

Modeling Processes in the South River: Discussion

South River Science Team
09-09-03

Dual Approach May Be Appropriate

- Fluvial Geomorphology
 - Study landforms and changes through erosion and sedimentation in response to forces and stressors
 - “Particle Tracking”
 - Qualitative predictive capabilities and empirical grounding
- Numerical Sediment Modeling
 - Understand historic and current river flows and net sediment transport
 - Prediction capabilities to evaluate remedial alternatives including hybrid solutions
 - Option to add Hg fate, transport and transformation (cutting edge)

Numerical Modeling Consultants

- Hydroqual, Inc.
 - Pls: Dom DiToro, Ferdy Hellweger,
 - TMDL/WASP 5 Modeling for Delaware River PCBs (current)
 - Numerous water quality projects and TMDL models
- QEA (Quantitative Environmental Analysis, 1998)
 - Pls: John Conolly and Kirk Zeigler
 - Housatonic River - sediment and flood plain modeling (current)
 - Lavaca Bay - Hg Source Identification and Hurricane modeling for sediment stability
 - Penobscot River Hg Study
 - GE Hudson River PCB Fate and Transport and Remed. Design
 - James River Kepone Study
 - Fox River / Green Bay PCB Fate, Transport and Bioaccumulation
- Limnotech (LTI, 1975)
 - Pls: Vic Bierman, Greg Peterson, Joe DePinto
 - Modeling of Hudson R., Fox R./Green Bay for Regulatory Agencies
 - Everglades Hg Research Program - Planning Support
 - Mercury Screening Model for Lake St. Clair
 - Waukegan Harbor PCB Modeling and Exposure Assessment

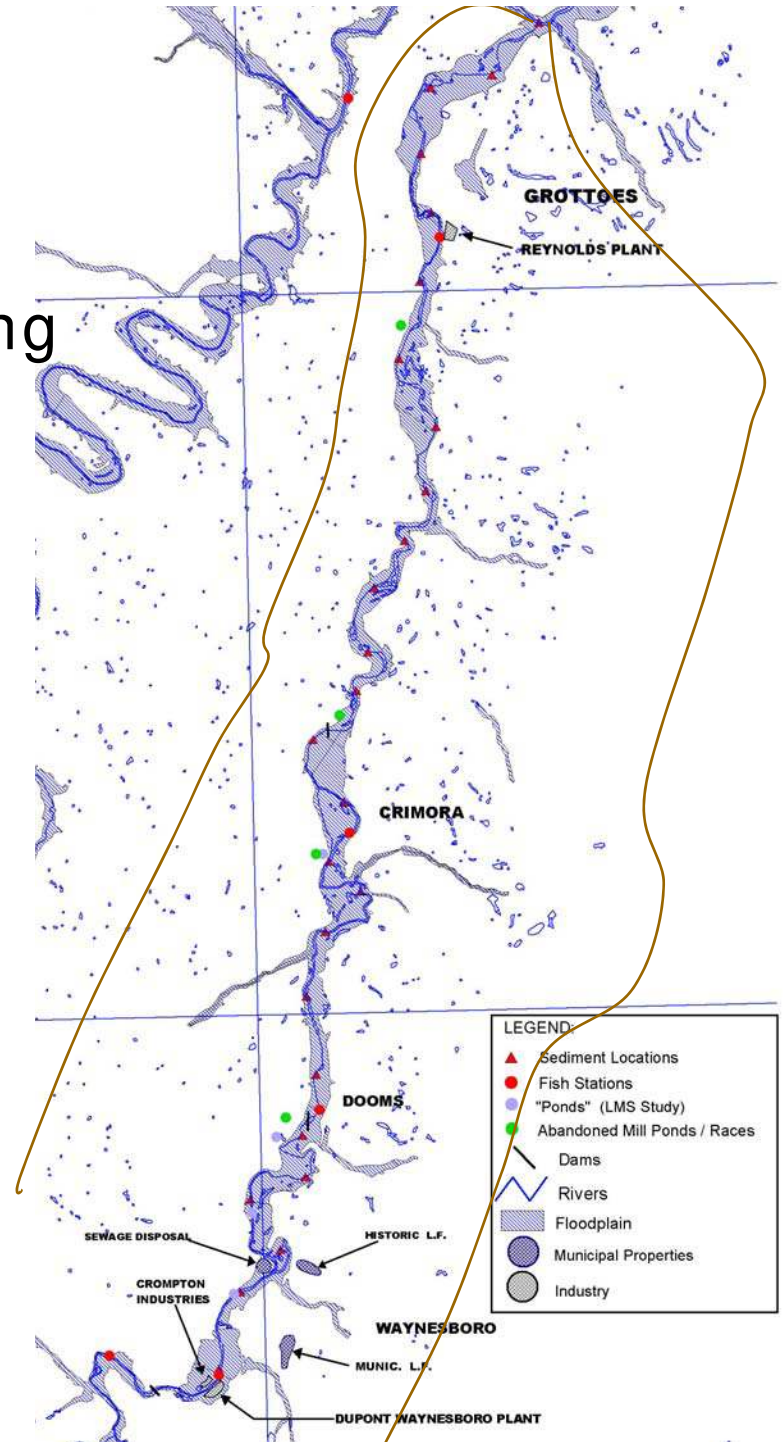
Geomorphologists

- Panayiotis Diplas - Virginia Tech (Engr)
 - Statistical approach for sediment sampling accuracy
 - Turbulent shear stresses on pavement formation and bedload motion in gravel streams
- Andrew Miller - UMBC (Geo)
 - Surface water hydrology -large floods in mountain rivers
 - Fluvial geomorphology of bedrock-controlled channels
- James Pizzuto -University of Delaware (Geo)
 - Sediment pulses in mountain rivers
 - Dispersion of bed material in gravel bed rivers
 - Ontogeny of a floodplain
 - Morphology of graded rivers
 - Sediment diffusion during overbank flows
- Karen Prestegard -University of Maryland (Geo)
 - Sediment transport and depositional processes in mountain gravel-bed streams
 - Mechanisms of streamflow generation and variations with watershed scale, geology and land use
- Peter Wilcock -Johns Hopkins University (Geo)
 - River sedimentation processes and river management
 - Fluvial and hillslope geomorphology
 - Field and Lab experiments in sediment transport
 - Open channel flow
- Others ?

