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.
    - PIs: 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)
    - PIs: 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)
    - PIs: 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

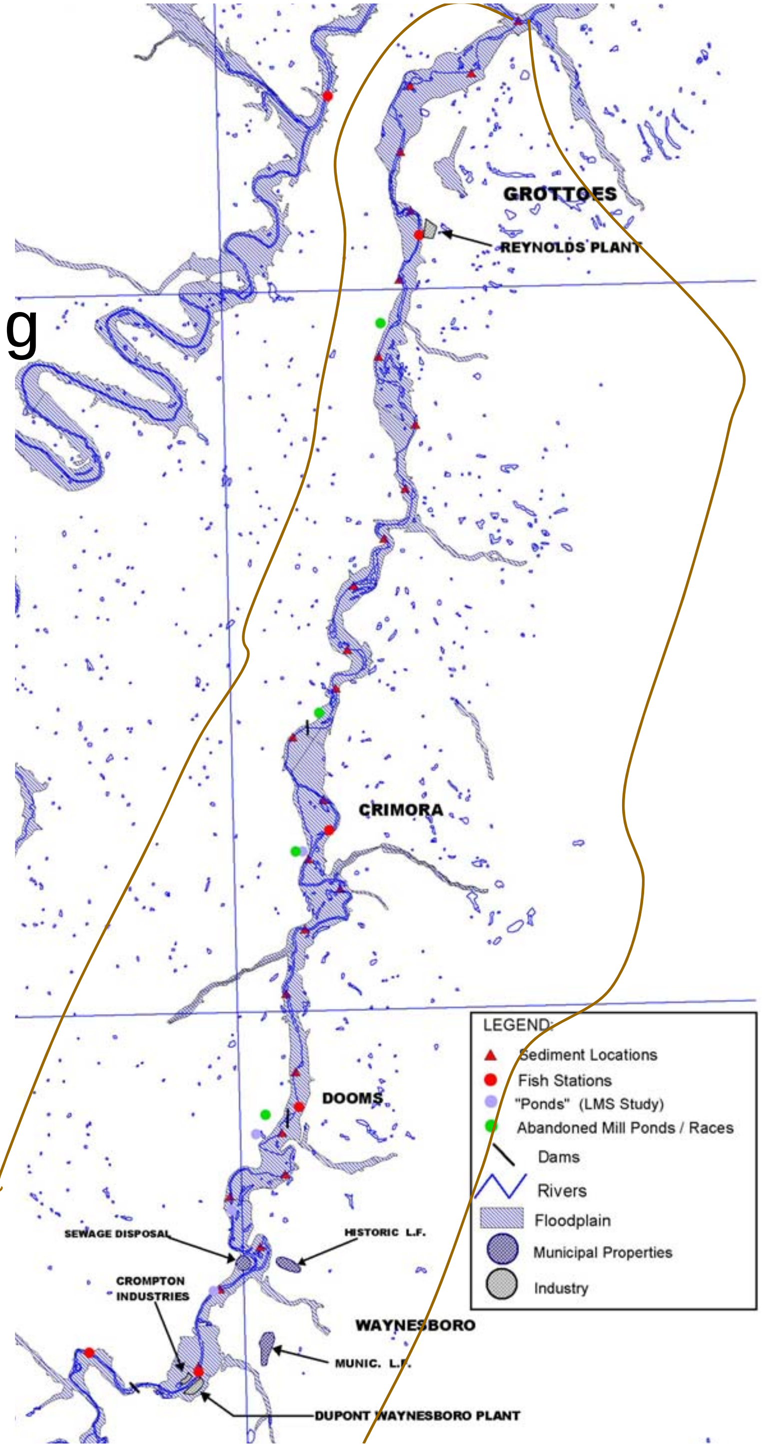
Geomorphologists

- 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 Prestegaard -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

