Water Supply Planning For Rappahannock County

Update on the water resources analyses to support the WSP

By Tim Bondelid
Consulting Engineer
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Agenda

- Review of the first analyses using a long-term “flow balance” approach
- The Flaw in this approach – “stationarity”
- What has been observed by residents and NPS personnel
  - Data examples that support this
- The steps currently being taken to re-evaluate the water resources in Rappahannock County

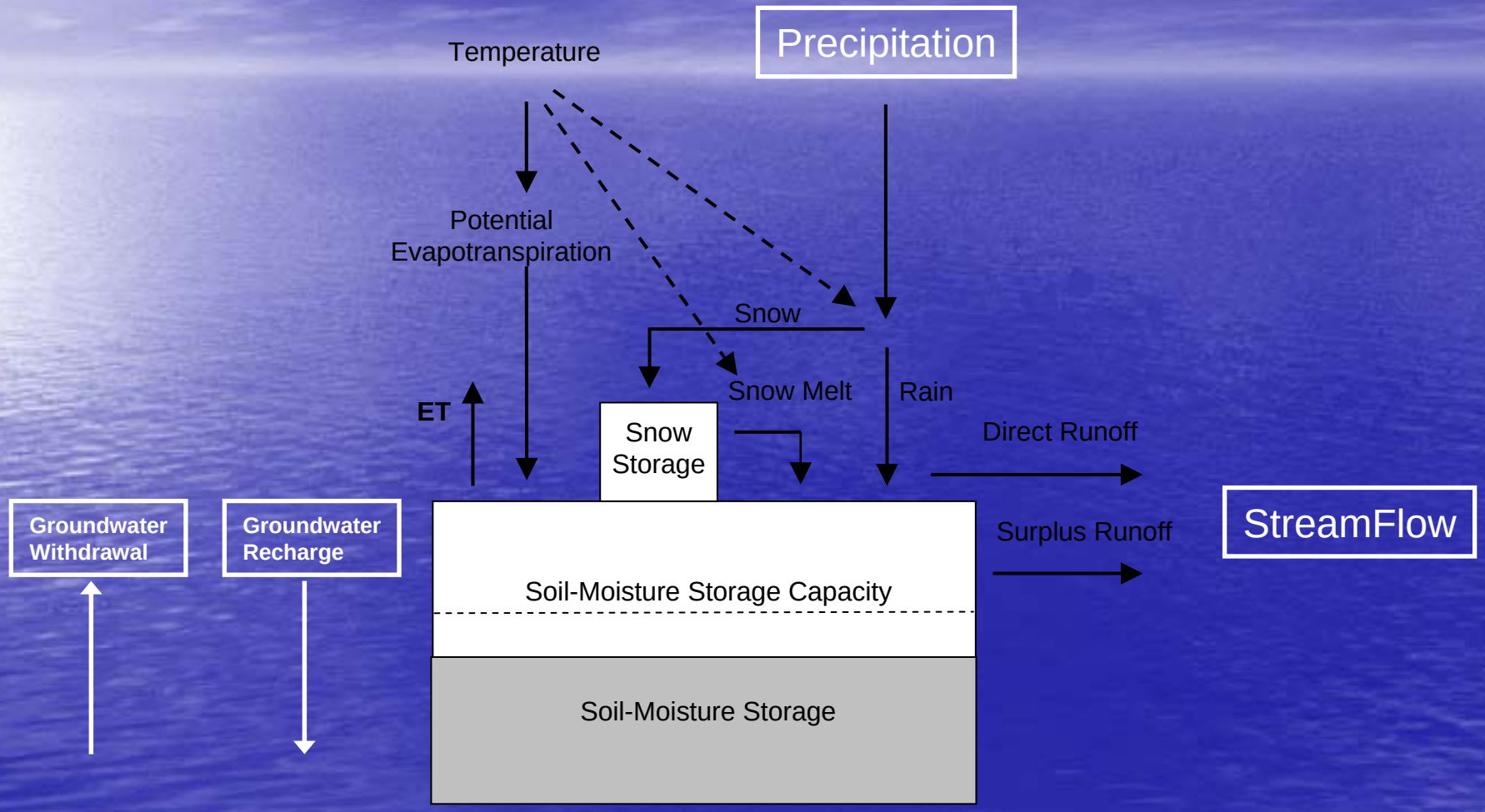
The “Water Balance” Approach To Evaluating Our Water Resources

- Estimate all of the water that enters the county, leaves the county, and is used within the county
  - If all of these factors are accounted for, then all water is accounted for
  - This method provides a way to determine how much water is available for use by the residents, farmers, and ALSO the maintenance of an ecologically safe streamflow.