South River Science Team Meeting September 9, 2003

Water Budget Calculation South River Drainage Basin

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Water Budget Evaluation Purpose

- Characterize general hydrology in the basin
- Determine a range for groundwater contribution to South River flow
- Evaluate potential for sub-aqueous springs
- Expand to understand solids balance in the basin

Data Sources

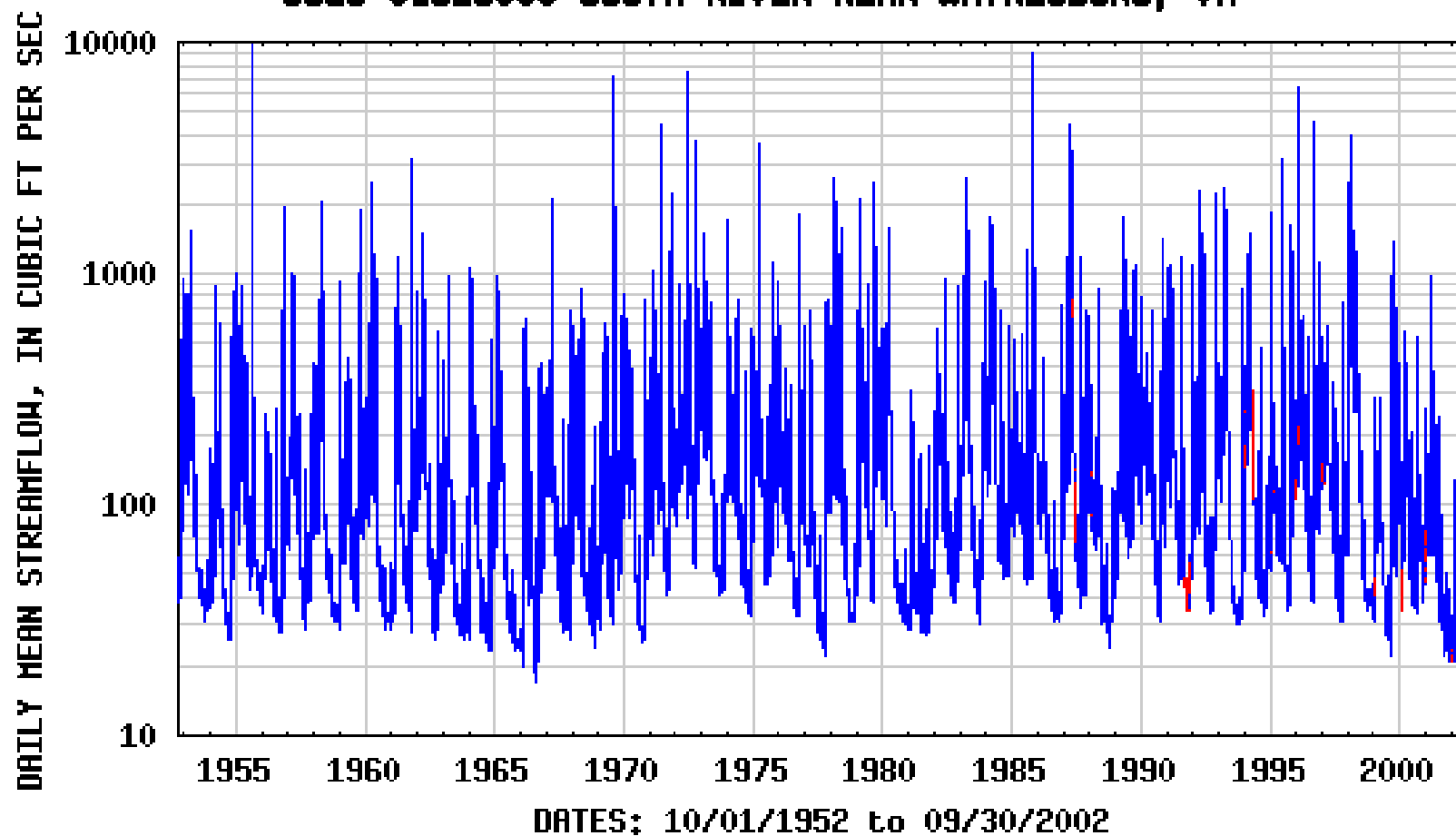
- USGS Gaging Stations (1970s to 2002)
- State Climatologic Data
- VADEQ Discharge/Withdrawal Permits
- Engineering Feasibility Study, LMS 1981
- Hydrogeologic Study of the Waynesboro Nurseries Inc., Tethys 1988
- Geology of Waynesboro, Gaithright et. al. 1977
- Maptech, per. com. 9-03

Approach

- Use mean annual statistics
- Evaluate basin using hydrologic (river flow) data
- Evaluate using climatological data
- Integrate results
- Look for anomalies that could indicate a significant localized GW discharge (source identification?)



USGS 01626000 SOUTH RIVER NEAR WAYNESBORO, VA



EXPLANATION

— DAILY MEAN STREAMFLOW

— ESTIMATED STREAMFLOW

Drainage Basin Summary

- From source to confluence with North River
234.4 mi² area
- The ratios of river flow to drainage area are relatively consistent ~ 1.2 cfs/ mi² (based on 3 gaging stations)
- Flow of South River at Port Republic is est.
282 cfs (16.3"/yr)
- Estimated flow of North River at Port Republic is 700 cfs

Drainage Basin Summary cont.

