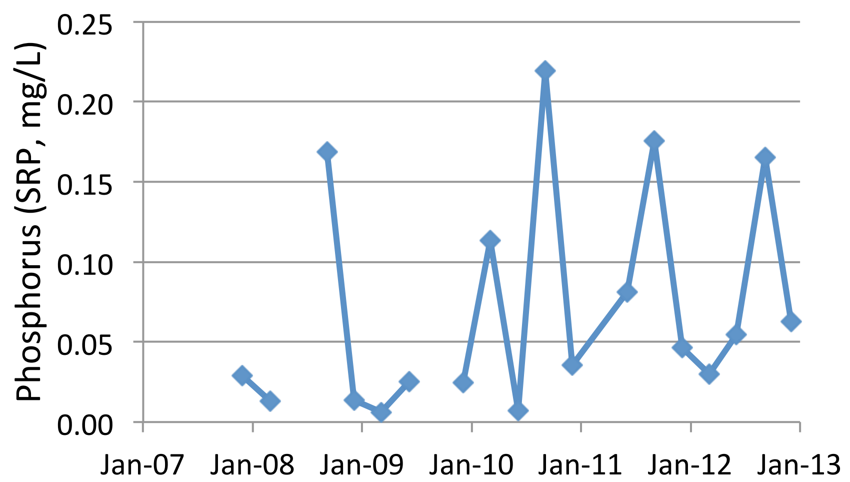


Temporal Variability – Site 6









Nitrate highly variable but declined in general

Ammonium was very high but declined halfway through 2010

Mifflinburg Sewage Treatment Plant upgraded with N-stripping technologies

