An exploration of streamflow and water chemistry patterns in urban waters

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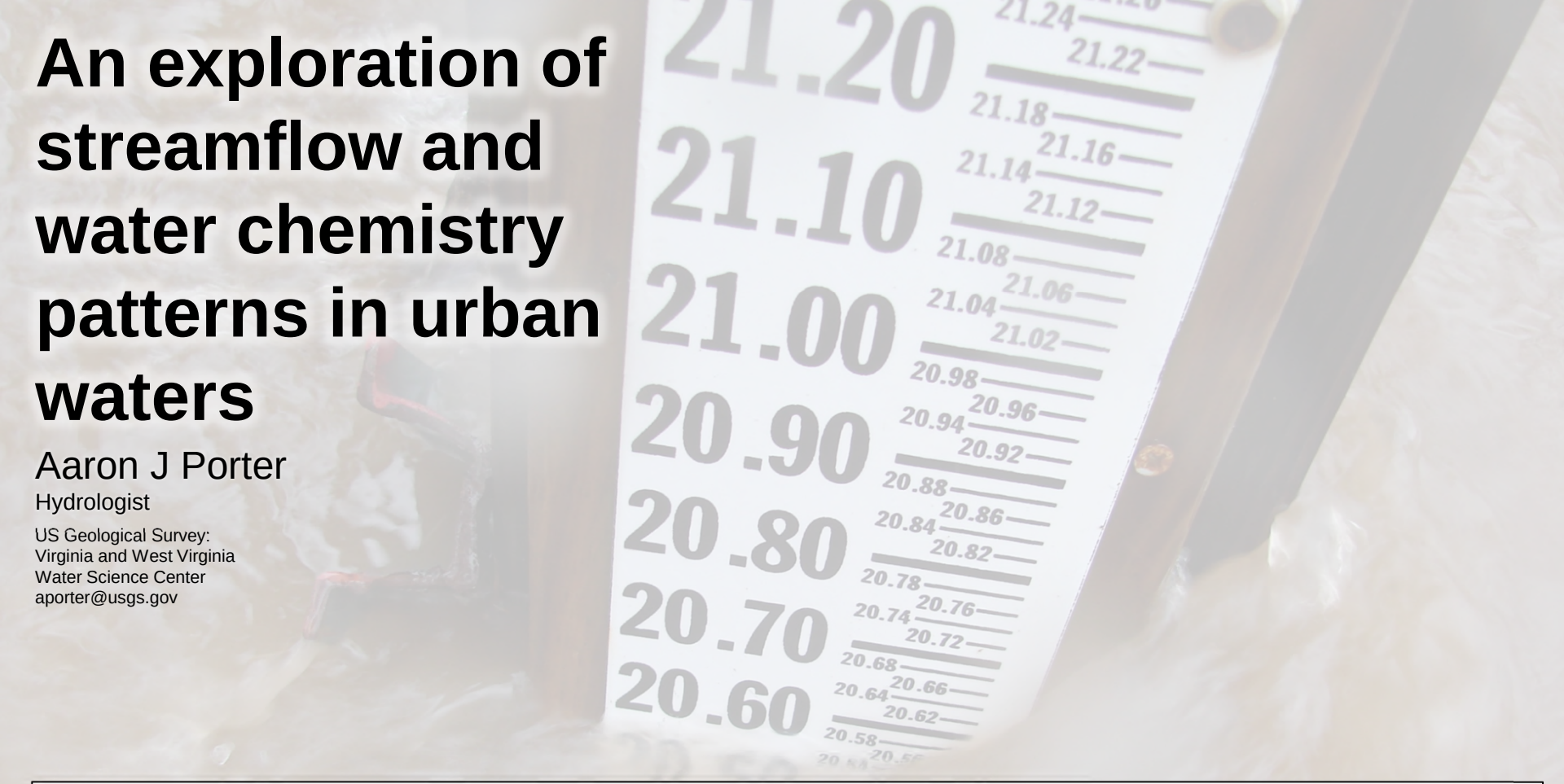
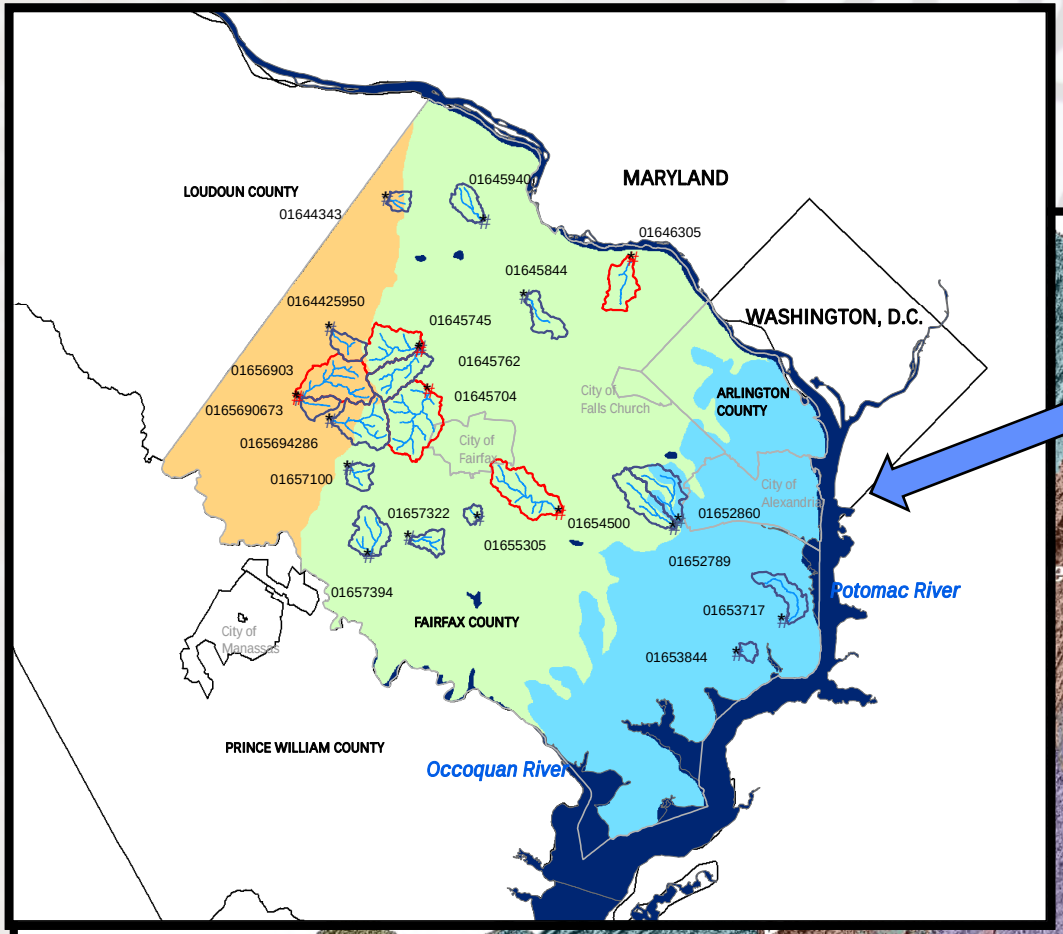
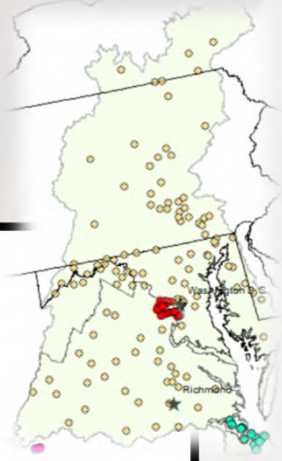