Groundwater Contribution Information

- River Flow = GW discharge + overland Runoff + permitted discharges
- Hydrographs suggest GW contribution is ~ 30% of total river flow
- MapTech *Basins* Model upstream of Waynesboro - GW contribution ~ 50%
- WNI Hydrogeologic Study, Tethys, 1988 - GW contribution in alluvial plain ~ 70%

Climatological Approach

- Simplified water balance
 - $PPT = \text{Evapotranspiration} + \text{Overland Runoff} + \text{GW Infiltration} + \text{Consumption}$
 - $\text{River flow} = \text{GW seepage} + \text{Overland Runoff} + \text{surface water discharges}$
- Precipitation 35.54"/yr
 - Average of Staunton and Stuart's Draft stations (36.18 to 34.9")
- Evapotranspiration estimated 19.54"/yr (55% PPT)
- Equates to river flow of 277 cfs or 16"/yr
 - recall hydrograph extrapolation of 282 cfs or 16.31"
- Permitted withdrawals and discharges amount to small net loss of 5 cfs annualized

Land Use Assumptions for Evapotranspiration Calculation

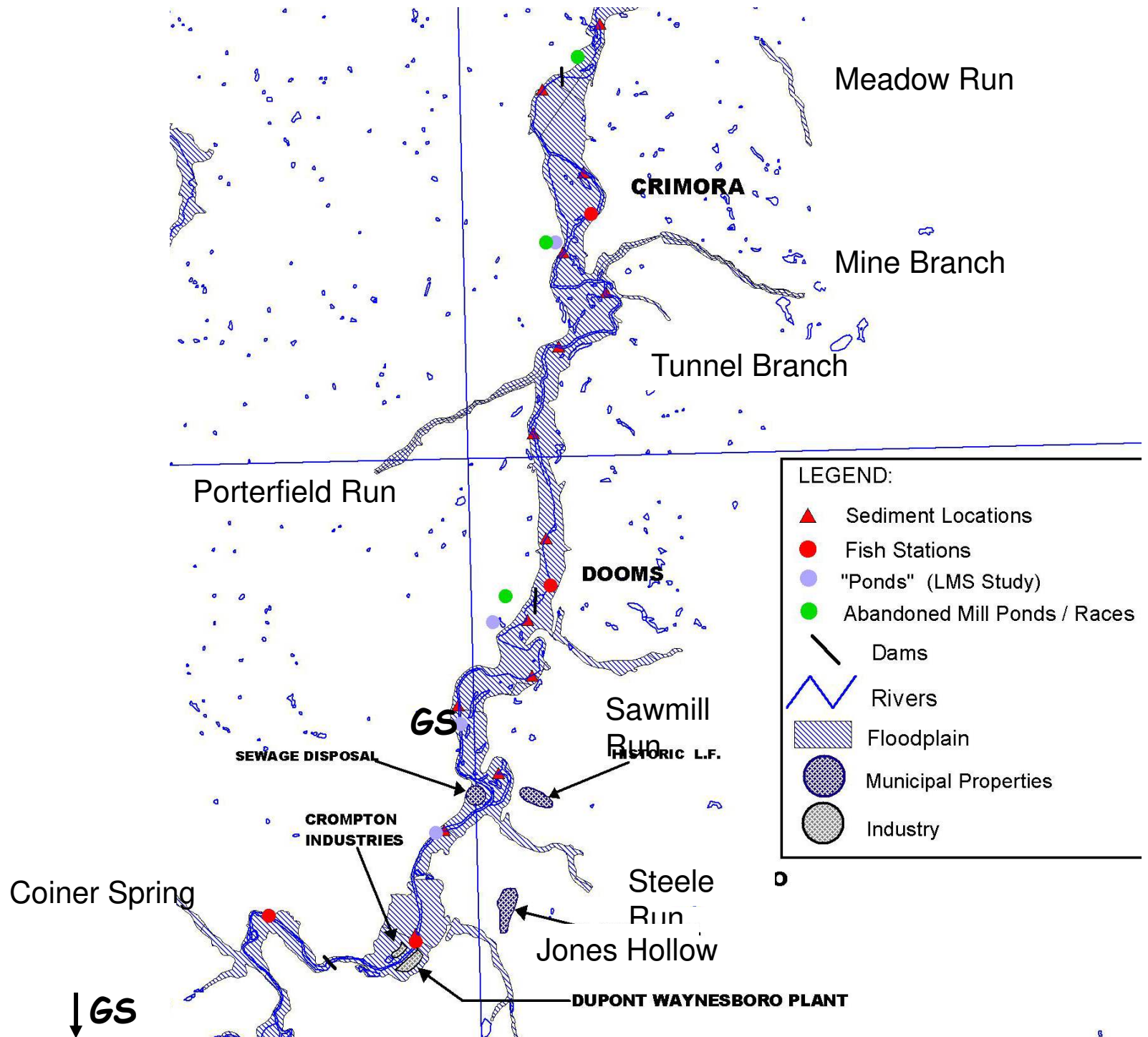
- 60% Forested
- 35% Grass and Cropland
- 5% Urban