N. R. Grosso
DuPont



Water Budget Evaluation Purpose

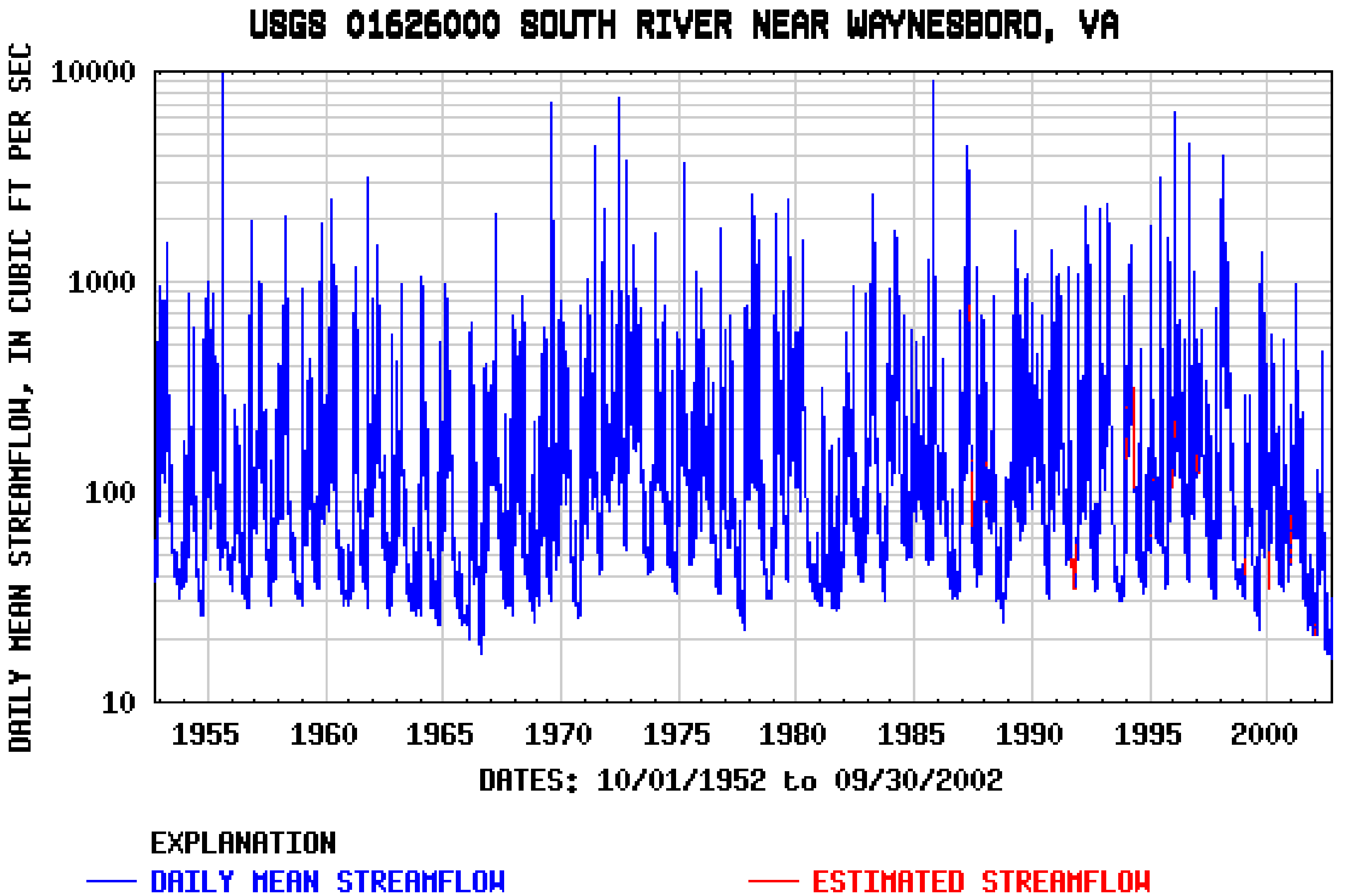
- Characterize general hydrology in the basin
- Determine a range for groundwater contribution to South River flow
- Evaluate potential for sub-aqueous springs
- Expand to understand solids balance in the basin

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
DAILY MEAN STREAMFLOW, IN CUBIC FT PER SEC
10000
1000
100
10
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
DATES: 10/01/1952 to 09/30/2002
EXPLANATION
DAILY MEAN STREAMFLOW
ESTIMATED STREAMFLOW

Drainage Basin Summary

- From source to confluence with North River 234.4 mi^2 area
- The ratios of river flow to drainage area are relatively consistent ~1.2 cfs/ mi^2 (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 = Evapotranspiration + Overland Runoff + GW Infiltration + Consumption**
  - River flow = GW seepage + Overland Runoff + 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

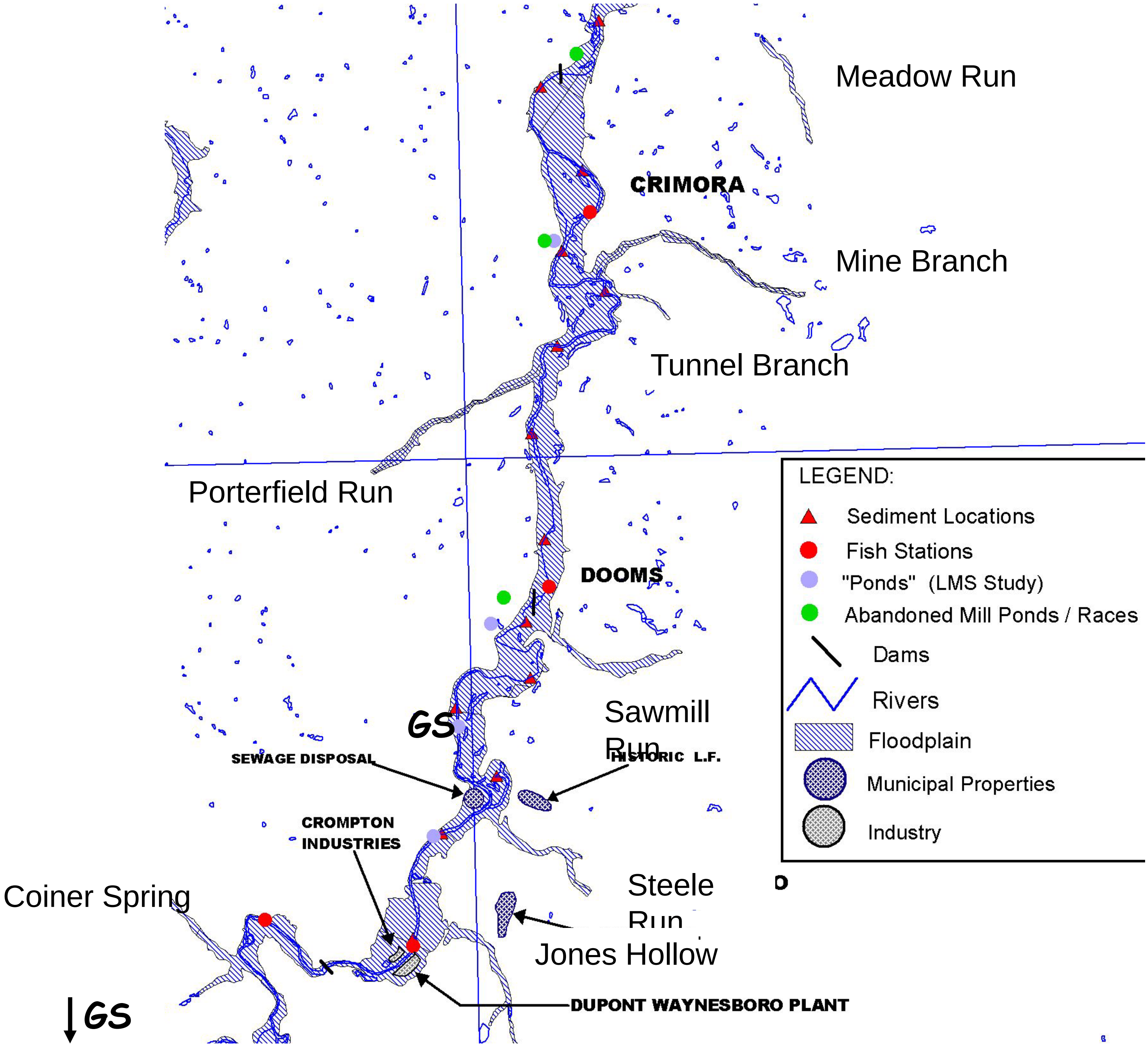
- 60% Forested
- 35% Grass and Cropland
- 5% Urban