Fairfax County Monitoring Objectives

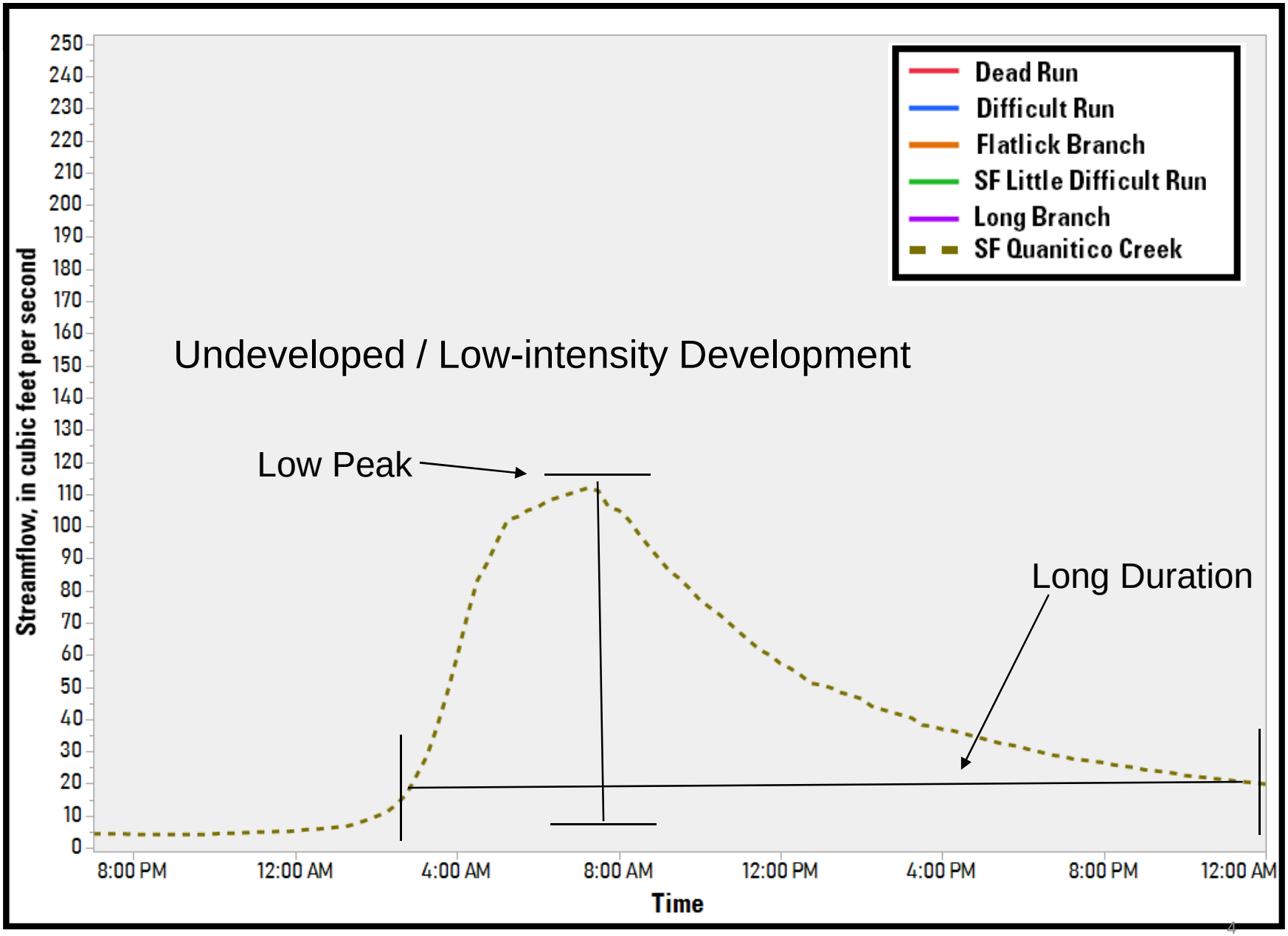
1. Determine how streamflow, water-quality, and benthic macroinvertebrates vary spatially *(across monitored watersheds)* and temporally *(seasonally/annually)*
2. Compute annual nutrient and sediment loads and analyze trends
3. Link changes in streamflow, water-quality, and benthic macroinvertebrates to changes in the landscape (e.g. development, BMPs)