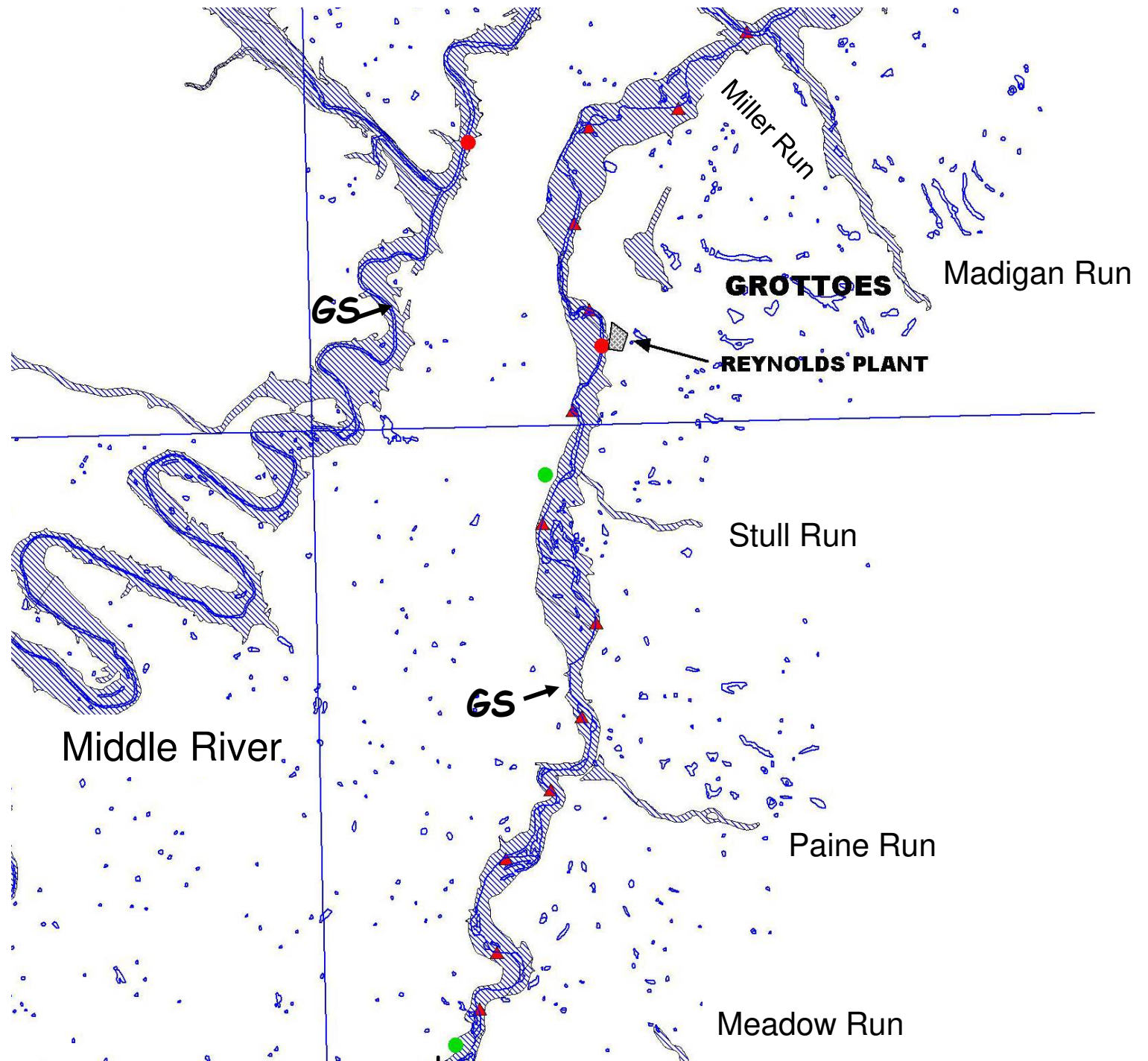
Two of the many possible solutions

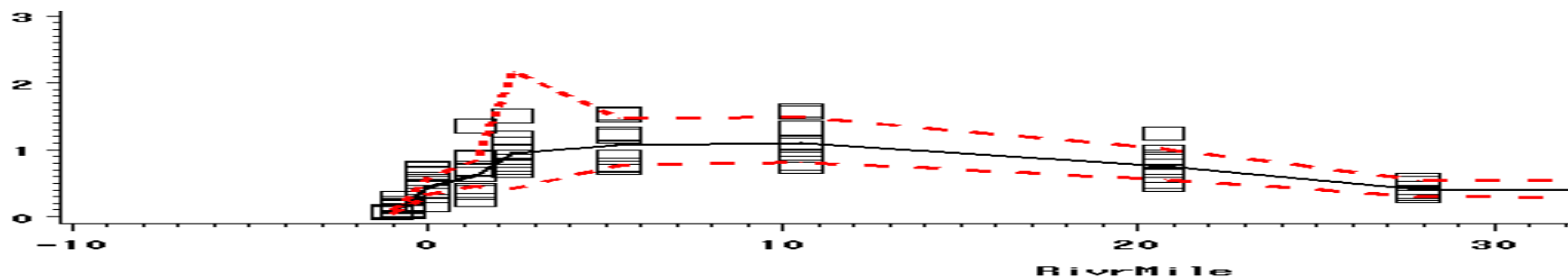
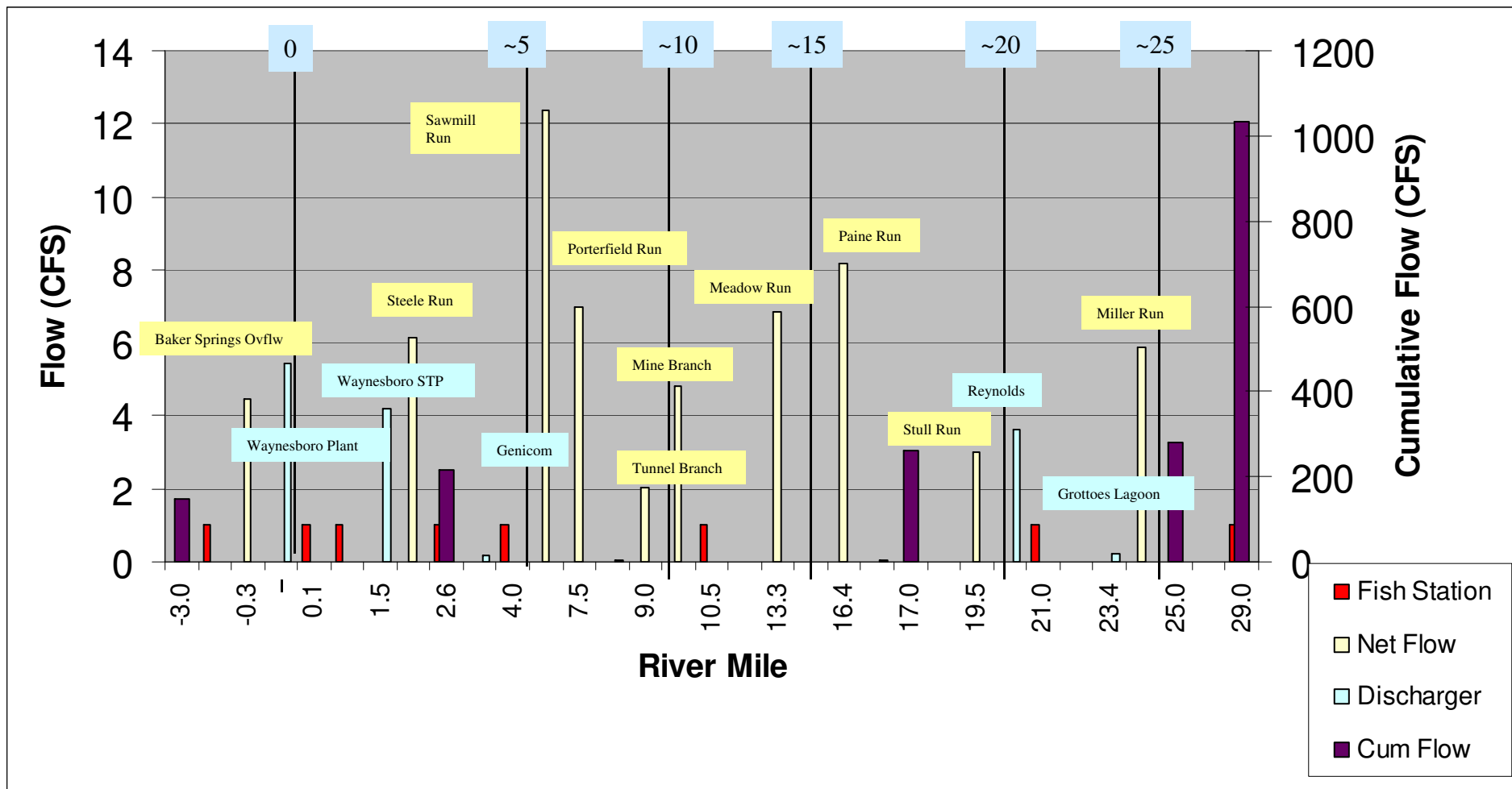
- $PPT = .55 \text{ as Et} + .13 \text{ as GW} + .32 \text{ as Runoff}$
- $PPT = .55 \text{ as Et} + .24 \text{ as GW} + .21 \text{ as Runoff}$
- Or total GW contribution to the river is between 99 cfs and 147 cfs of the 282 cfs total