Two of the many possible solutions

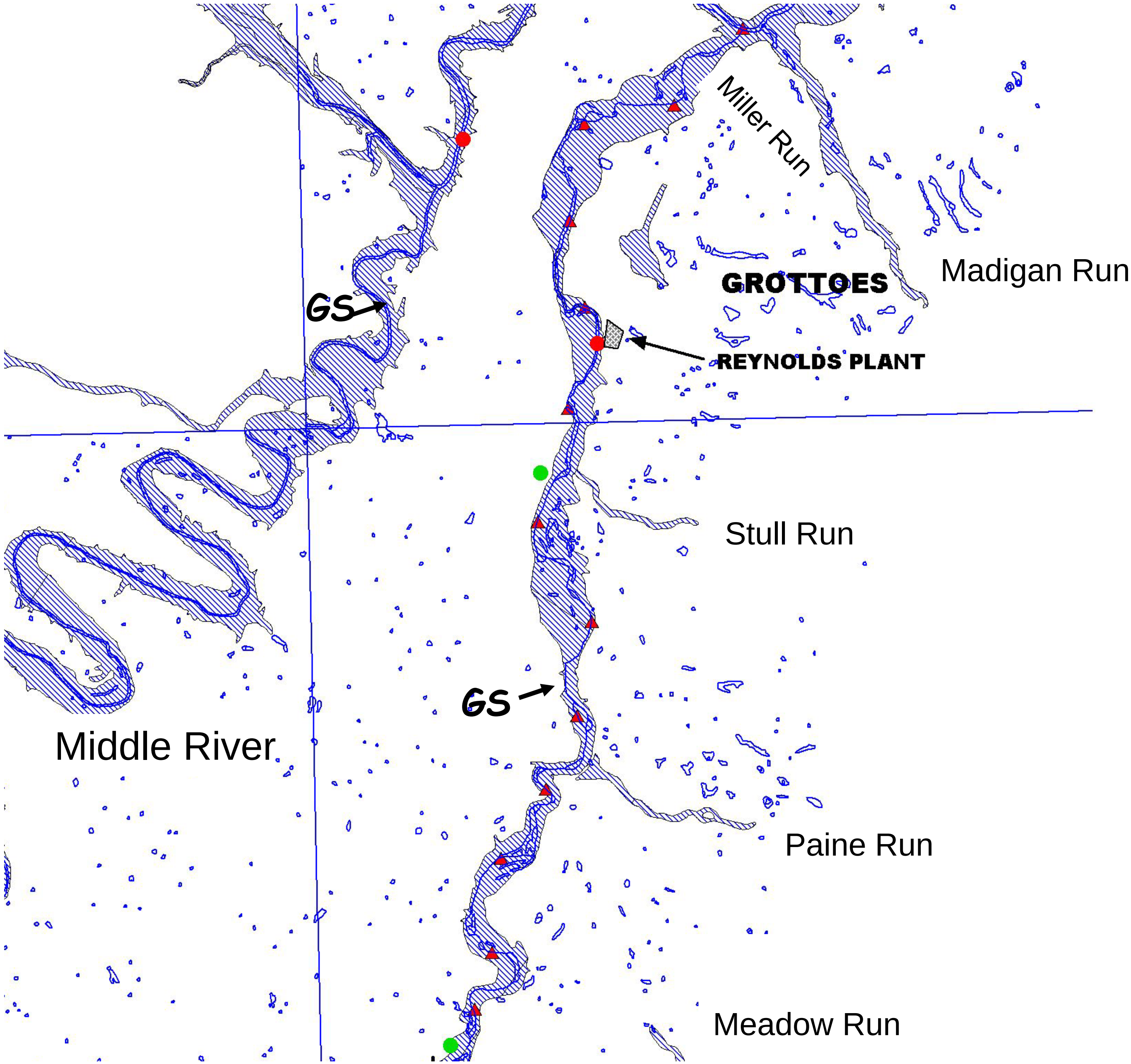
- PPT = **.55** as Et + **.13** as GW + **.32** as Runoff
- PPT = **.55** as Et + **.24** as GW + **.21** as Runoff
- Or total GW contribution to the river is between 99 cfs and 147 cfs of the 282 cfs total