Streamflow

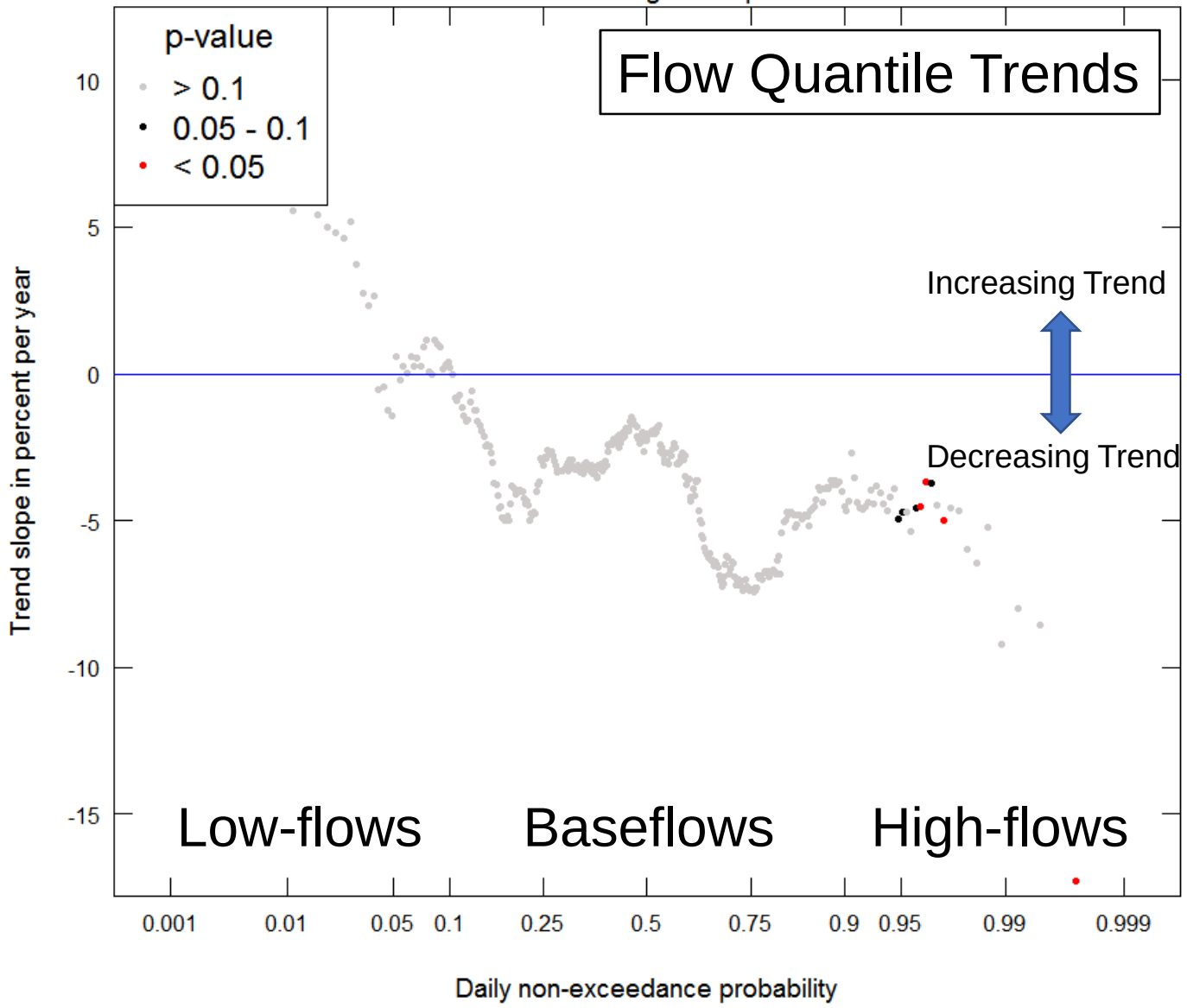
Storm Peak and Duration



DIFFICULT RUN ABOVE FOX LAKE NEAR FAIRFAX, VA
2007-10-01 through 2017-09-30

S F LITTLE DIFFICULT RUN ABOVE MOUTH NR VIENNA, VA
2007-10-01 through 2017-09-30

DIFFICULT RUN ABOVE FOX LAKE NEAR FAIRFAX, VA
2007-10-01 through 2017-09-30
Year Starting With April



Trend slope in percent per year

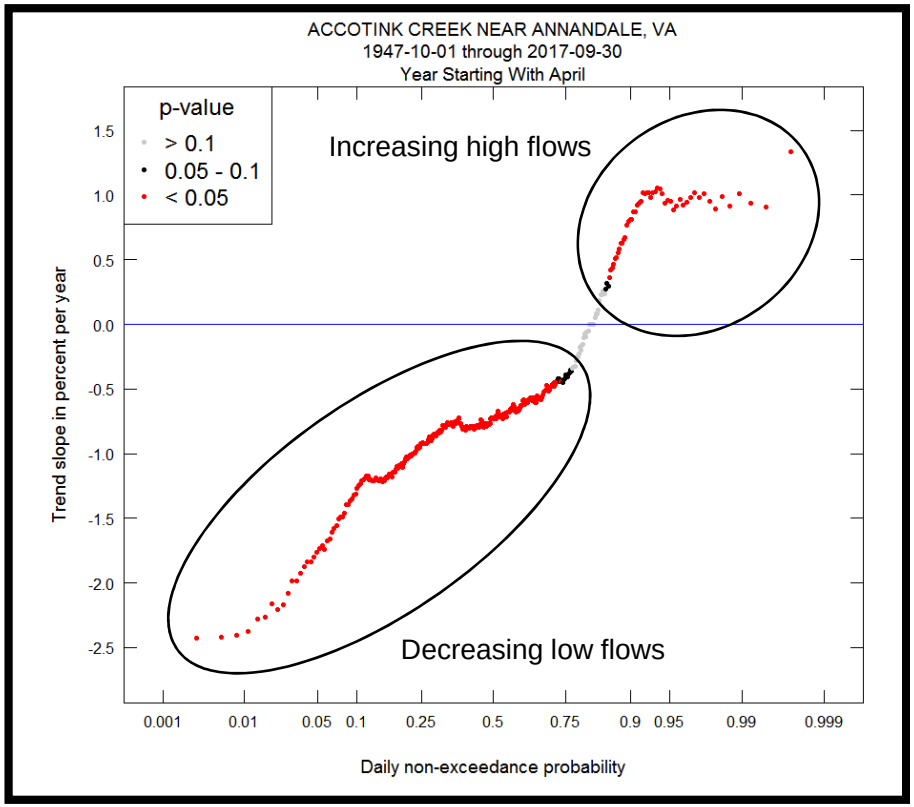
Daily non-exceedance probability

Trend slope in percent per year

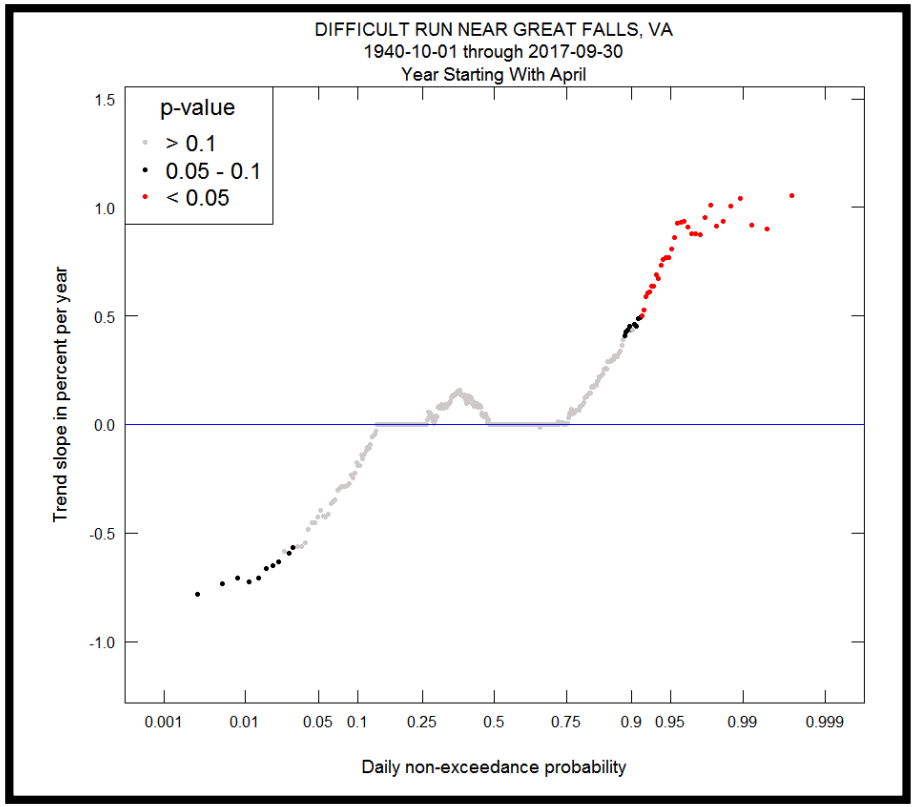
Daily non-exceedance probability

Long-Term Monitoring (70+ years)