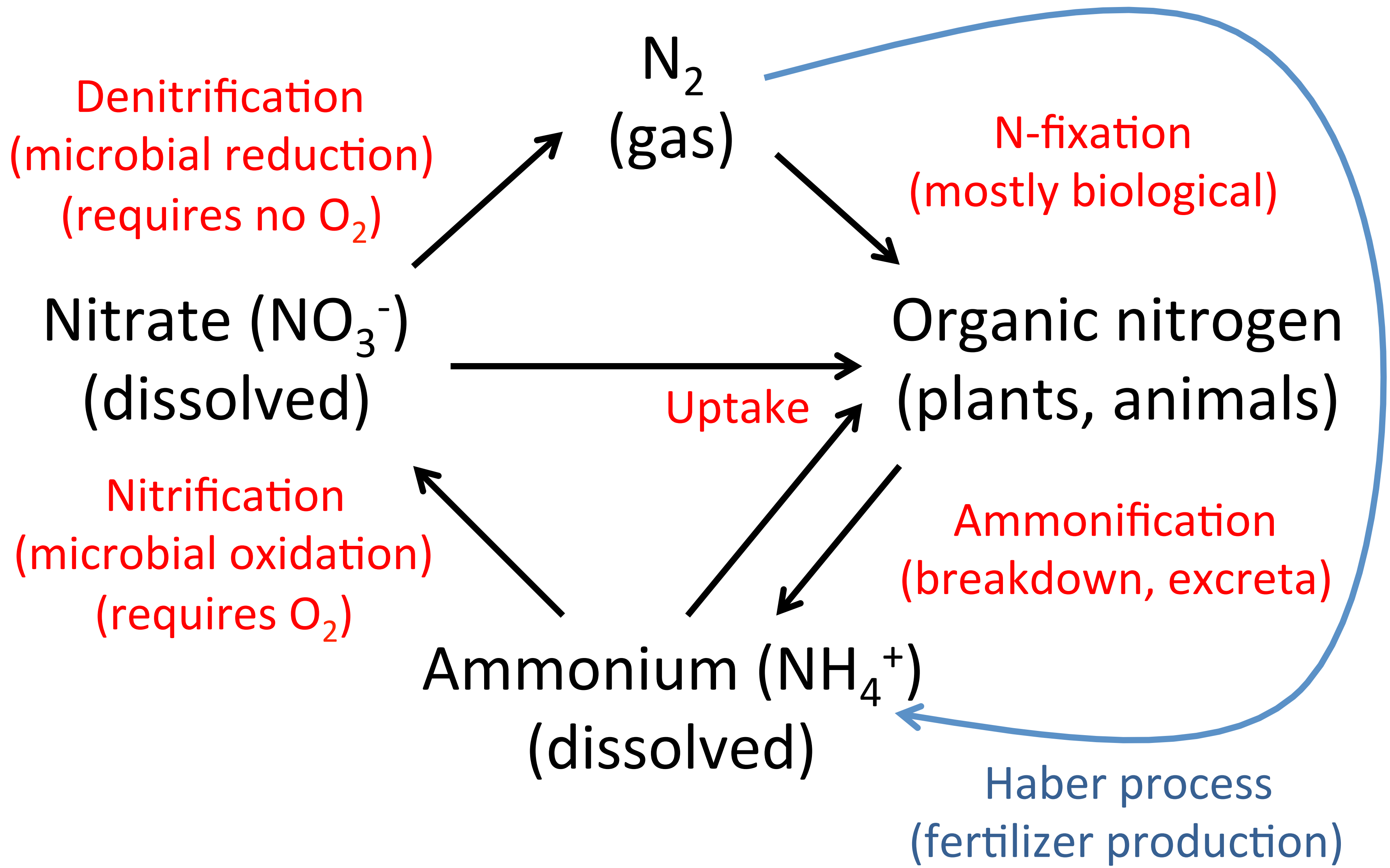
Every high point is in September

Lowest flow time (minimal dilution)

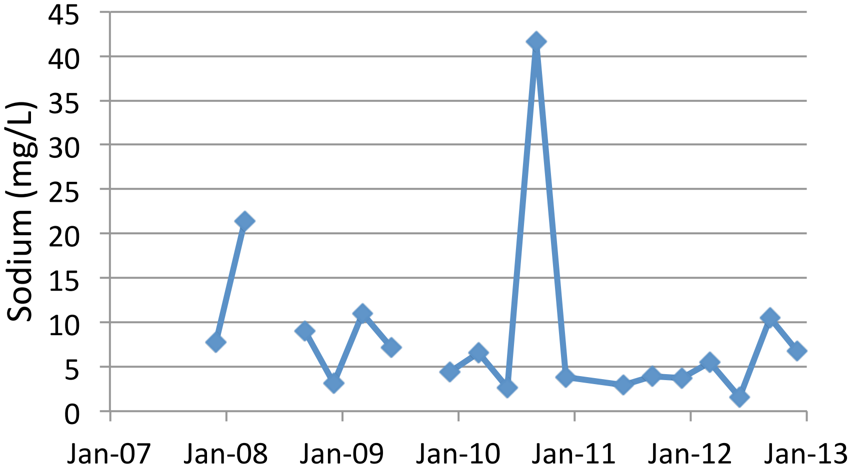
Active agriculture

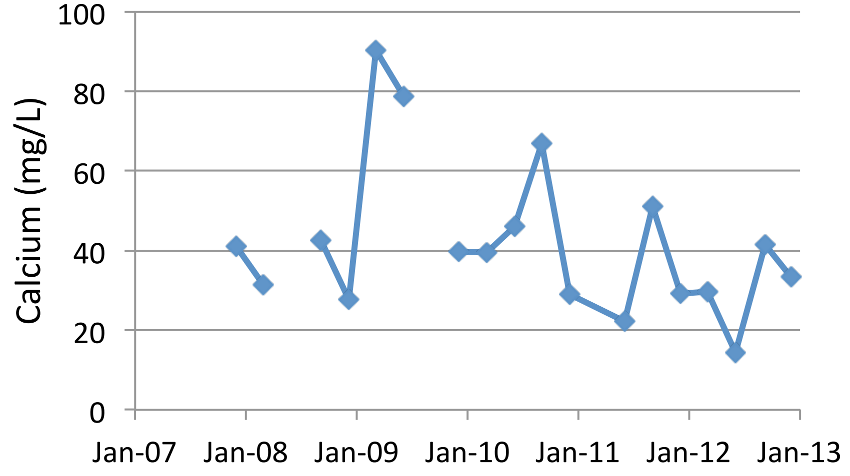
Lower TSS = SRP dissolved and not sediment-bound?