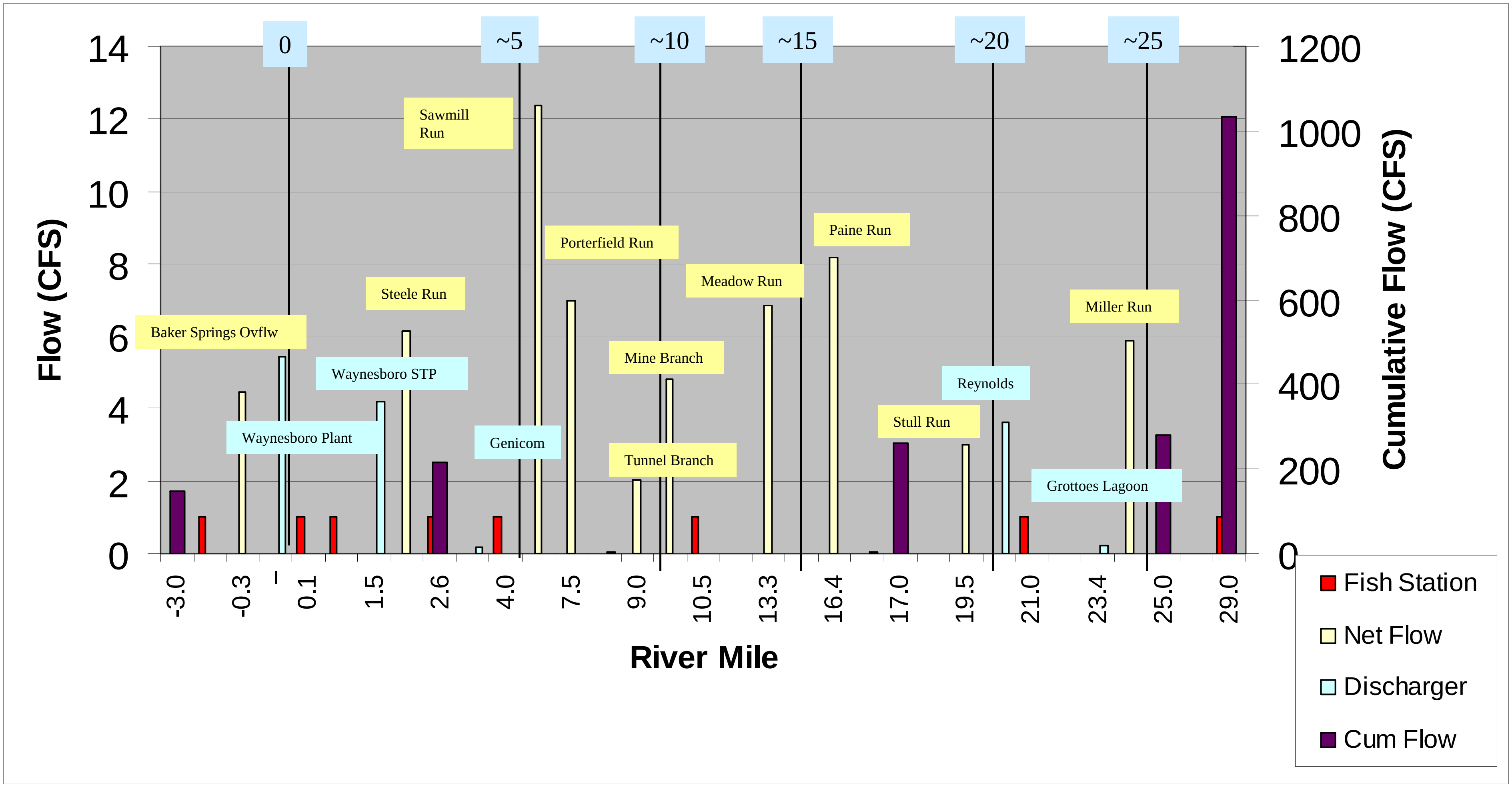
Spatial Considerations

- 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

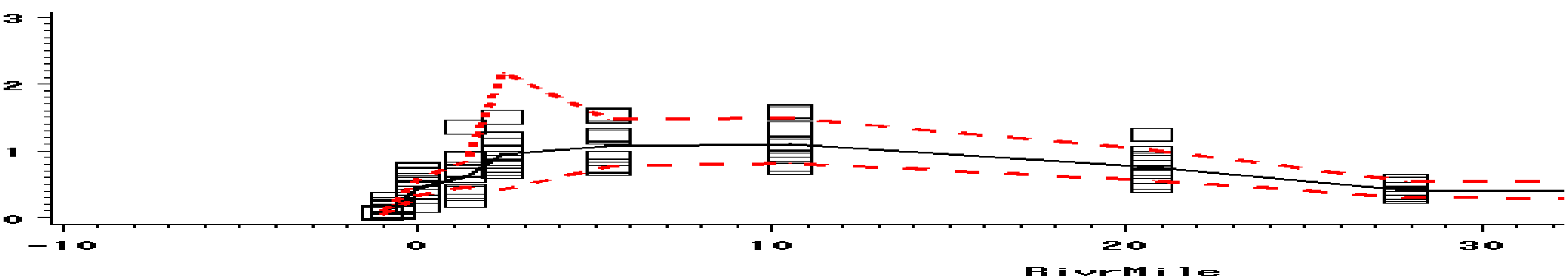


Meadow Run
CRIMORA
Mine Branch
Tunnel Branch
Porterfield Run
DOOMS
GS
Sawmill Run
SEWAGE DISPOSAL
HISTORIC L.F.
CROMPTON INDUSTRIES
Steele Run
Coiner Spring
Jones Hollow
DUPONT WAYNESBORO PLANT
GS
LEGEND:
Sediment Locations
Fish Stations
"Ponds" (LMS Study)
Abandoned Mill Ponds / Races
Dams
Rivers
Floodplain
Municipal Properties
Industry

