

SURFACE WATER NUTRIENT IMPACTS: WHY SO VARIABLE?

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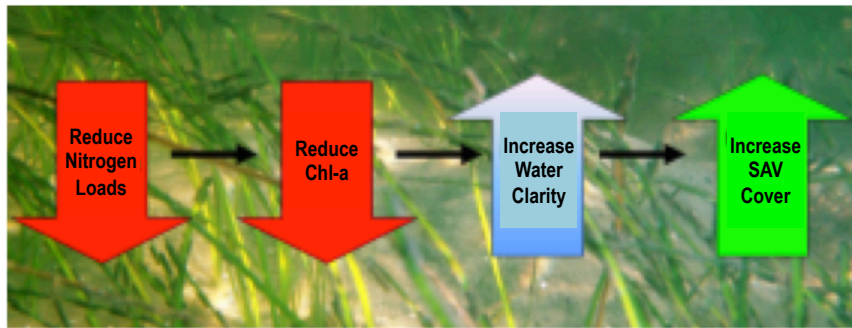


01 **NUMERIC NUTRIENT CRITERIA**

02 **WHY SO VARIABLE?**

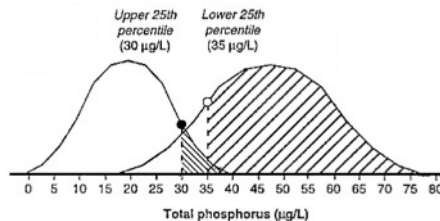
03 **UTILITY OF WATER QUALITY MODELS**

04 **SUMMARY**



NUMERIC NUTRIENT CRITERIA (NNC)

- EPA started developing NNC guidance & recommendations in 2000-2001 for rivers, lakes & estuaries
- Range in methods varies
 - Gather all TN/TP data for an ecoregion & select the 25th percentile
 - Gather “unimpacted” TN/TP data for an ecoregion & select 75th percentile
 - Correlations between biological effects & nutrients
 - Reference conditions / sites
 - Water quality modeling
- Summary of correlation methods
 - Lakes – OK, River/Streams – Not OK, Estuaries - Complicated



United States
Environmental Protection Agency

Office of Water
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Nutrient Criteria Technical Guidance Manual

Estuarine and Coastal Marine Waters

United States
Environmental Protection
Agency

Office of Water
Office of Science and Technology
Washington, DC 20460

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Nutrient Criteria Technical Guidance Manual

Rivers and Streams

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Nutrient Criteria Technical Guidance Manual

Lakes and Reservoirs

NUTRIENT EFFECTS

- Nutrients do not behave as toxics
 - Toxics follow dose-response relationships; nutrients are much more complicated
- Nutrient are like BOD, they are the cause of an effect (algal growth, DO depletion, reduced transparency)
 - For BOD, DO standards were developed not BOD criteria
 - Models used to relate BOD loading (cause) to DO effect for developing WLA
- Nutrients should follow the same procedure
 - Not treated solely as causal criteria but must consider effects criteria
 - Effects criteria include: algal growth, DO depletion, transparency reduction & other more subtle impacts (e.g., eelgrass effects, HABs)

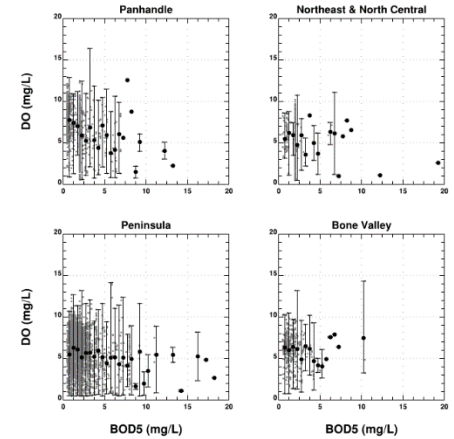


Figure 3. FDEP IWR DO and BOD5 Data (1995-2009)