Components Of the Water Balance

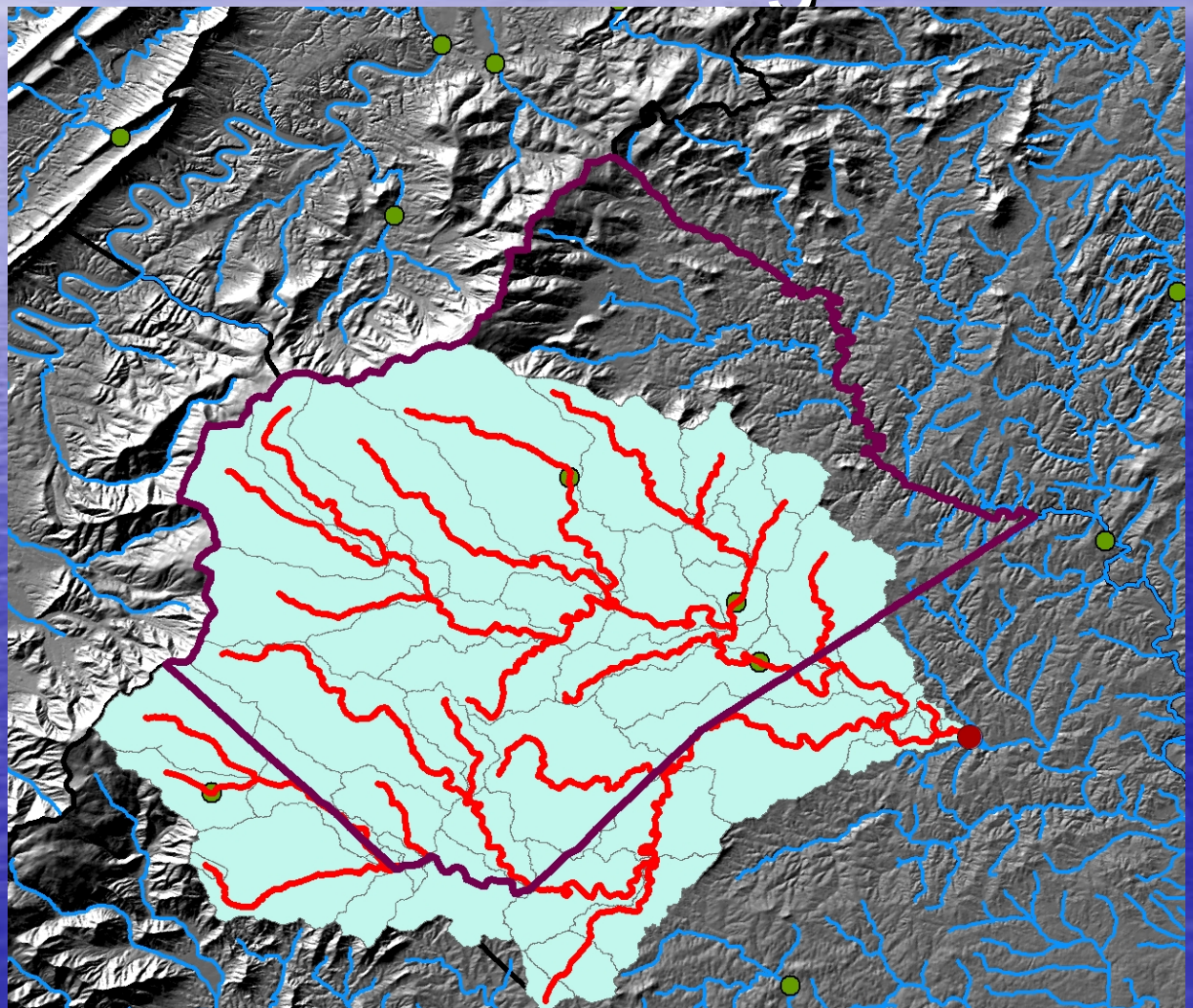
1. Rappahannock County is a “Headwater” county, so there is no water coming into it from upstream.
2. The primary components to take into account are:
   - Precipitation
   - Evapotranspiration (**ET**) = evaporation from the land and transpiration from vegetation
   - Streamflow leaving the county
   - Groundwater recharge
   - “Consumptive Use” by people, farming, fire fighting, etc.
3. Virtually all of the human water use in the county is from wells
4. Springs are used especially for agriculture and they help to maintain streamflows, especially important in dry periods

A Water Balance



Note: Figure courtesy of Dave Wollock, USGS Hydrologist; modified by Tim Bondelid

Constructing the Water Balance – Use the drainage area for the Hazel River Flow Monitoring Station



Using Long-term statistics: The Water Balance Conclusions

- The Area is 287 sq. mi. (The county area is 267 sq. miles)
- One inch of water on this watershed = 5 billion gallons
- Annual means:
  - Precipitation = ~ 43 inches
  - ET + ~ 17 inches
  - Streamflow out = 15.9 inches
  - Groundwater Recharge = ~ 10 inches
  - Water Consumption in Rappahannock = ~ 0.1 inches
- The Water Balance (in inches/year):

  43 – 17 – 15.9 – 10 – 0.1 = 0

  Conclusion: The Groundwater recharge is 10 inches/yr., Rappahannock County withdraws ~ 0.1 inches/yr.