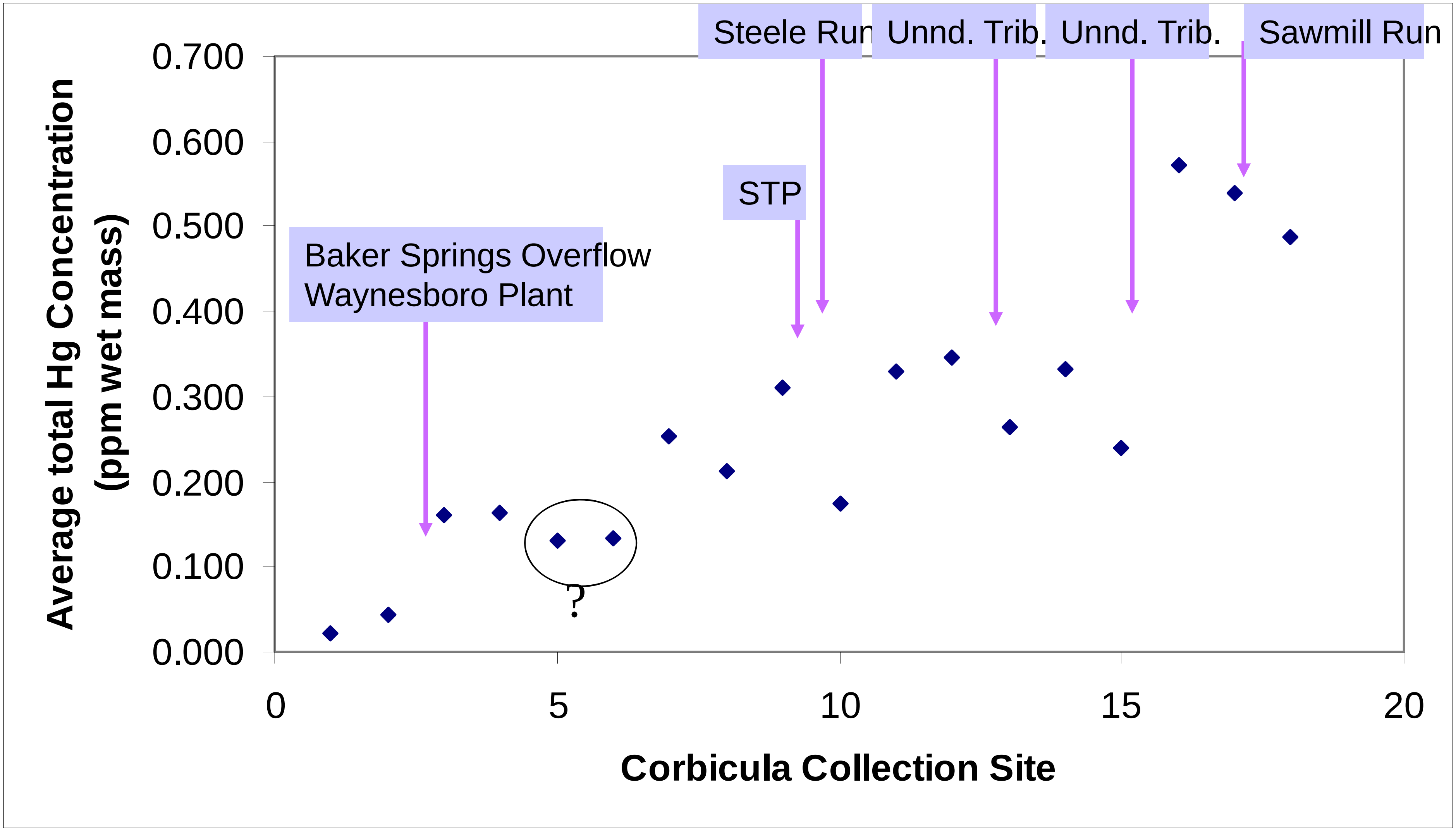

Miller Run
Madigan Run
GROTTOES
GS
REYNOLDS PLANT
Stull Run
GS
Middle River
Paine Run
Meadow Run



0
~5
~10
~15
~20
~25
Sawmill Run
Porterfield Run
Paine Run
Meadow Run
Steele Run
Miller Run
Baker Springs Ovflw
Waynesboro STP
Mine Branch
Reynolds
Waynesboro Plant
Genicom
Tunnel Branch
Stull Run
Grottoes Lagoon
Flow (CFS)
Cumulative Flow (CFS)
River Mile
14
12
10
8
6
4
2
0
1200
1000
800
600
400
200
0
-3.0
-0.3
0.1
1.5
2.6
4.0
7.5
9.0
10.5
13.3
16.4
17.0
19.5
21.0
23.4
25.0
29.0
Fish Station
Net Flow
Discharger
Cum Flow