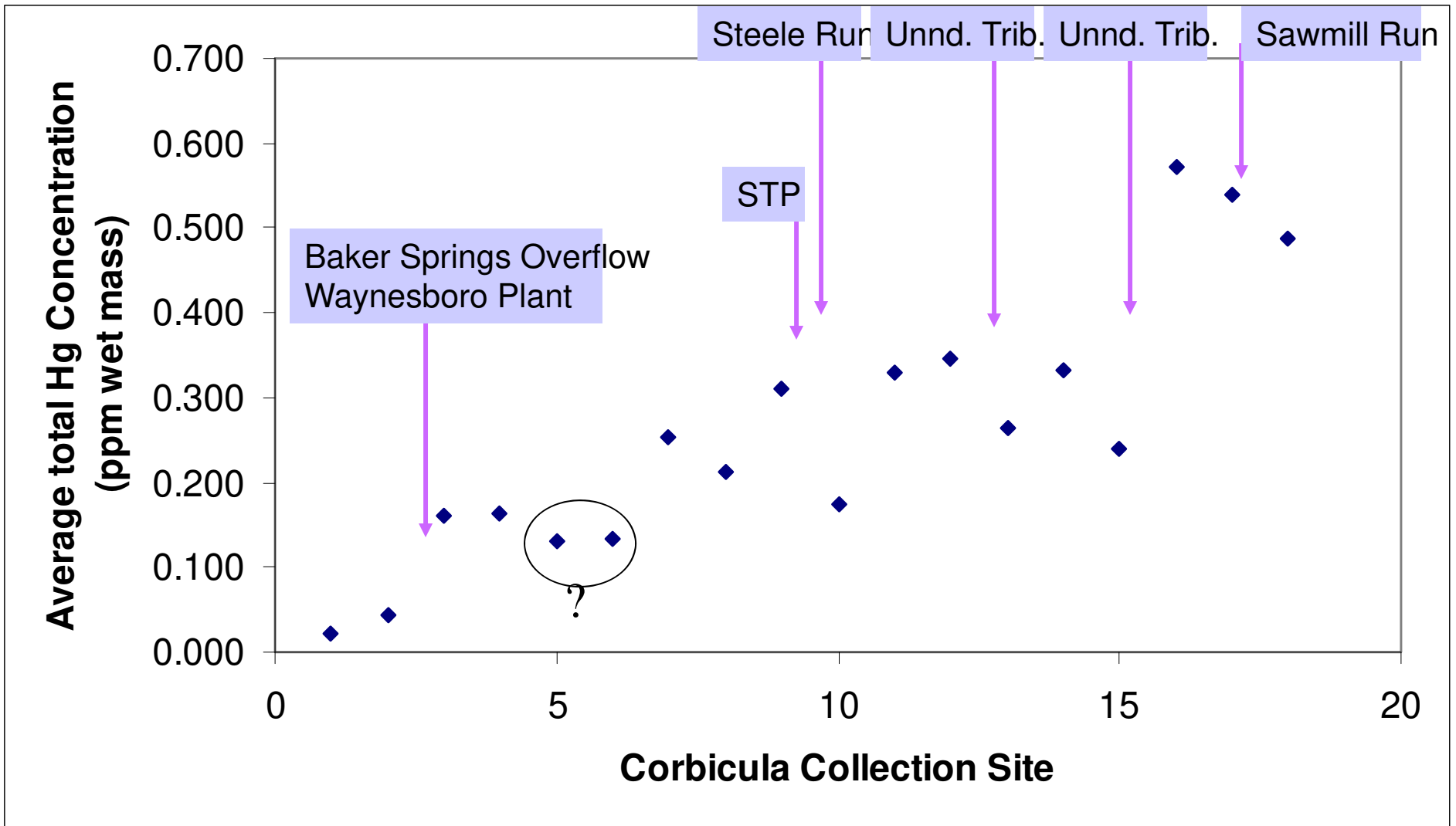
Spatial Considerations

- Inputs to/ withdrawals from the system are not consistent up and down the watershed
- Small scale changes in water quality data may result from local inputs