  Based on Long-term historical data, Rappahannock is in good shape; we are nowhere near using up our groundwater!

The Flaw in This Analysis

- The Flow Balance is based on long-term historical data
  - An assumption in this analysis is that this approach is applicable to the present and future
  - This assumes what is known as “stationarity”
    - Stationarity is the assumption that hydrologic conditions are not changing over time

From a Conference on Non-Stationarity Held in Boulder, CO In January, 2010

- Robert Hirsch: Senior Hydrologist for USGS:
- **“It is non-stationary – get over it!”**
- **“Focus on description and understanding, considering the full range of possible drivers”**

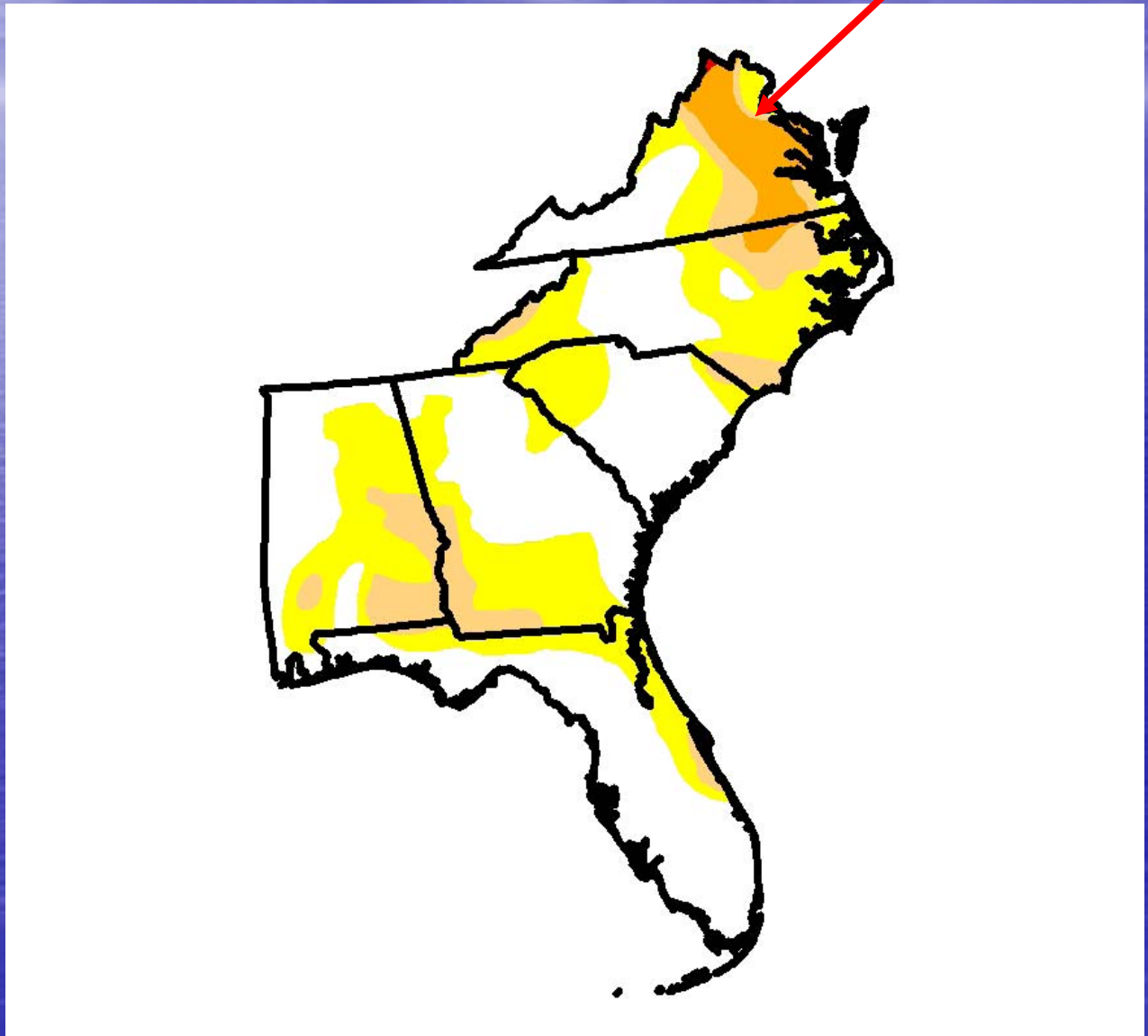
What Have We Been Seeing Over the Past 20 Years?