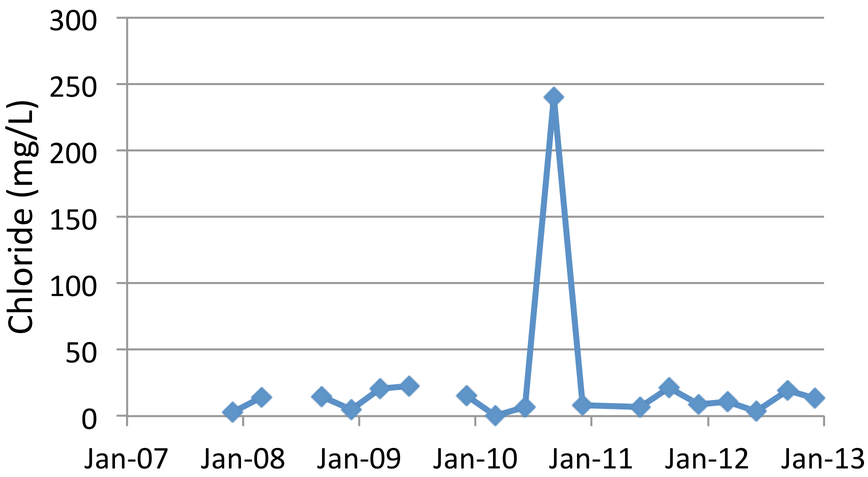
Nitrogen Cycling

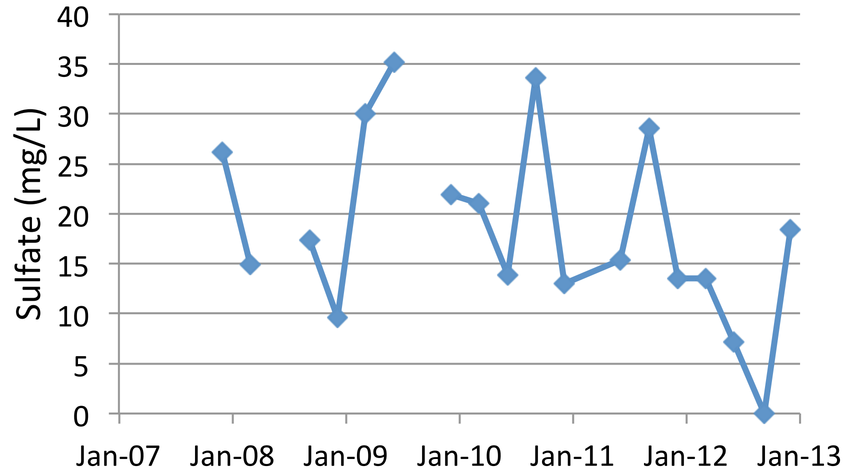


Temporal Variability – Site 6









Other influences of STP upgrade on water quality?

Na, Cl - increased temporarily but no long term increase

Other water quality values decreasing slightly (e.g., Ca, SO4)