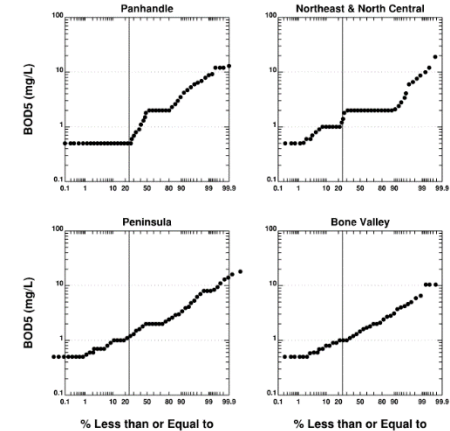
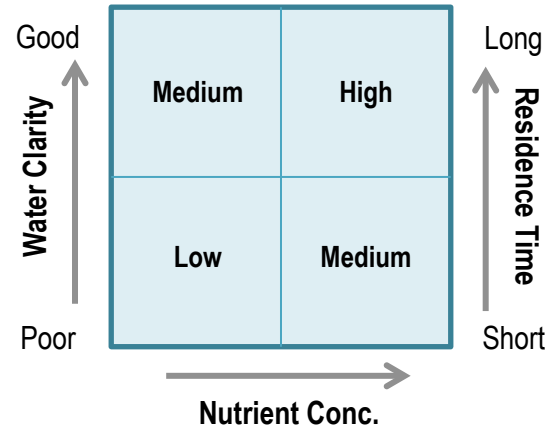
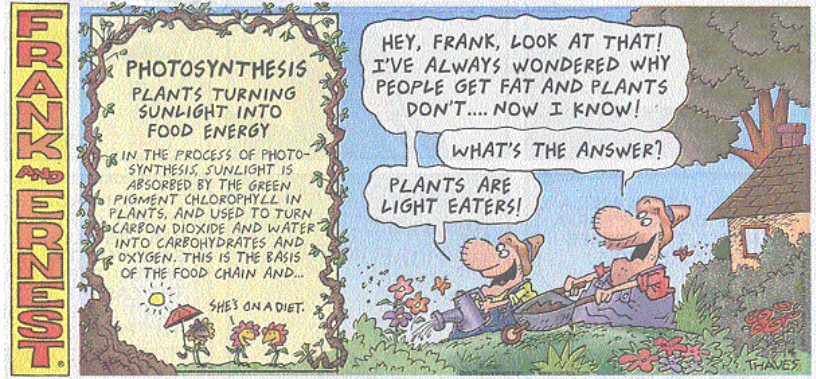


Figure 4. BOD5 Criteria Development Example (1995-2009)

WHAT CONTROLS NUTRIENT EFFECTS?