- It has not been good
  - From Steve Bair, NPS Backcountry, Wilderness and Trails Manager:
    - “Many springs have dried up in the Park”
    - “The changes seem to have started about 20 years ago”
    - “We used to always have snow in December – March, now it is rare”
  - From Bill Fletcher:
    - On the small mountain that drains to his land, he noticed that the springs higher up dried up about 20 years ago, the lower-level springs dried up about 10 years ago. This is causing severe water shortages for his farming operations.
  - I have gotten similar feedback from others, and I have noticed it as well:
    - Wells going dry in Sperryville
    - Farmers not being able to get water from streams for mixing fertilizers
    - Where are the nice, long-lasting drenching rains?
    - It seems we get storms instead

We Are (Again) In A Severe Drought Situation

- “Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed”

The Drought Map:



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Regional Highlights from

Global Climate Change Impacts in the United States

www.globalchange.gov/usimpacts

Southeast

The annual average temperature in the Southeast has risen 2°F since 1970, with the greatest seasonal increase in the winter months. There has been a 30 percent increase in fall precipitation over most of the region but a decrease in fall precipitation in South Florida. Summer precipitation has decreased over almost the entire region. The percentage of the Southeast in moderate to severe drought increased over the past three decades. There has been an increase in heavy downpours. The power of Atlantic hurricanes has increased since 1970, associated with an increase in sea surface temperature.

Continued warming is projected, with the greatest temperature increases in summer. The number of very hot days is projected to rise at a faster rate than average temperatures. Average annual temperatures are projected to rise 4.5°F under a lower emissions scenario and 9°F under a higher emissions scenario with a 10.5°F increase in summer and a much higher heat index. Sea-level rise is projected to accelerate, increasing coastal inundation and shoreline retreat. The intensity of hurricanes is likely to increase, with higher wind speeds, rainfall intensity, and storm surge height and strength.