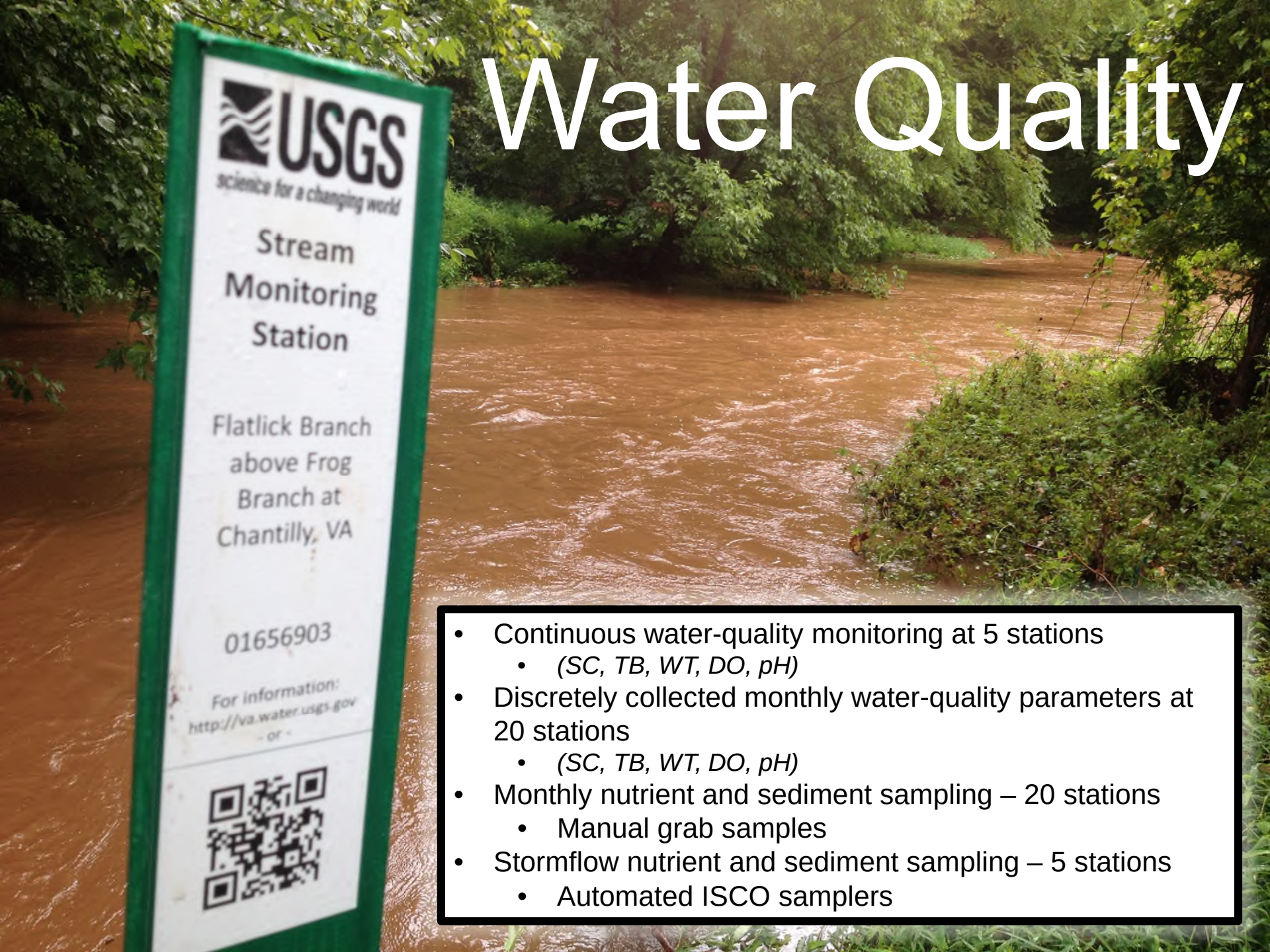
Accotink Creek near Annandale, VA



Difficult Run near Great Falls, VA



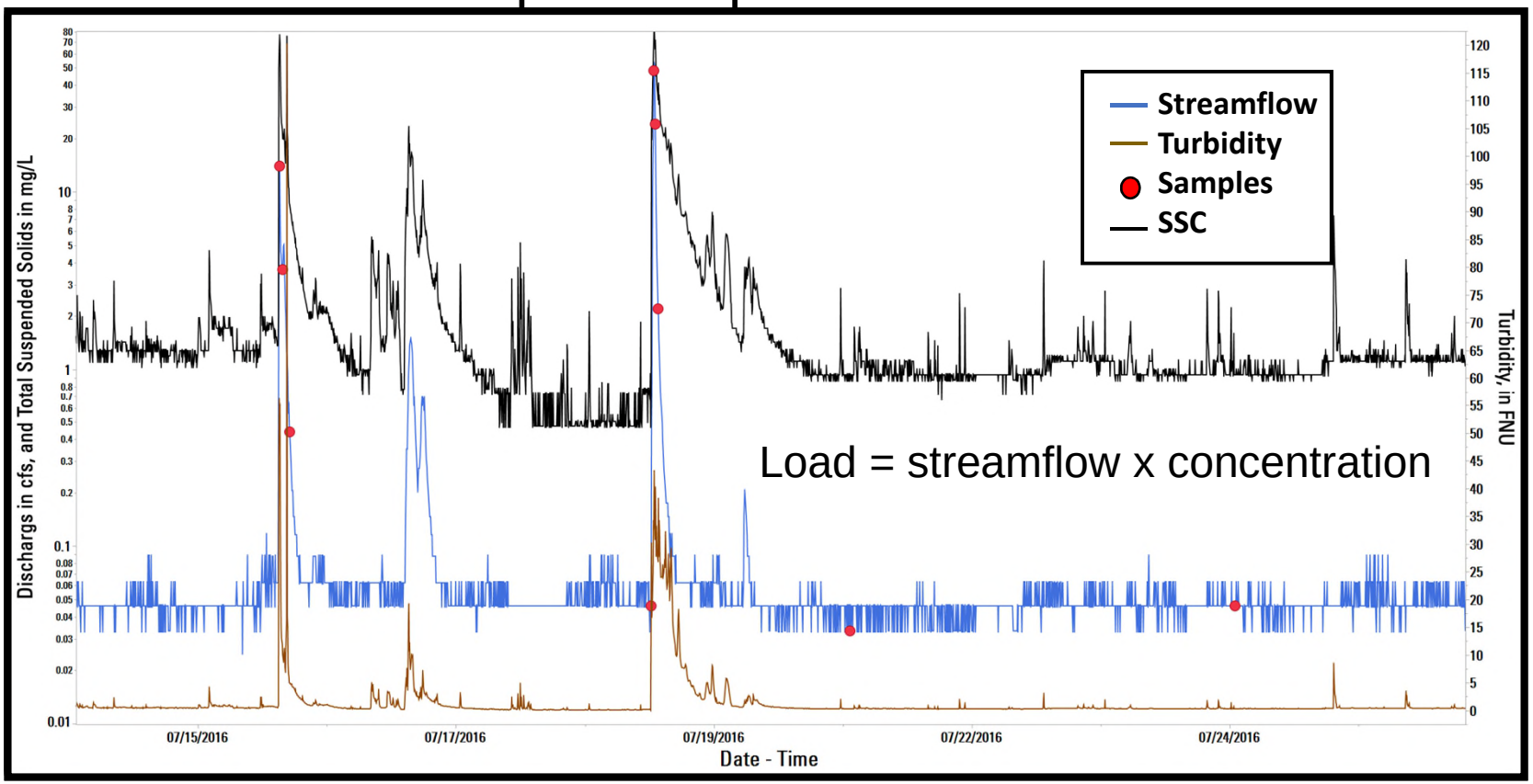
Water Quality



- Continuous water-quality monitoring at 5 stations
  - *(SC, TB, WT, DO, pH)*
- Discretely collected monthly water-quality parameters at 20 stations
  - *(SC, TB, WT, DO, pH)*
- Monthly nutrient and sediment sampling – 20 stations
  - Manual grab samples
- Stormflow nutrient and sediment sampling – 5 stations
  - Automated ISCO samplers