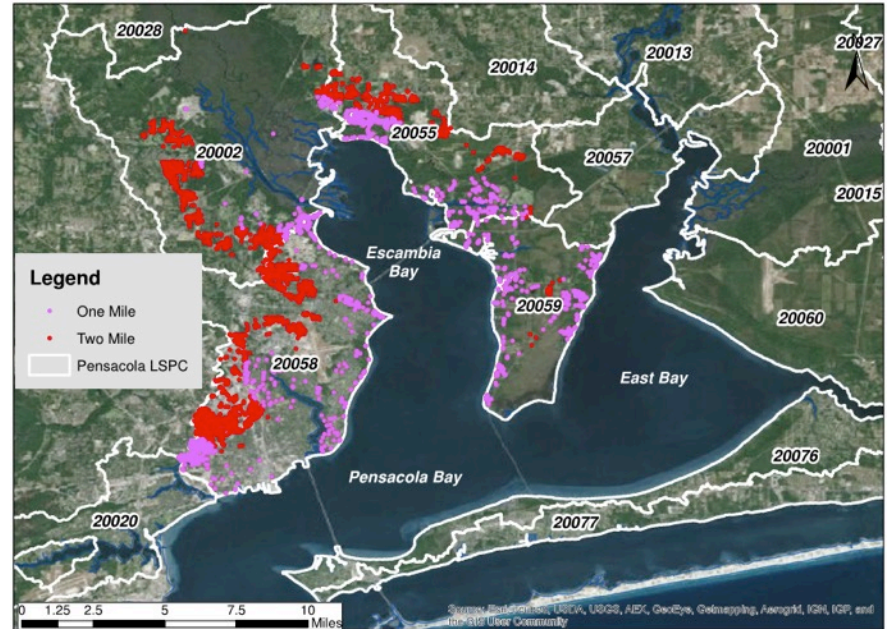
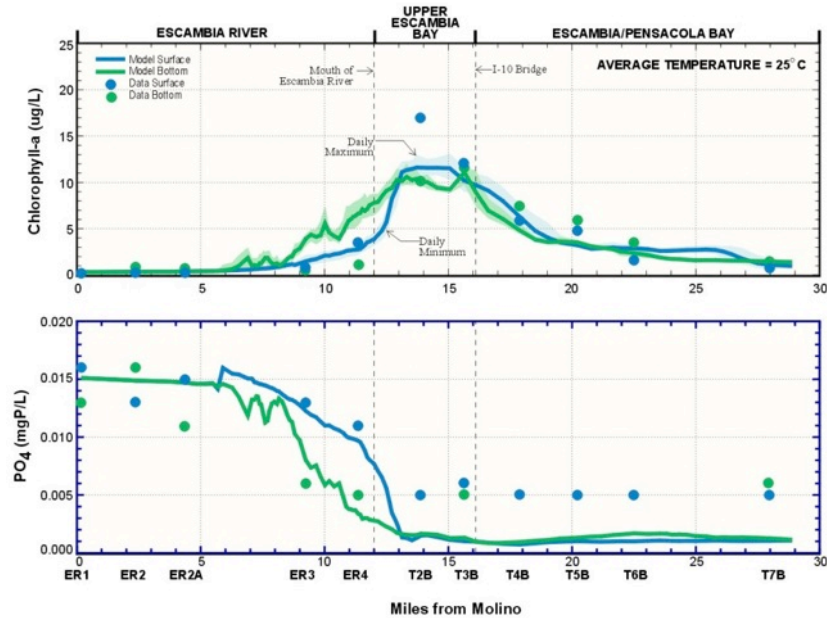
- Nutrient levels - algal growth limited at:
 - ~10 $\mu\text{g/L}$ DIN (NH_3 plus $\text{NO}_2 + \text{NO}_3$)
 - ~1 $\mu\text{g/L}$ PO_4
- Light levels
 - Light needed for photosynthesis
 - Affected by turbidity (algal, non-algal, color)
- Residence time
 - Long – larger effects
 - Short – smaller effects
- Temperature, grazers, habitat



WHY SO VARIABLE?