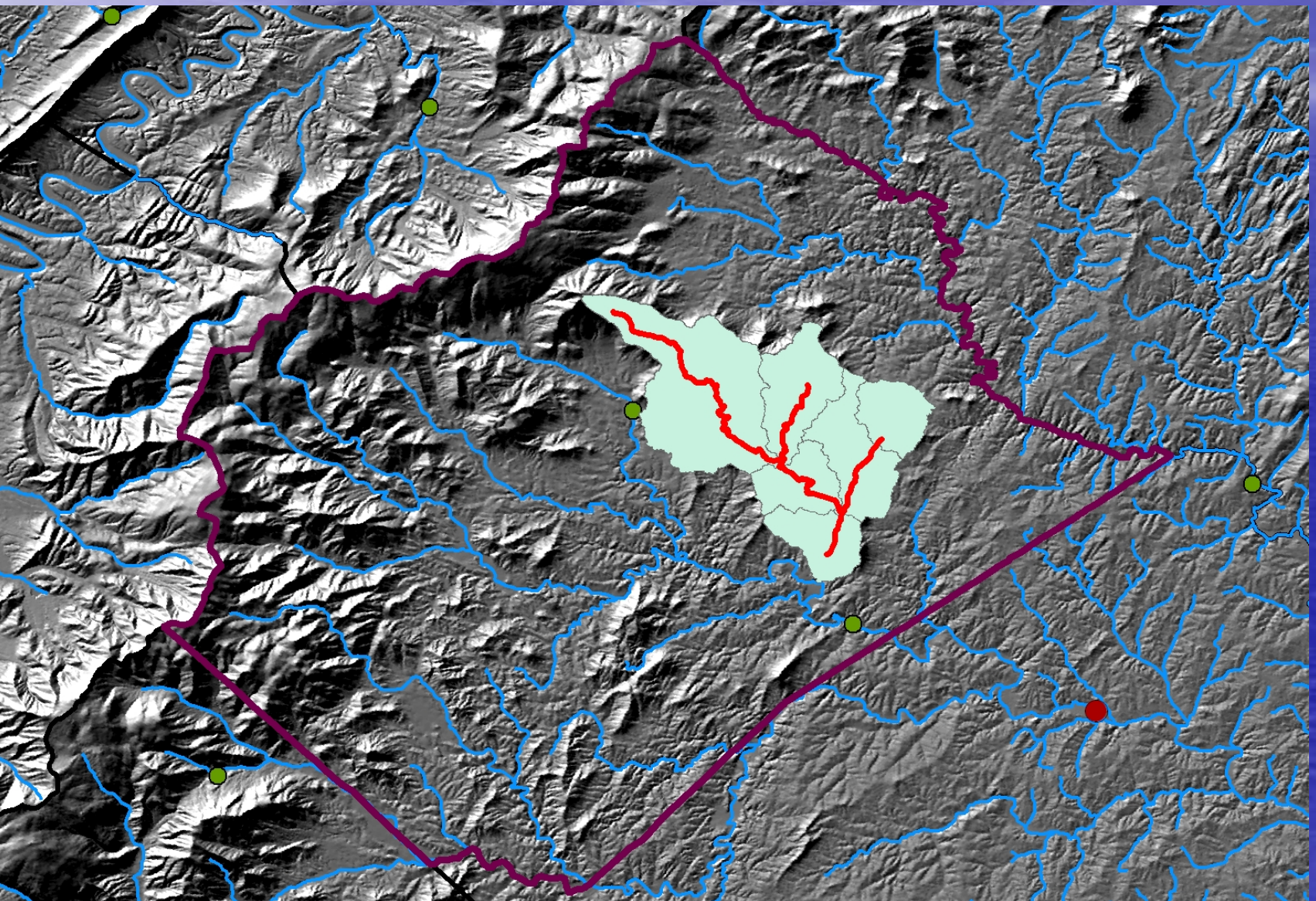
A note on the emissions scenarios

None of the emissions scenarios used in this report include any policies specifically designed to address climate change. All, including the lower emissions scenario, lead to increases in heat-trapping gas emissions for at least the next few decades, though at different rates.

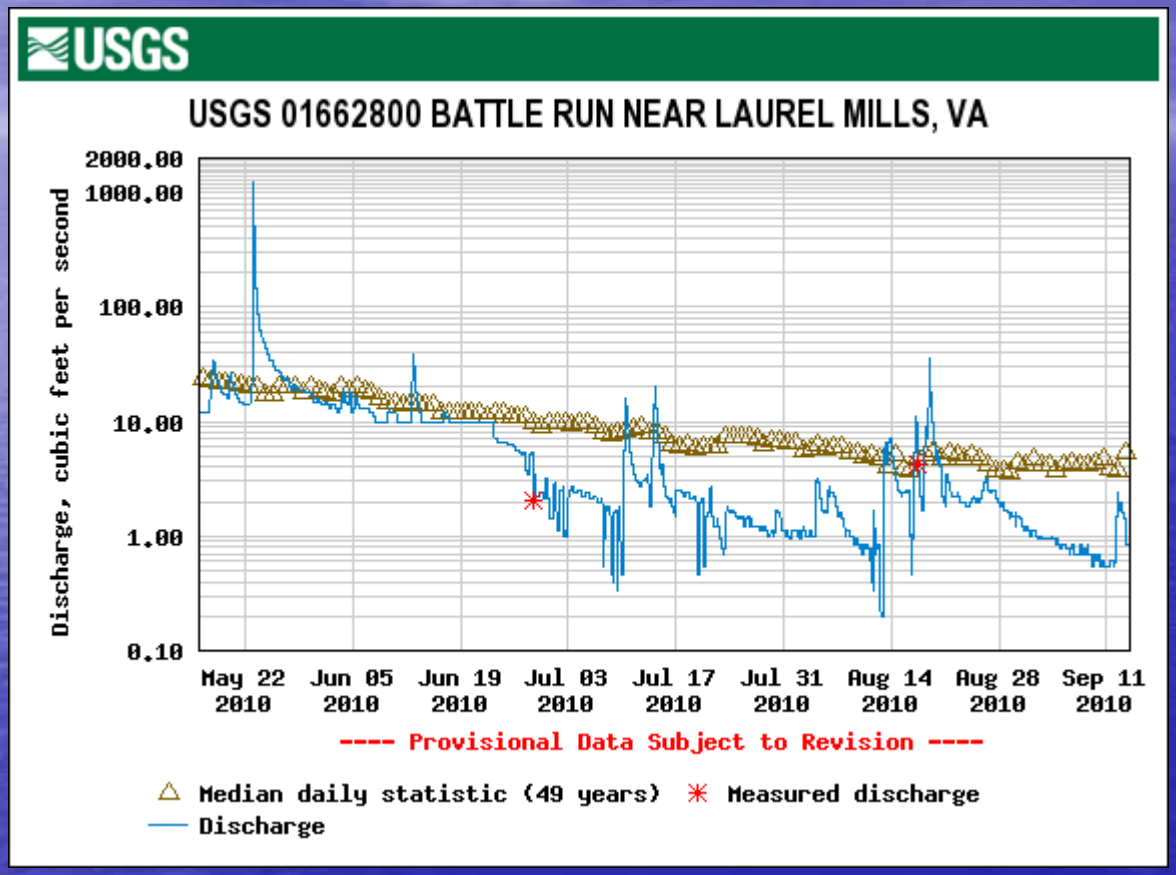
Key Issues

Projected increases in air and water temperatures will cause heat-related stresses for people, plants, and animals.