Surrogate Regression Modeling

Example: Suspended Sediment

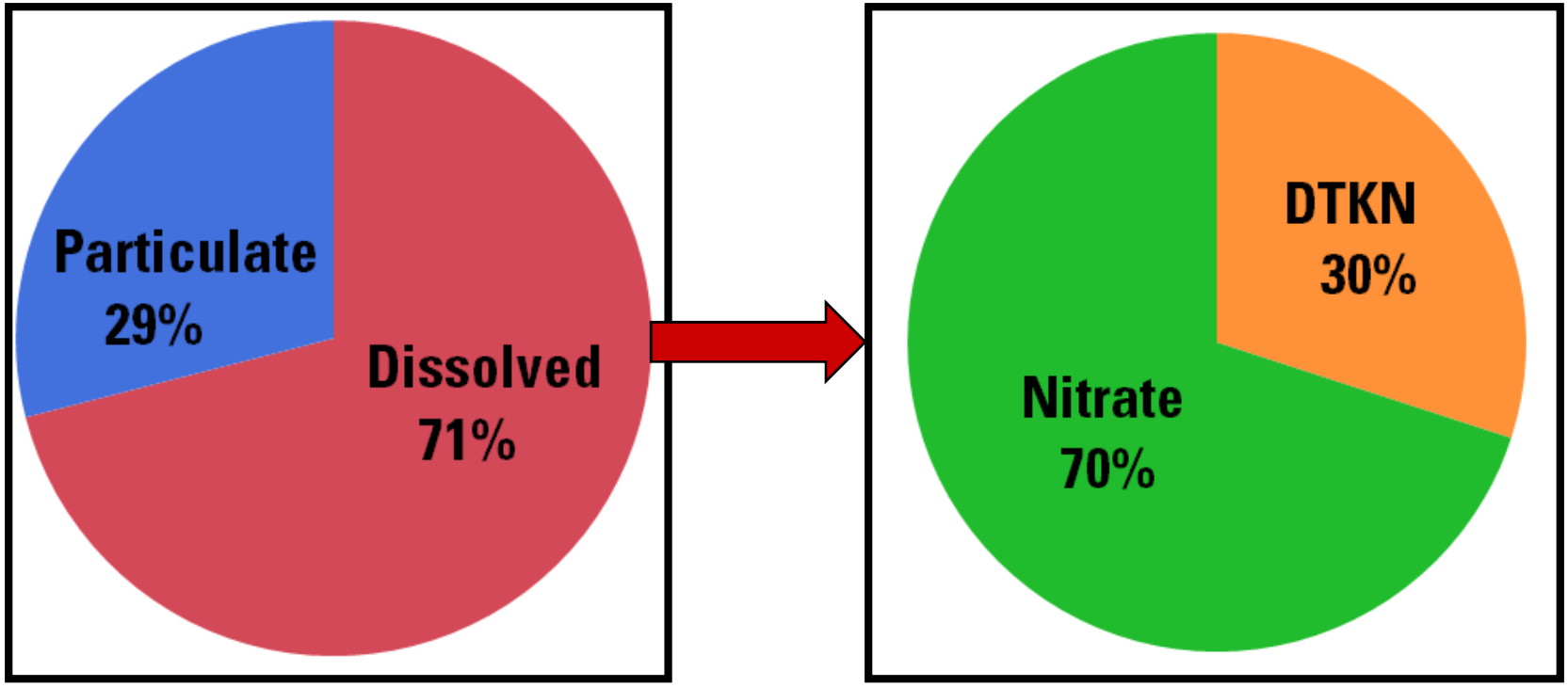


Station-specific models developed for:

Suspended Sediment, Total N, Total Dissolved N, Total Particulate N, Nitrate + Nitrite, Total P, Total Dissolved P, and Total Particulate P

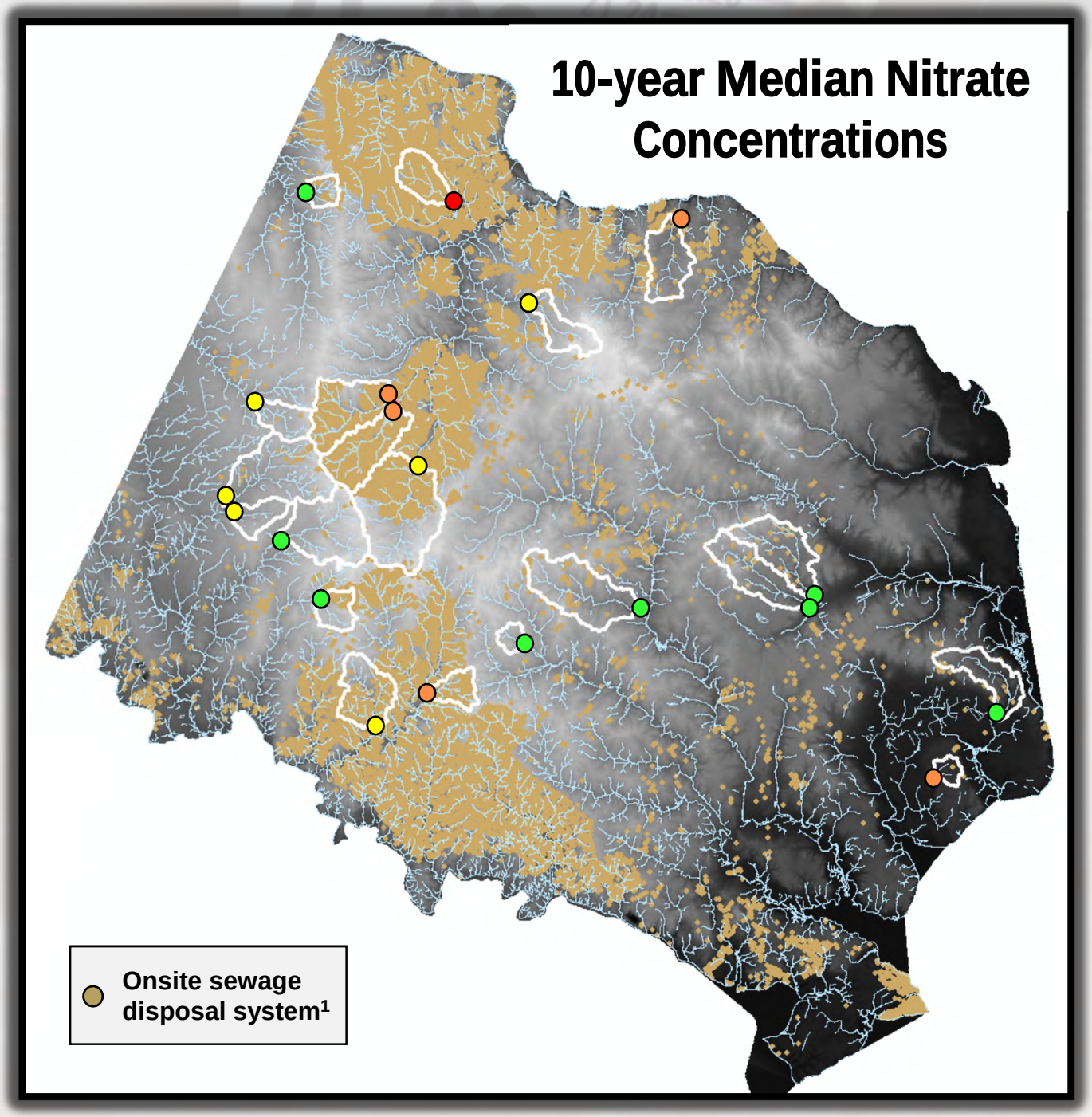
Composition of Nitrogen Loads

- *Total Nitrogen primarily dissolved*
- *Dissolved N primarily Nitrate*



Nitrate, as well as orthophosphate, is a key limiting nutrient of phytoplankton growth in Chesapeake Bay –Fisher and others, 1992

Thomas R. Fisher, Emily R. Peele, James W. Ammerman and Lawrence W. Harding Jr. *Marine Ecology Progress Series,* Vol. 82, No. 1 (May 14 1992), pp. 51-63.