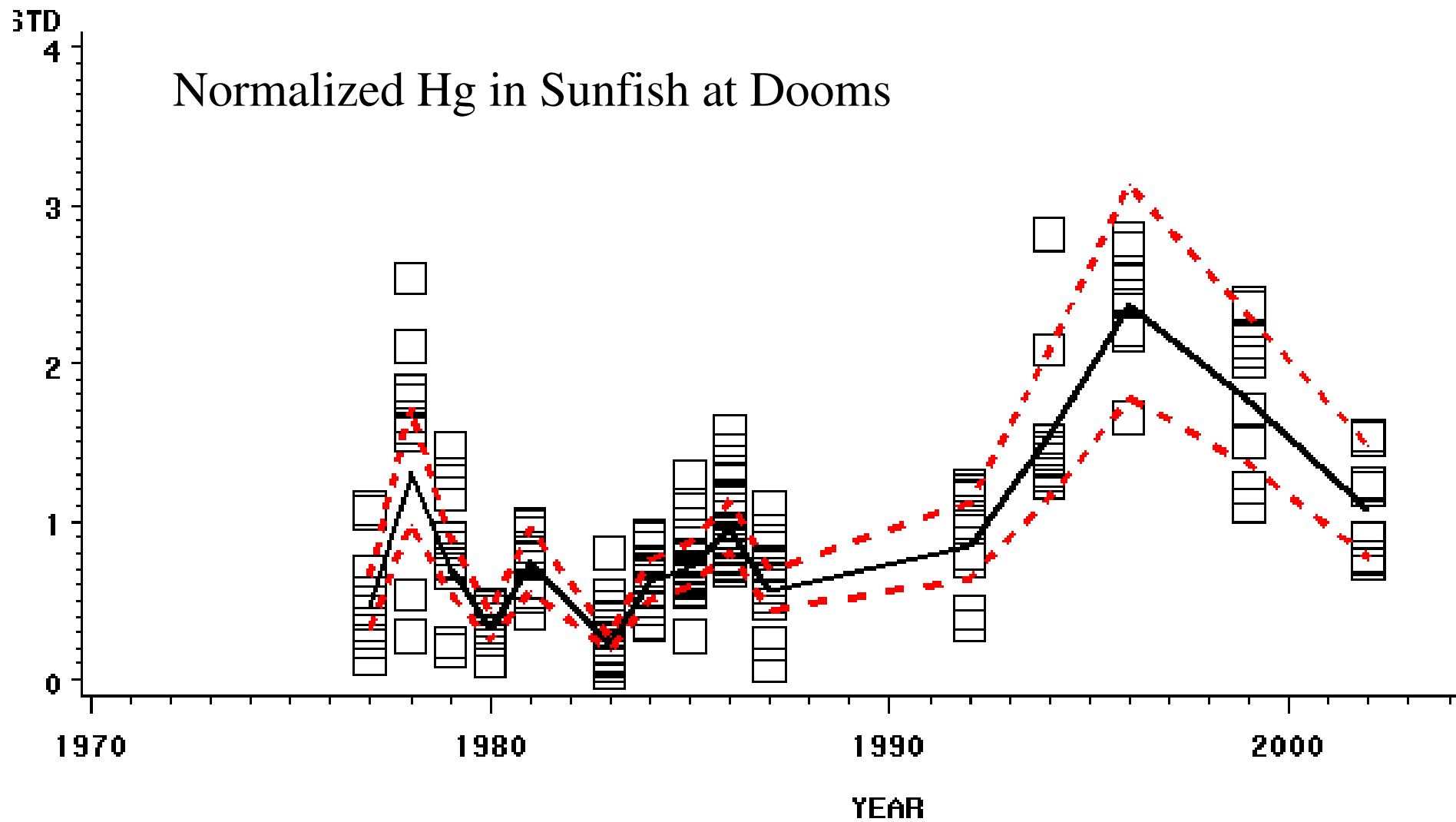


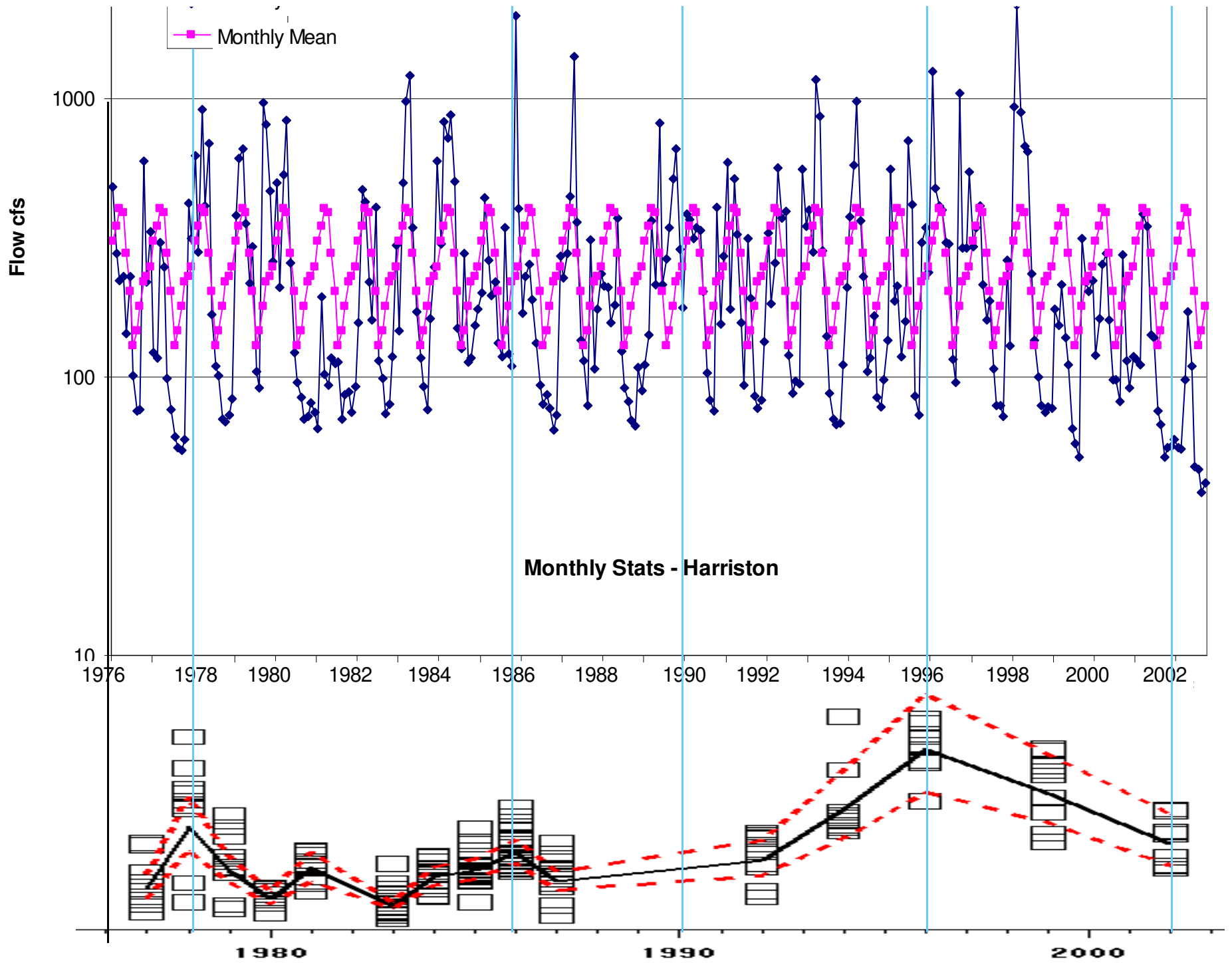


from Bowles and Benzing

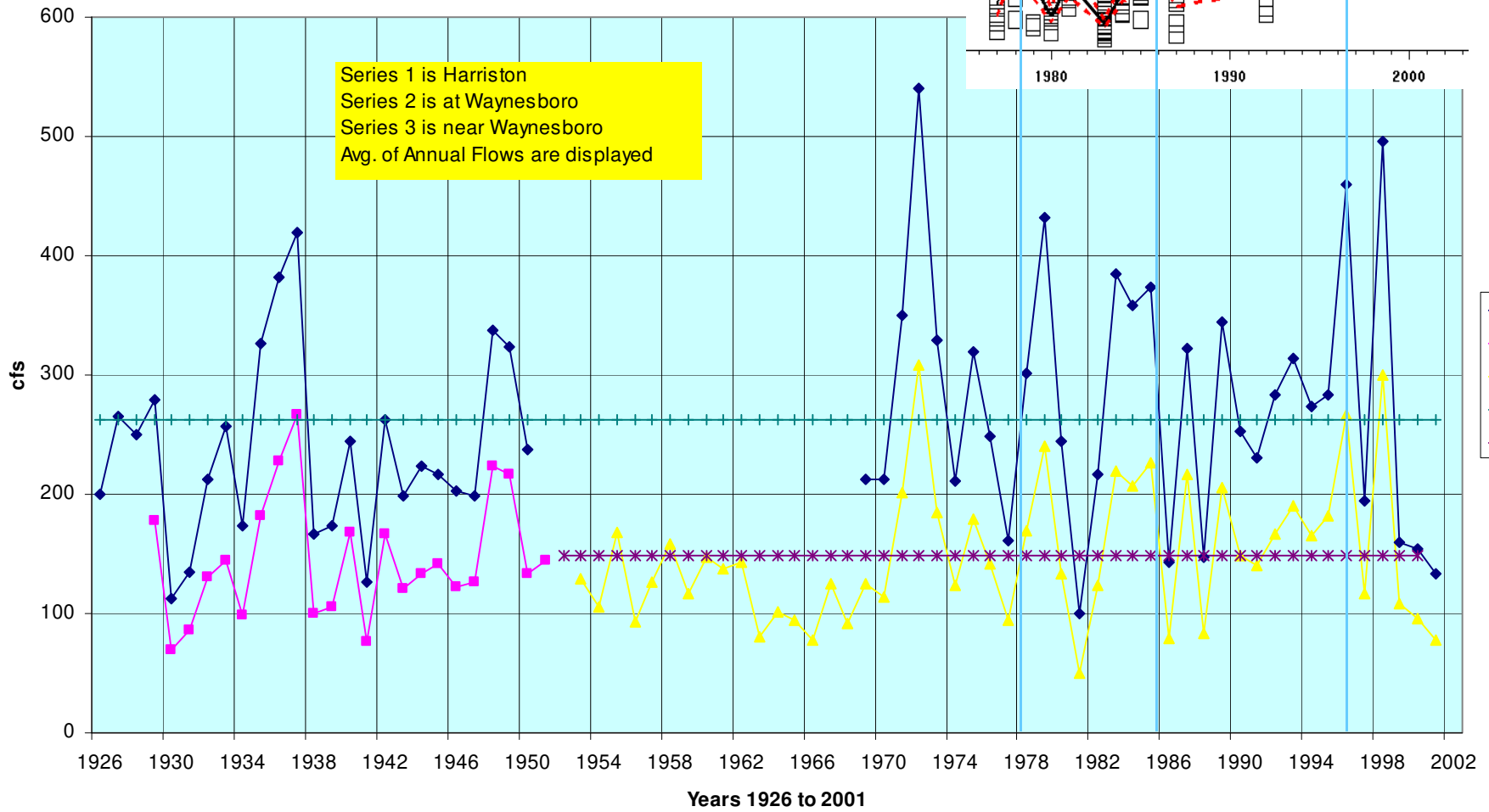
Other Dynamic Considerations

- Temporal - long term
 - Hydrographs suggest last 30 years wetter than previous 30
 - More controls on discharges and erosion (BMP) suggest less sediment loading
 - Wetter Conditions and Less sediment load would result in net erosion
- Temporal - short term