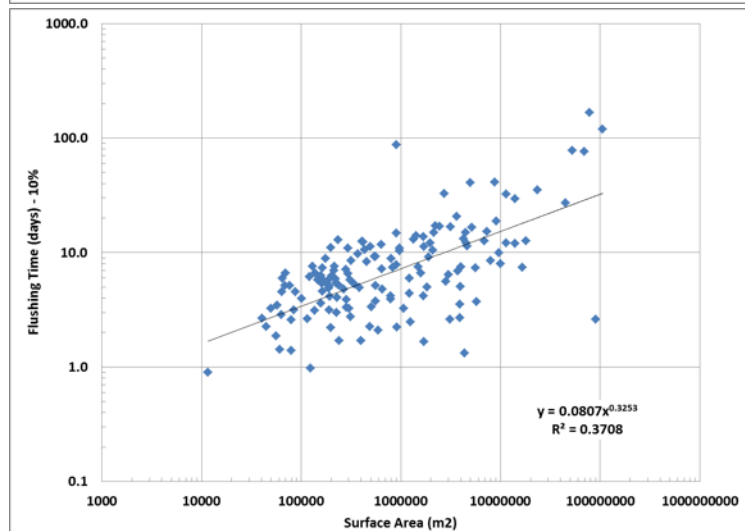
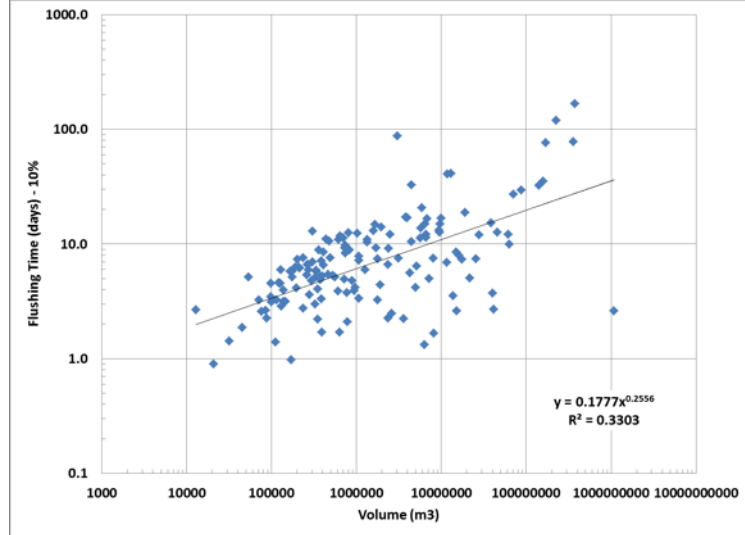
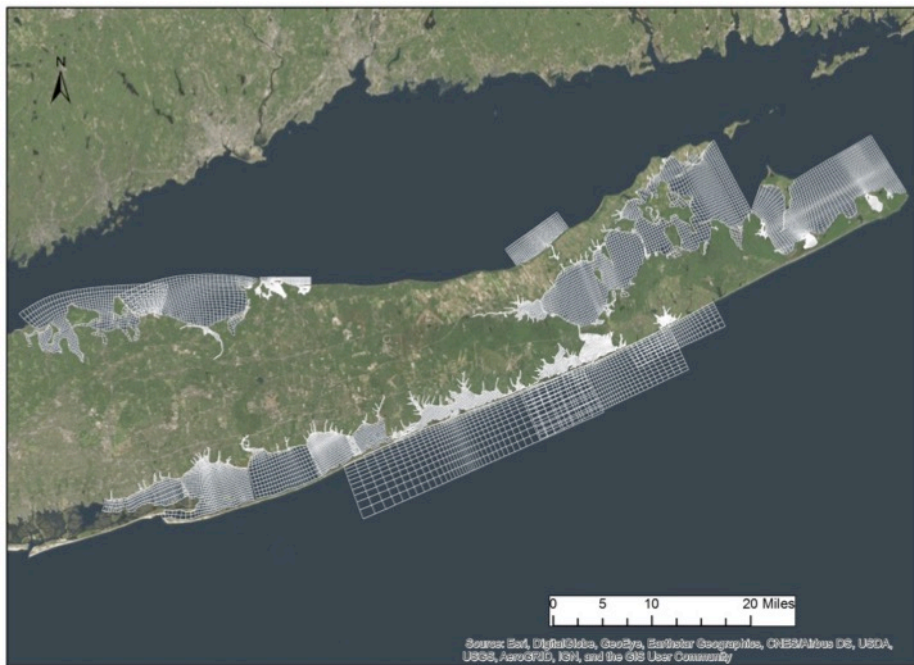
(ESTUARIES)

- Escambia River entering Escambia Bay (FL)
 - Plenty of nutrients in river, short residence time – low chl-a levels
 - Bay longer residence, nutrient uptake, increasing chl-a levels until nutrient used up



LONG ISLAND ESTUARIES (RESIDENCE TIME)