[1]Active onsite sewage disposal systems supplied by Paul Shannon on 7/17/2018

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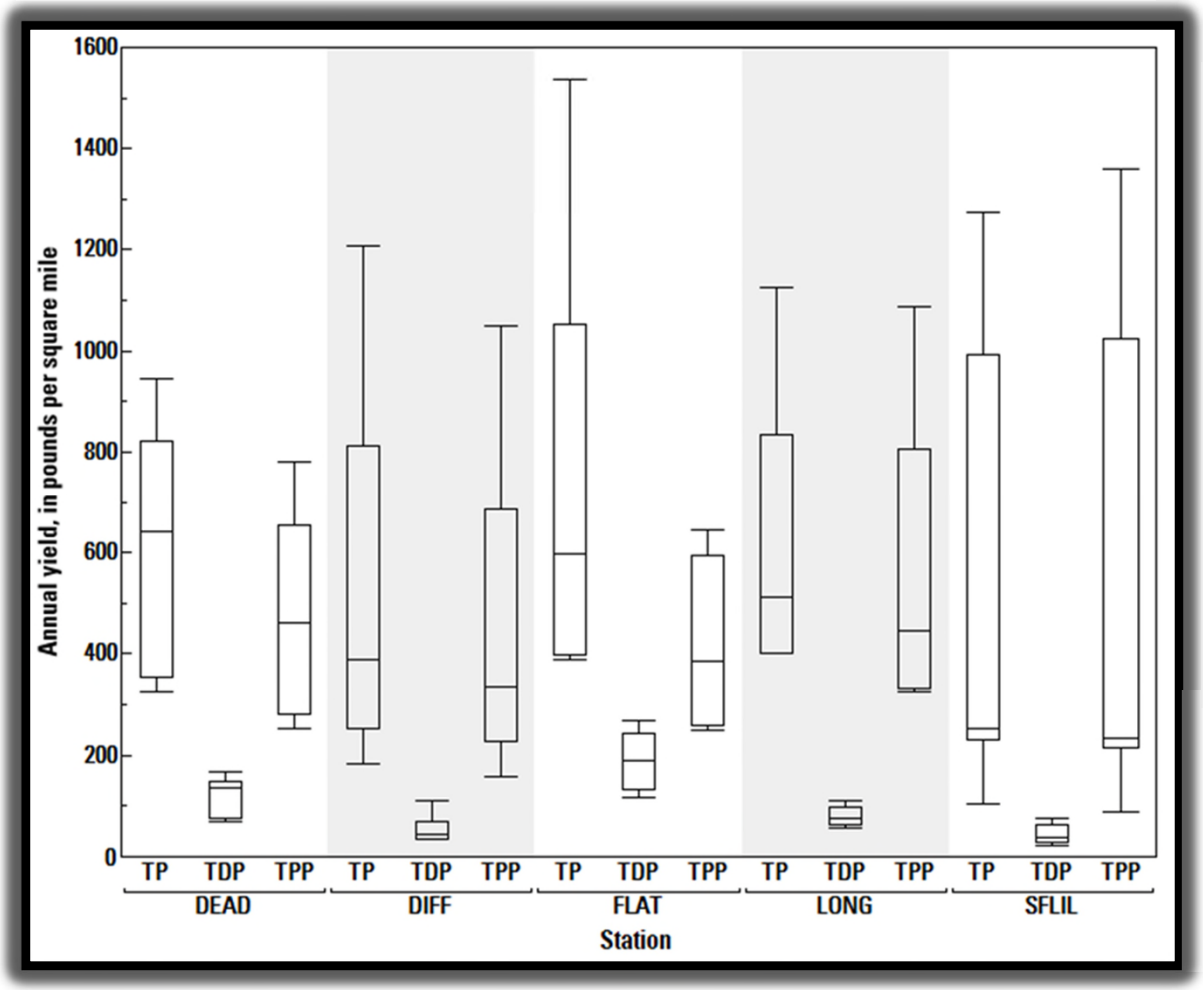
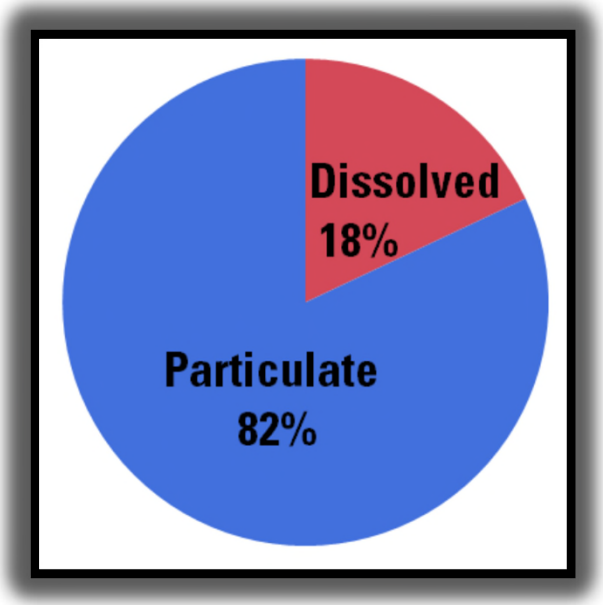
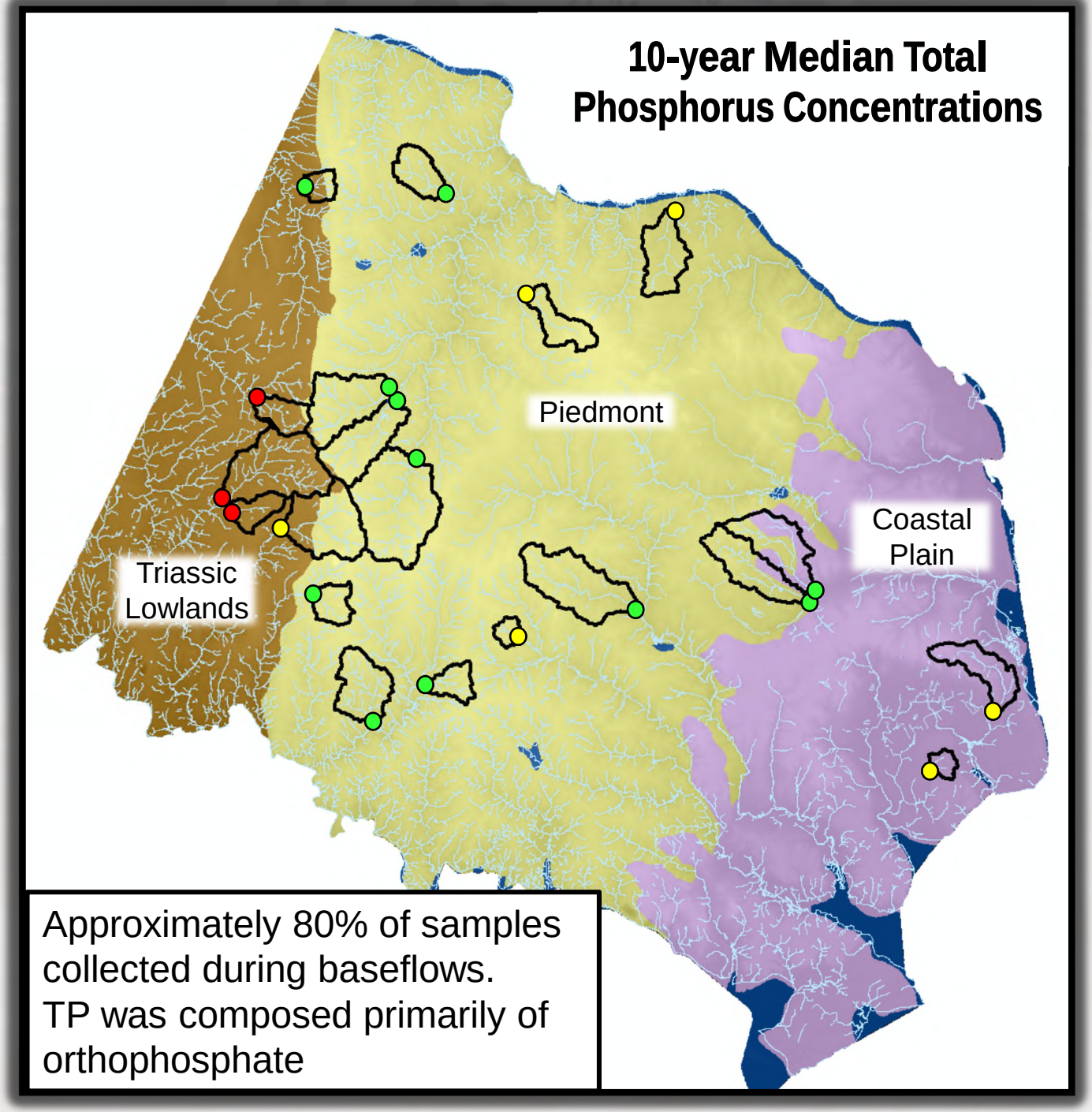
Composition of Phosphorus Loads