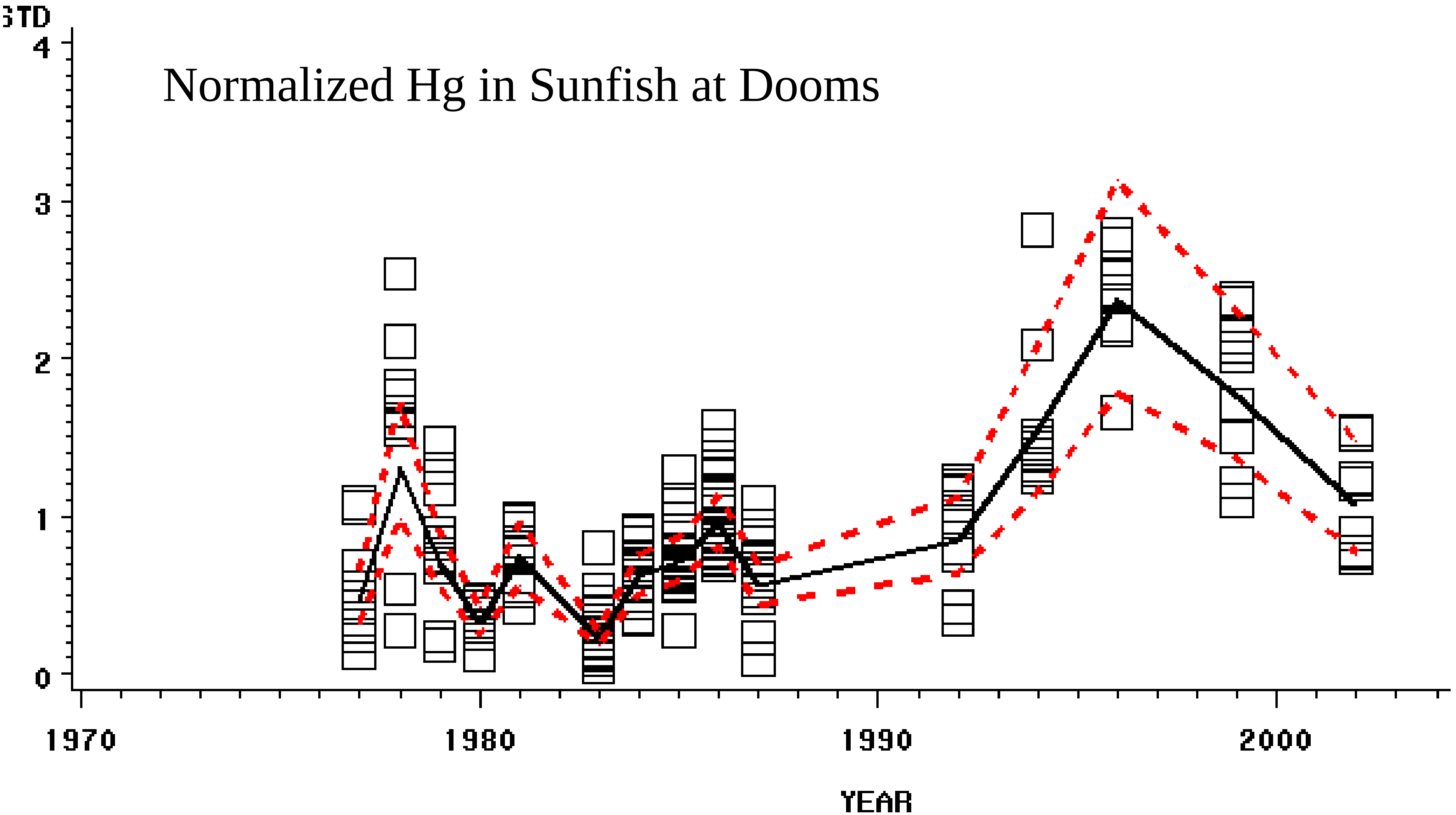
3
2
1
0
-10
0
10
20
30
RivrMile



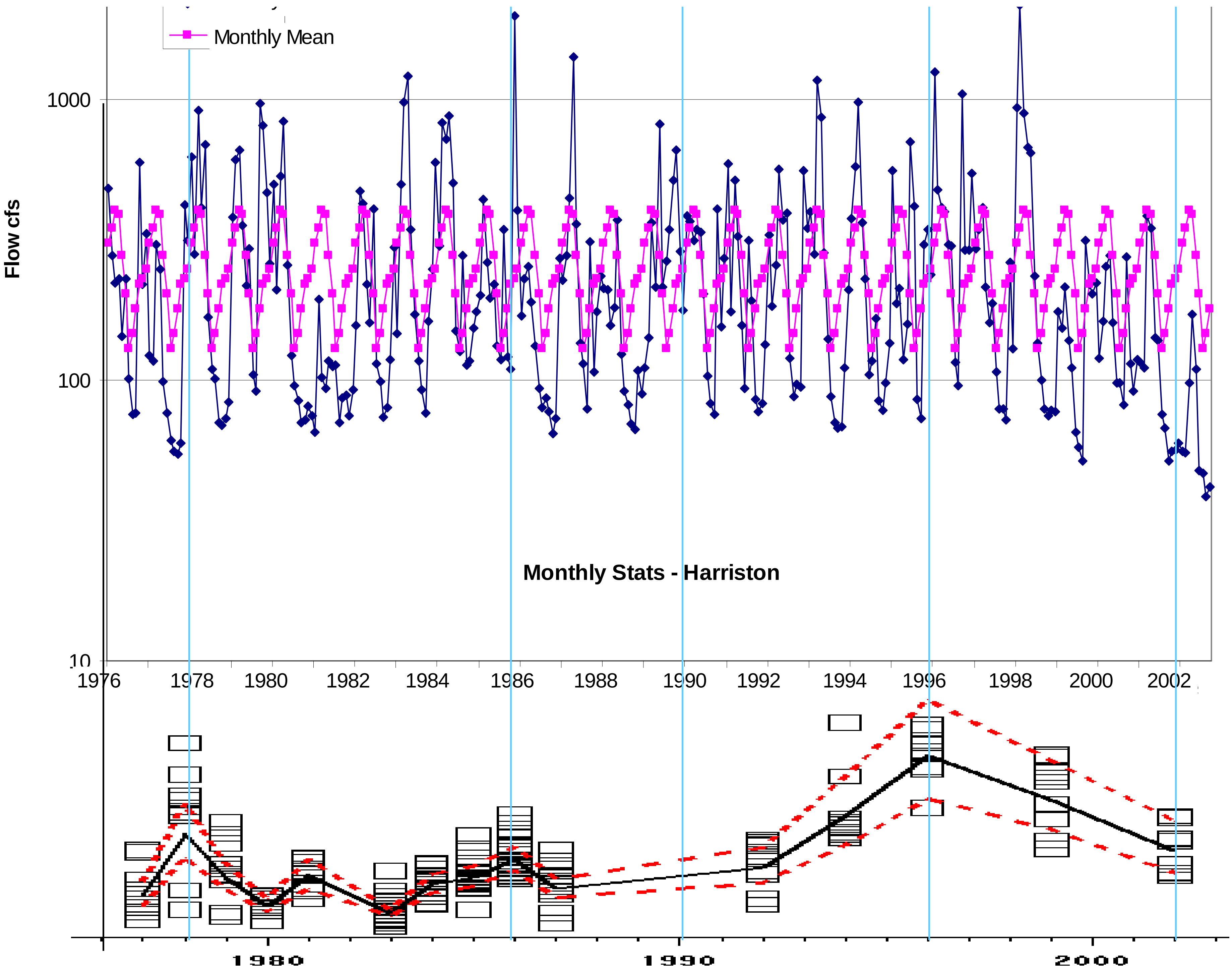
from Bowles and Benzing

Other Dynamic Considerations

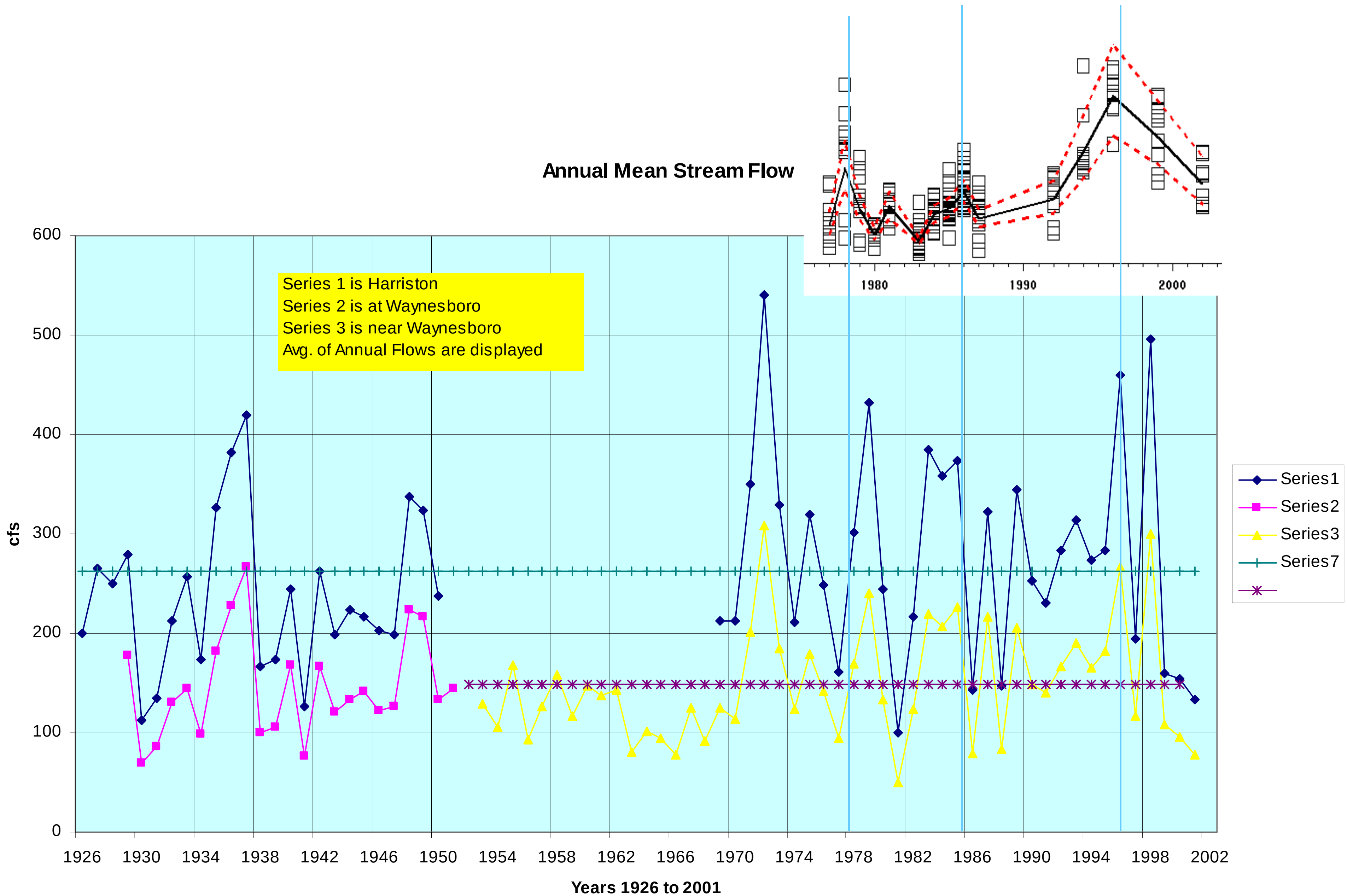
- Temporal - long term
  - Hydrographs suggest last 30 years wetter than previous 30
  - More controls on discharges and erosion (BMP) suggest less sediment loading
  - Wetter Conditions and Less sediment load would result in net erosion
- Temporal - short term
  - Alternating dry/wet years could influence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