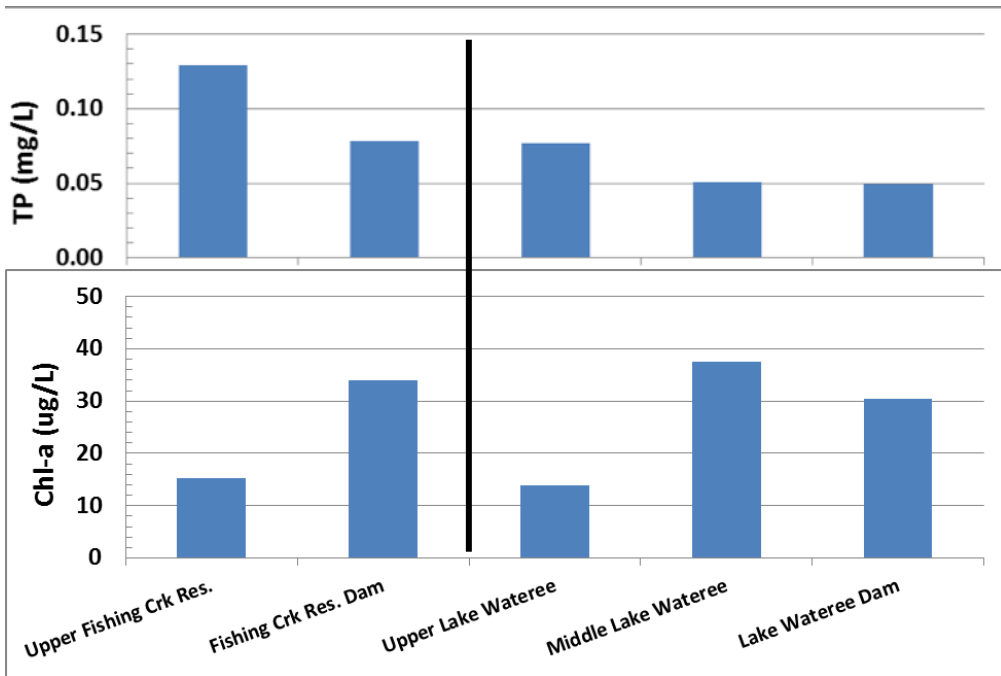
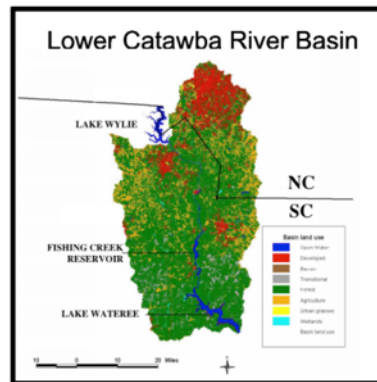
- Hydrodynamic modeling (EFDC) to calculate flushing time
- 140 tidal embayments – affected by tides & GW/SW flow



WHY SO VARIABLE?

(LAKES)

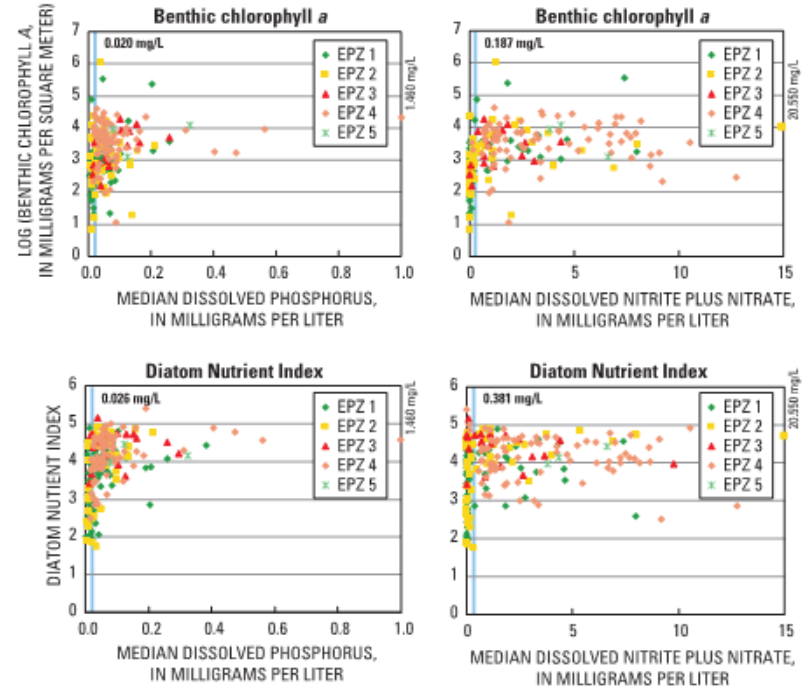
- Lower Catawba River & Reservoirs (SC)
 - Upper reservoirs: sufficient nutrients, short residence time, low light (turbid) – low chl-a levels
 - Middle reservoirs: longer residence time, improved light – high chl-a levels
 - Lower reservoirs: longer residence time but nutrients used up – low chl-a levels



WHY SO VARIABLE?