Phosphorus primarily transported via suspended particulates

Substantial inter-annual variability due to annual precipitation volume and intensity



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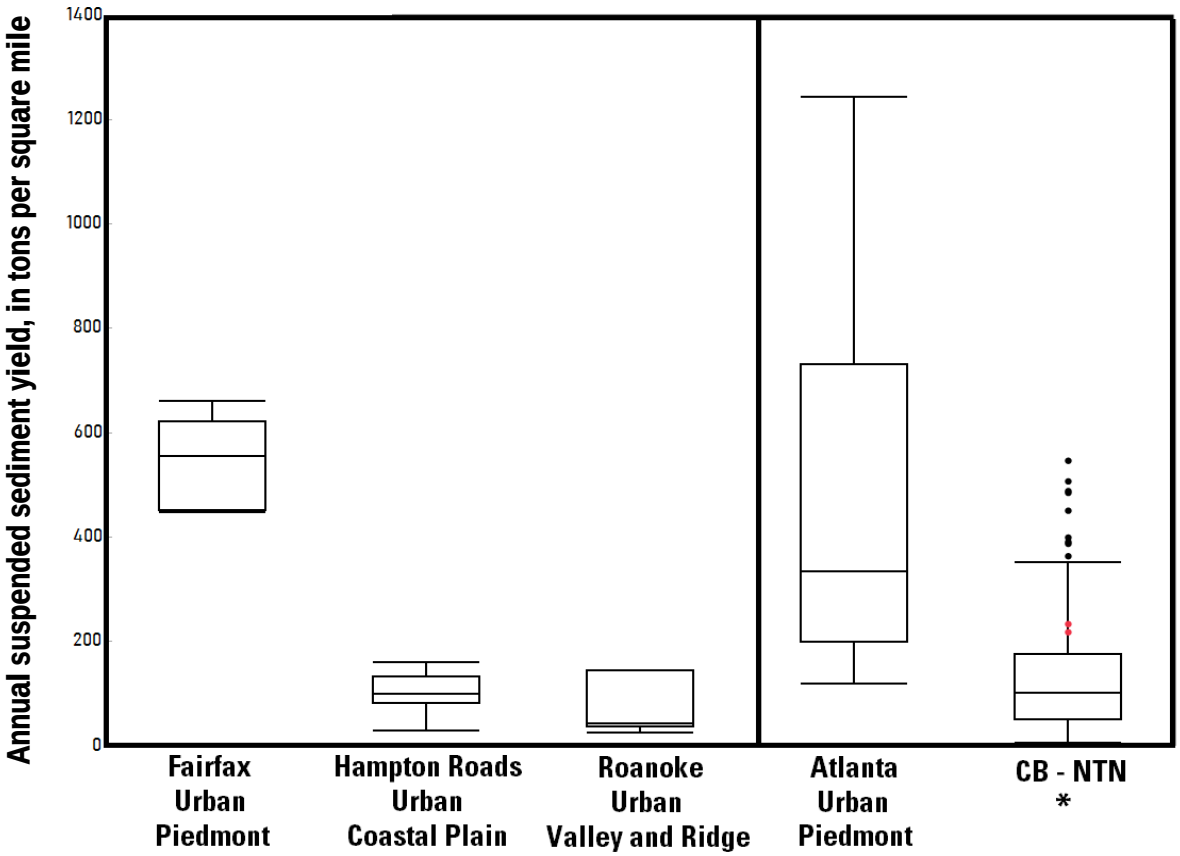
Lee, K.Y and Froelich, A.J., 1989, Triassic-Jurassic stratigraphy of the Culpeper and Barboursville Basins, Virginia and Maryland: U.S. Geological Survey Professional Paper 1472, 52 p.

Comparison of Sediment Yields



Important factors affecting sediment yielding rates
1. Source pools/availability
2. Land use/land cover
3. Topographic relief
4. Stream order