Let’s look at Battle Run:

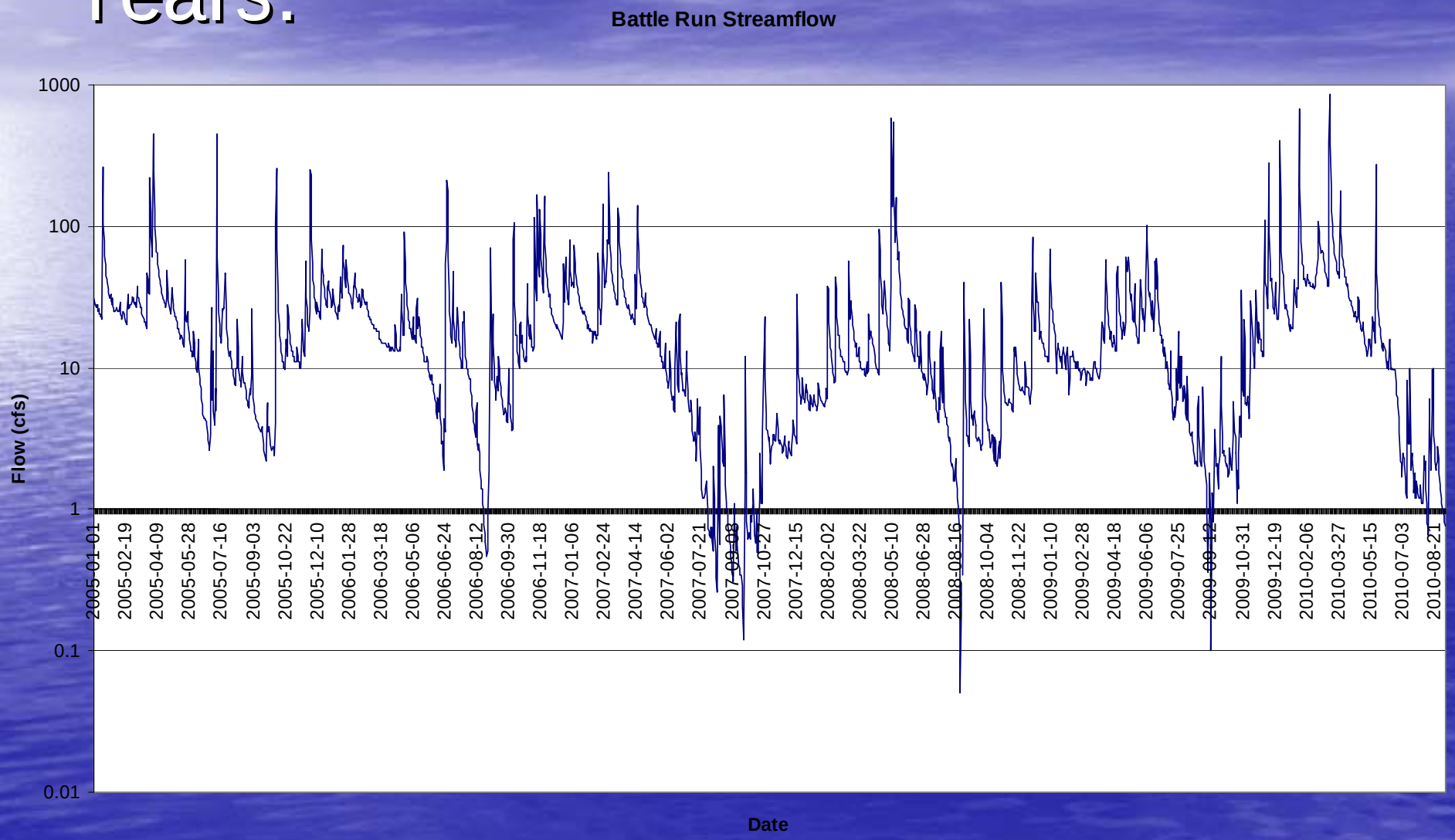


Battle Run Over the Past Two Months:



On the day this graph was produced (Sept. 13, 2010),
the long-term mean flow is 8.6 cfs, the median flow is 5.4 cfs;
The flow on September 13th was 0.85 cfs

Battle Run Over the Past Few Years:



South Fork, Thornton River:

September 14, 2010

Where Do We Go From Here?