(RIVERS)

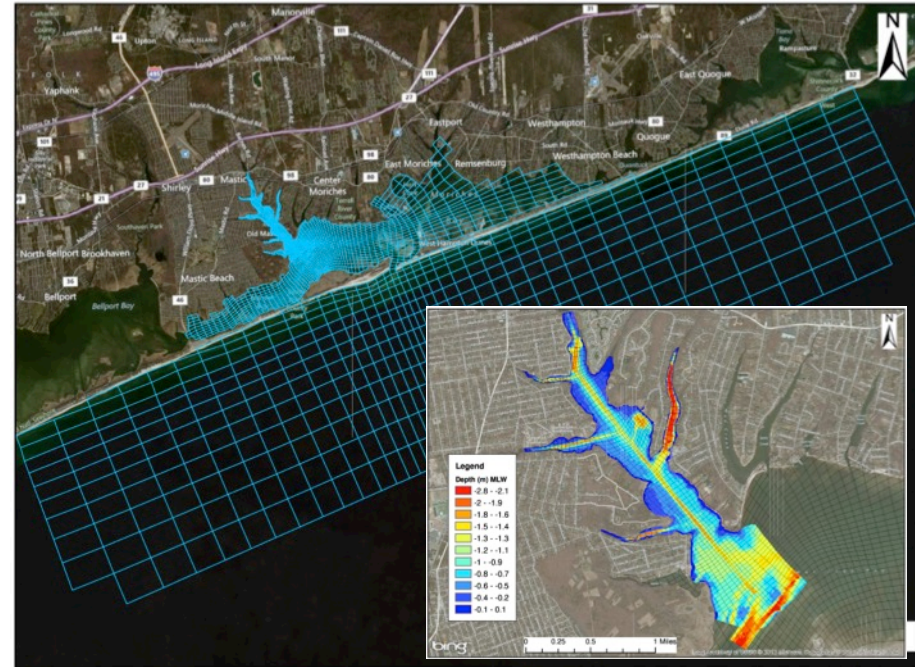
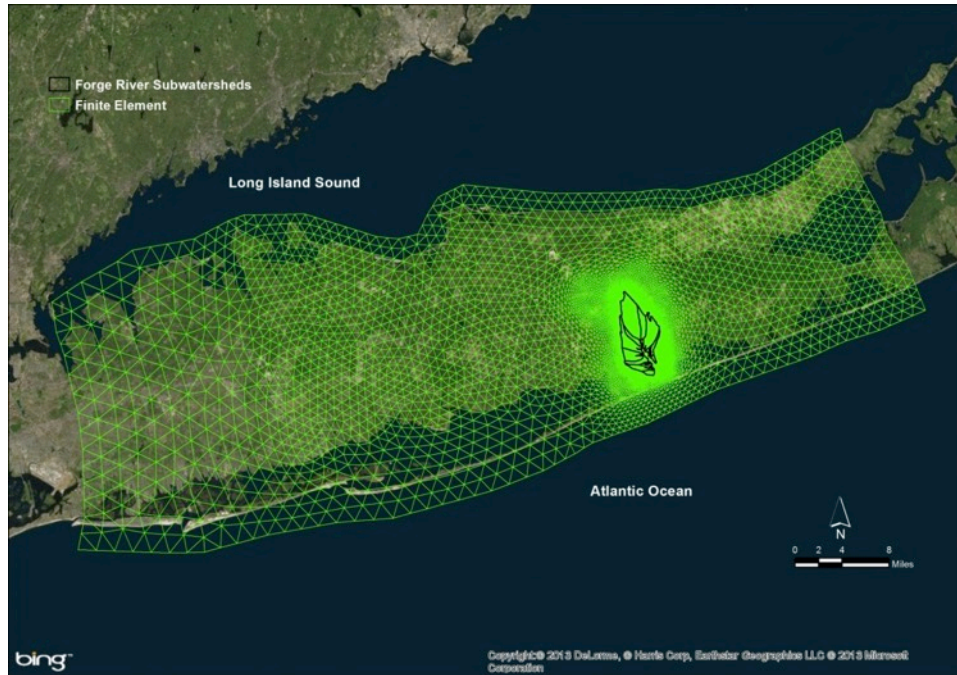
- Way more complicated
 - Suspended & attached algae (periphyton)
 - Hydraulic & shading effects
- Attached algae (periphyton) are not affected by residence time (they are fixed in space)
 - Riparian shading, water velocity
- Correlations are typically not good due to these factors
- Periphyton can be highly variable depending on shading, grazers, water velocity (scour), sampling