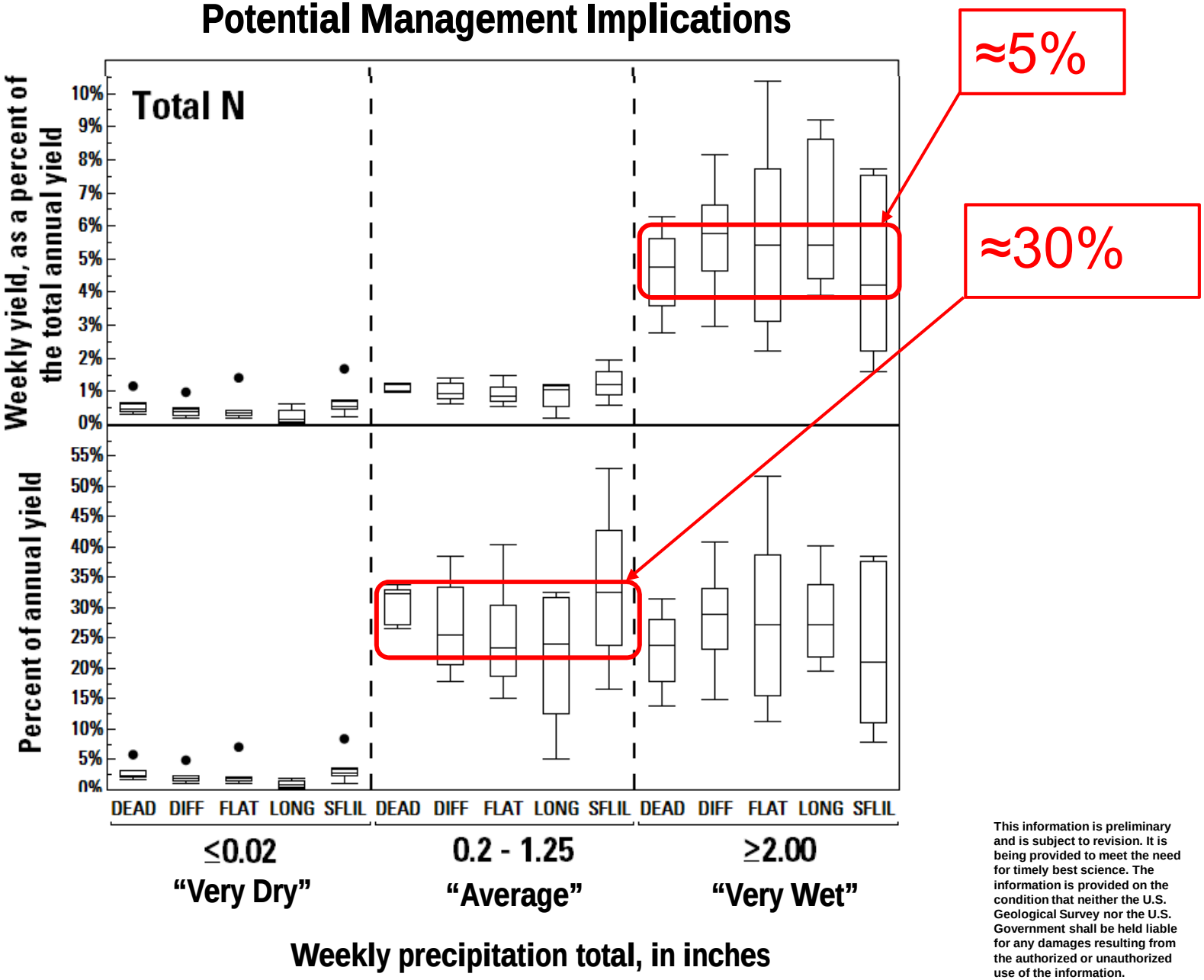
- **Piedmont – Fairfax County**: moderate topographic relief, large pools of legacy sediments, urbanization
- **Coastal Plain – Hampton Roads**: low topographic relief, largely sand
- **Valley and Ridge - Roanoke**: High topographic relief, shallow soils – reduced source pools

- In Piedmont, pre-colonial geologic rates of erosion were low
- Centuries of agriculture led to accumulation of legacy sediments
- Modern sediment yields are highest in the Piedmont region irrespective of current land uses

Gellis, A.C., and others, 2009, Sources, transport, and storage of sediment in the Chesapeake Bay Watershed: U.S. Geological Survey Scientific Investigations Report 2008–5186, 95 p.

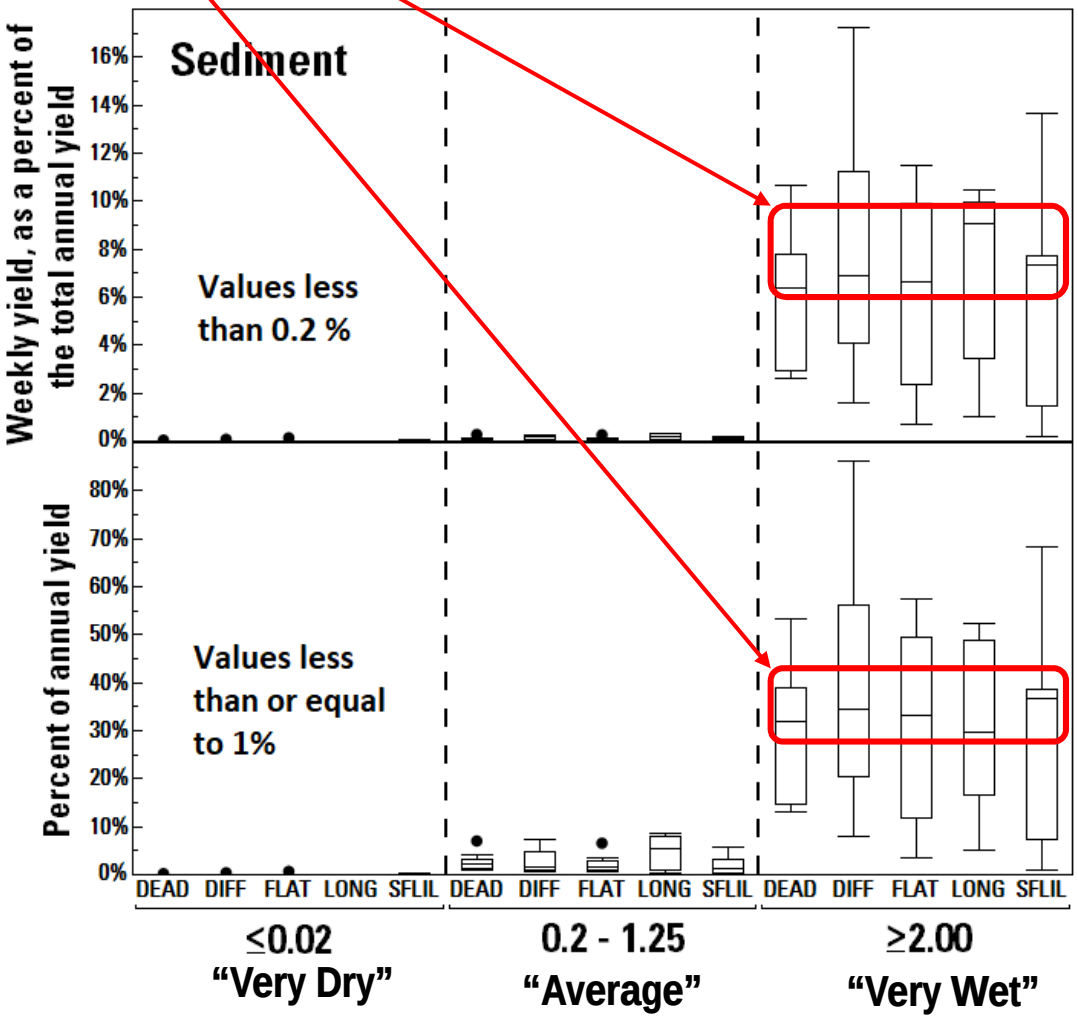
* Mix of Land Types
Mix of Physiographic Provinces
Larger Watersheds

Precipitation - Constituent Yield Relations:
Potential Management Implications



Precipitation - Constituent Yield Relations:
Potential Management Implications

≈35%
≈8%



-No silver bullet for load reduction

-Some constituents may be best mitigated with upland BMPs

-Upland BMPs such as wet or dry ponds can become inefficient/ineffective during large storms

-Stream restoration may represent an alternative by altering hydrologic processes and limiting stream bank/bed erosion.

-Fairfax County has made substantial investments in stream restoration projects

In Closing…

<u>Fairfax County streams show many key symptoms of urbanization</u>

- Increased peak flows, decreased baseflows
- “Flashy” storm hydrographs
- Hotspots of elevated nutrient inputs
- Altered stream geomorphology and stability (high sediment loading rates)
- Issues which require a variety of watershed management strategies

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