- Need to quantify the changes
  - Streamflow
  - Precipitation
  - Temperature
  - Snowfall
  - When and where springs have dried up
  - Well Data: preferably long-term data
- Develop a new “picture” of where we stand and what we might expect
  - Develop strategies for dealing with it: short and long term
  - Note: this a regional issue

Trends Analyses Can Be Challenging:

- Extracting the “signal” of change from the “noise” in the data
- Missing data is a problem
- Correlating trends found in the data with on-the-ground observations:
  - Relating springs going dry to the data
  - Determining if this is some sort of long-term cycle, or a condition we can expect to continue
- What measures should we be taking for dealing with the results?

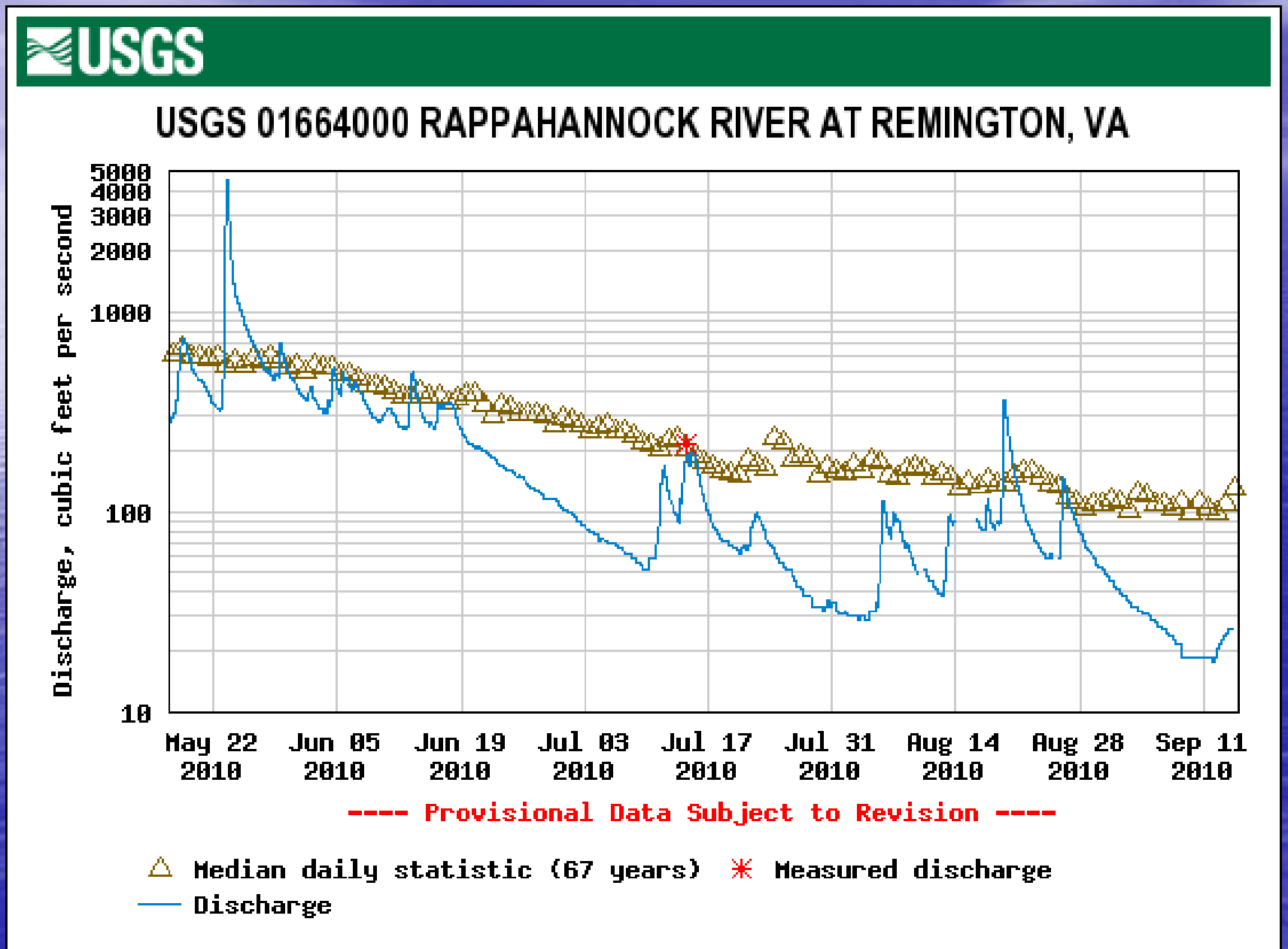
What I Am Doing

- Working to extract trends in the streamflow data
  - I have been trying a few things, nothing has worked as yet.
  - A Colleague is using the long-term data from Battle Run, Hazel River, and Rappahannock as a research project using sophisticated statistical techniques for trends
- Assembling as much relevant long-term data as I can find on precipitation, temperatures and snowfall
- Other professional work of mine has a good potential to be able to segue into long-term temperature and precipitation trends
  - While this work is national in scope, it can be applied regionally and locally
  - This work may also wind up looking at climate change scenarios.
- Andy Putscher of DEQ is assisting in some of this