MODELING TOOLS

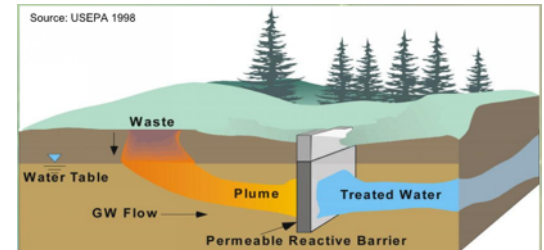
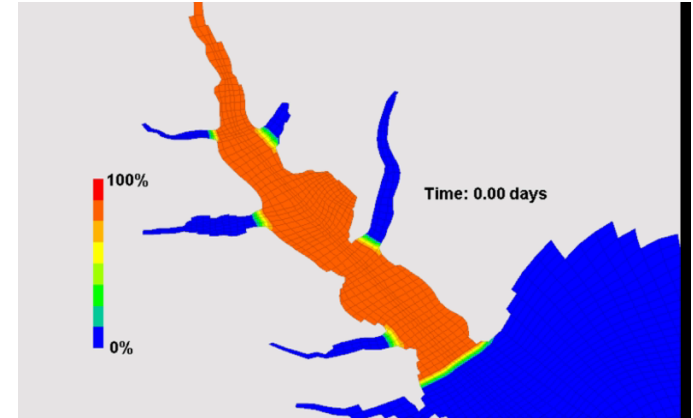
(GROUNDWATER & SURFACE WATER)

- Surface water models include hydrodynamic (circulation) & eutrophication (nutrient/algal/DO)
- Coupling groundwater models to surface water models



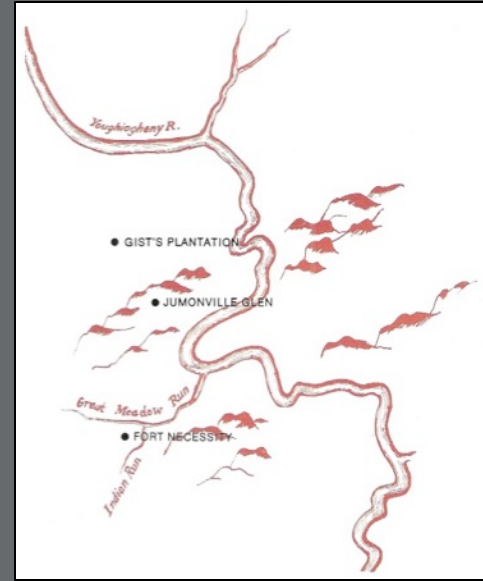
WHY USE MODELS TO DETERMINE NUTRIENT EFFECTS?

- Provides quantitative framework that includes factors affecting nutrient effects
 - Nutrient level, light level, residence time
- Modeling tools allow for evaluation of management options
 - Focused/adaptive implementation (i.e., phased sewerage, innovative onsite systems, PS control)
 - Assess attainability of nutrient criteria or to set nutrient criteria (natural background conditions)
- Allows evaluations of sources
 - GW, SW, PS, offshore



SUMMARY

- Many factors control nutrient effects in water bodies
 - Nutrient source & levels, residence time, available light, “other” factors
- Water quality models are valuable in assessing the effects of nutrient loading
 - Models can include the “other” factors affecting nutrient effects
- Nutrient management of PS & NPS sources requires a modeling tool due to the high cost associated with nutrient removal



Fort Necessity (Natural Background?)

“He placed his wagons and pitched his tents between two shallow gullies that might serve as natural entrenchments. **The ground was marshy in spots. Great Meadows Run, a twisting, weed grown stream some 10 feet wide in places,** and a smaller branch later known as Indian Run, crossed the area.”

George Washington, 1754

QUESTIONS ?

- Andy Thuman – andrew.thuman@hdrinc.com (862-236-1709)



AUDIENCE PARTICIPATION

- Are your facilities impacted by nutrient criteria or nutrient related problems? Anticipated to be?
- Has your State implemented nutrient criteria? In the process of developing?
- Do you have enough data to assess the nutrient impacts of your discharge?
- Are you worried about the consequences?