 - Alternating dry/wet years could influence trends in monitoring data

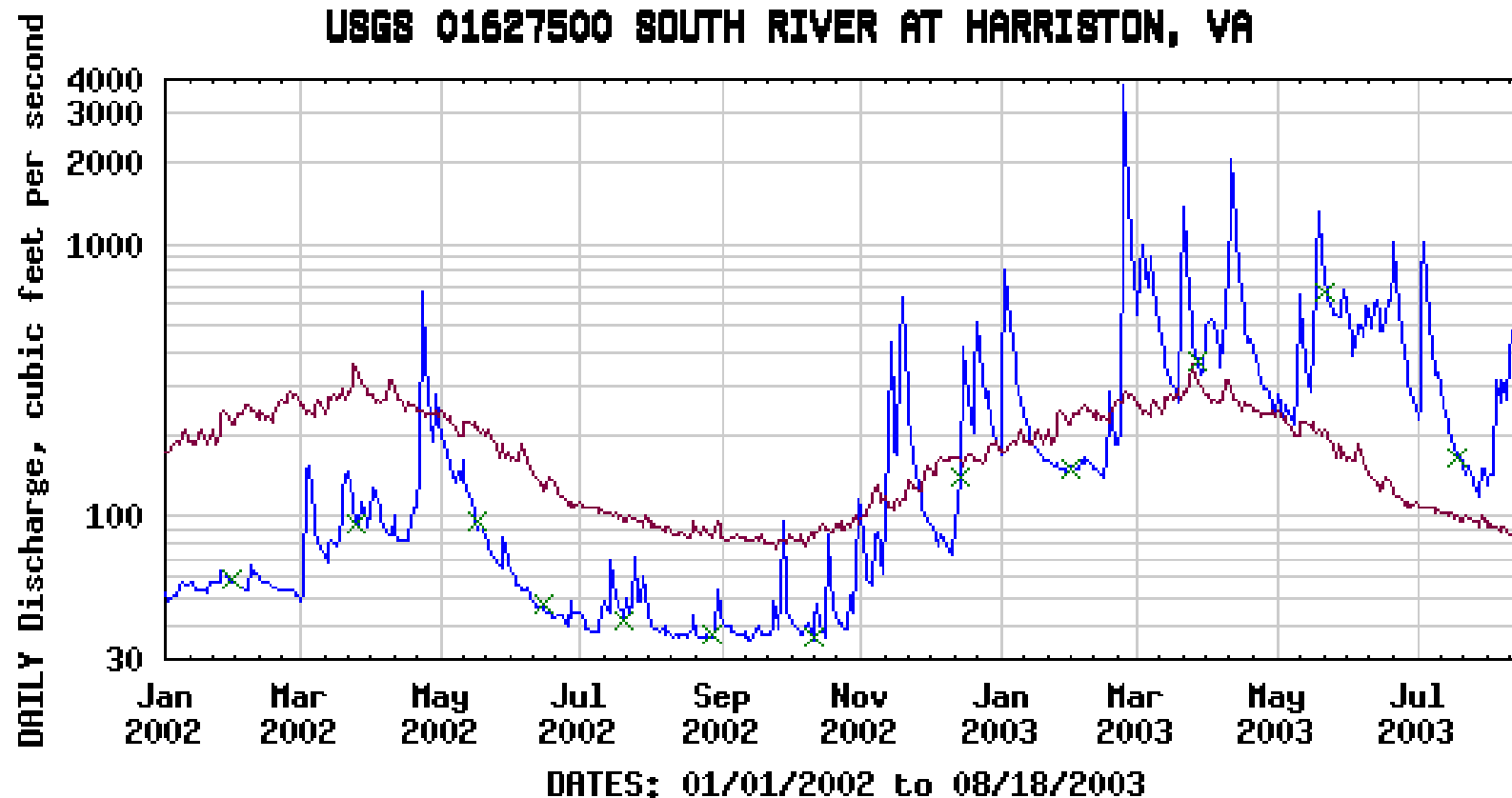




Annual Mean Stream Flow



USGS 01627500 SOUTH RIVER AT HARRISTON, VA



EXPLANATION

- DAILY MEAN DISCHARGE
- MEDIAN DAILY STREAMFLOW BASED ON 60 YEARS OF RECORD
- × MEASURED Discharge

Provisional Data Subject to Revision

Water Budget - Conclusions

- Hydrologic data and climatologic data are comparable in the 234 mi² watershed
- Total budget available to river (overland and groundwater seepage) is 16 to 16.31"/yr but proportion of groundwater is still uncertain
- GW discharge could make up 30 to 50% of total river flow
- Data does not have the spatial resolution to identify specific areas of higher GW discharge (springs)
 - Could be groundwater underflow below river but probably shortly returns to river
- Monthly/Annual variations in rainfall be one factor influencing trends in data