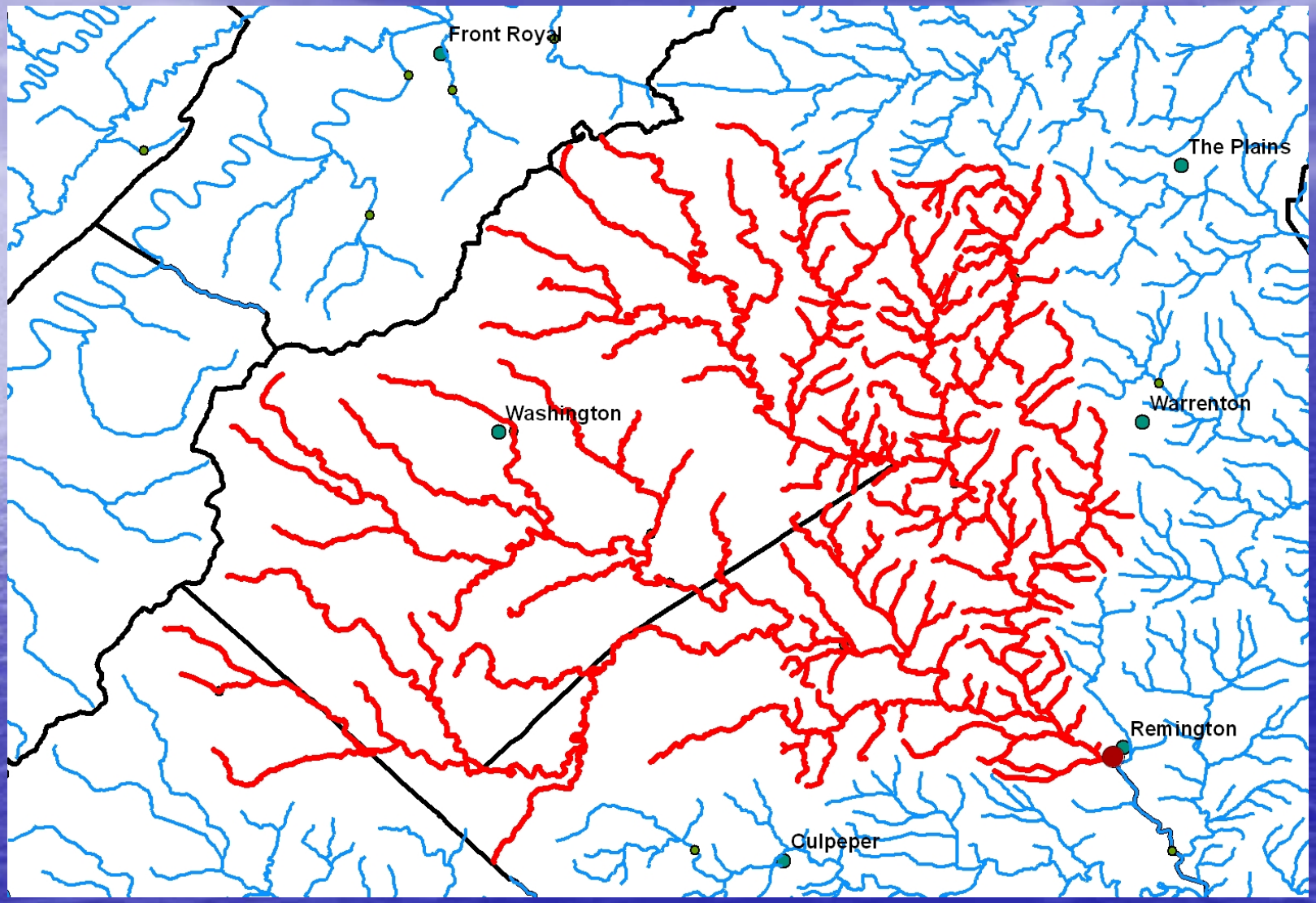
Conclusions

- It has gotten more complicated
- I may need help
  - Georeferencing springs, wells
  - Preparing data for analysis
  - Possibly needing to purchase some data (small costs)
  - Help in developing options
  - There are some possibilities for getting this help
- Should there be a regular “Drought Monitor” item in the paper?
- This is a Regional issue, not limited to our County

Rappahannock River at Remington



Remington Drainage



Note: Warrenton adds ~ 1.9 cfs to the Rappahannock flow, transferred from the Potomac Basin

Discussion

- Feedback
- Ideas for what to do?
  - I have some general idea of approaches
- Next steps