Summary

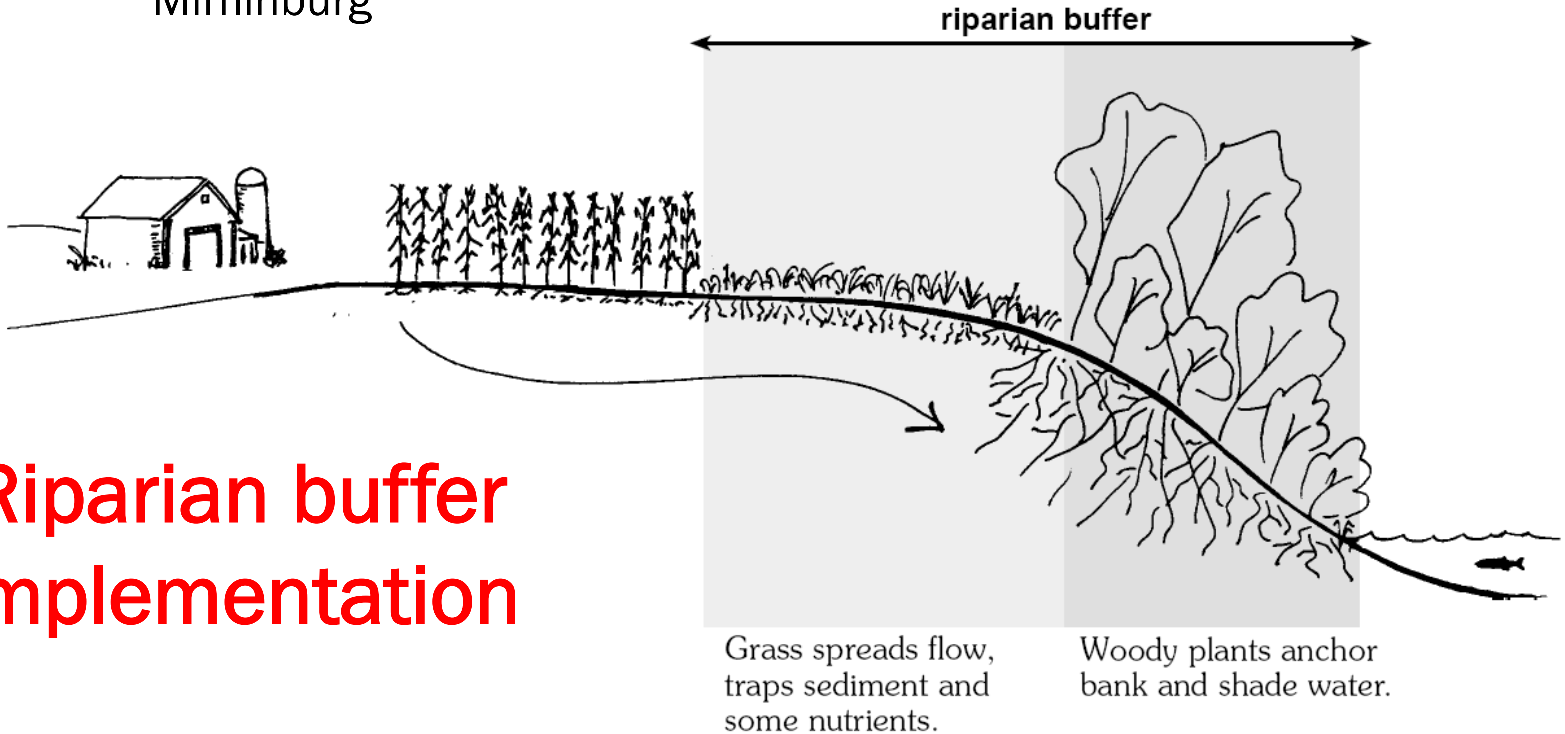
- Geology causes higher pH, alkalinity, and ionic concentrations downstream
- Human influences cause higher nutrient concentrations downstream
- Interannual variability makes determining long-term patterns in water quality difficult
- Acid remediation working well to elevate pH and alkalinity but with some temporary nutrient increase

Next steps for monitoring program

- Not calling for “Phase 3”
- Continue quarterly monitoring at long-term baseline sites (#s)
- Continue monitoring at acid remediation sites
- Consider monitoring additional sites (project or impaired) to have data pre and post treatment

Agricultural reach of Buffalo Creek near Mifflinburg

Riparian buffer implementation



Next steps for BCWA

- Fund intensive survey (including biota) from headwaters to mouth
- Assemble data set and “publication” collection from various projects and agencies over the past decade or so (Smithsonian; Bucknell – theses, classes, summer research; PA-DEP; fecal coliform testing; PA-FBC; US-FWS)

Trends (Phase 2 sites)

- What do the data show?
- Geologic changes (cations, alkalinity, pH)
- Acid precipitation and treatment
- Land use influences (nutrients, sediments – sites 5 and 10)
- Mifflinburg sewage treatment plant upgraded with nutrient reduction capacity (coupled nitrification and denitrification)

Long-term Trends

- Temp and DO = no change over time (seasonal and interannual variability)
- Alkalinity & pH = no change over time (interannual variability) other than in headwaters
- Calcium and Magnesium = slight decline over time (high flow years = dilution?) other than in headwaters
- Nutrients and TSS highly variable over time = flow-related (esp. TSS)
- Most other ions declining slightly with time… reason?