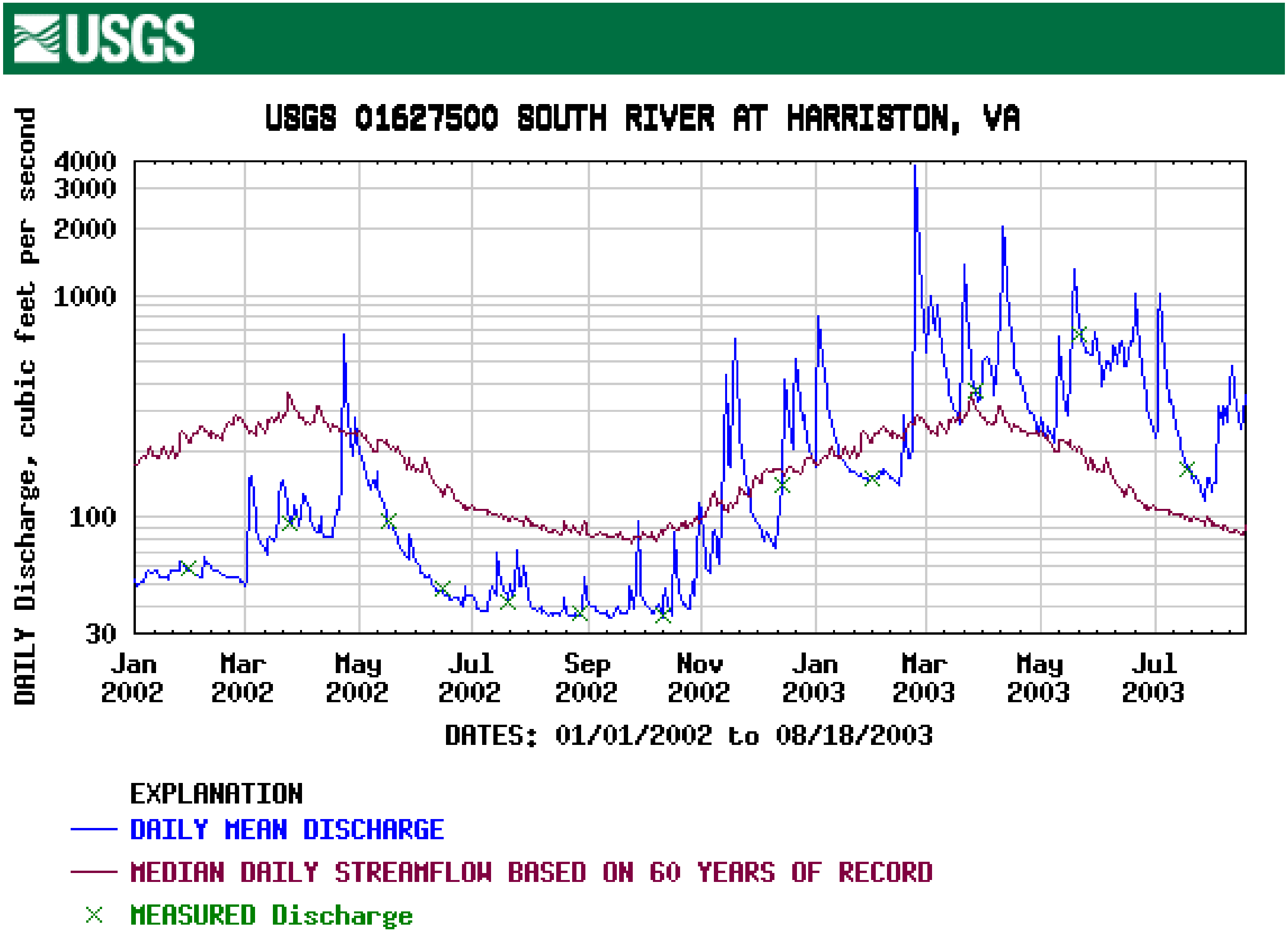


STD
4
3
2
1
0
Normalized Hg in Sunfish at Dooms
1970
1980
1990
2000
YEAR


Monthly Mean
Flow cfs
1000
100
10
Monthly Stats - Harriston
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
1980
1990
2000

Annual Mean Stream Flow





Provisional Data Subject to Revision

Water Budget - Conclusions

- Hydrologic data and climatologic data are comparable in the 234 mi^2 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