

Progress Report

Phase I System Characterization: Ecological Study of the South River and a Segment of the South Fork Shenandoah River

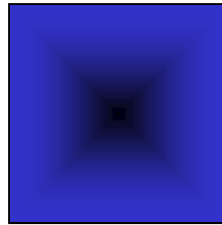


Presentation Outline

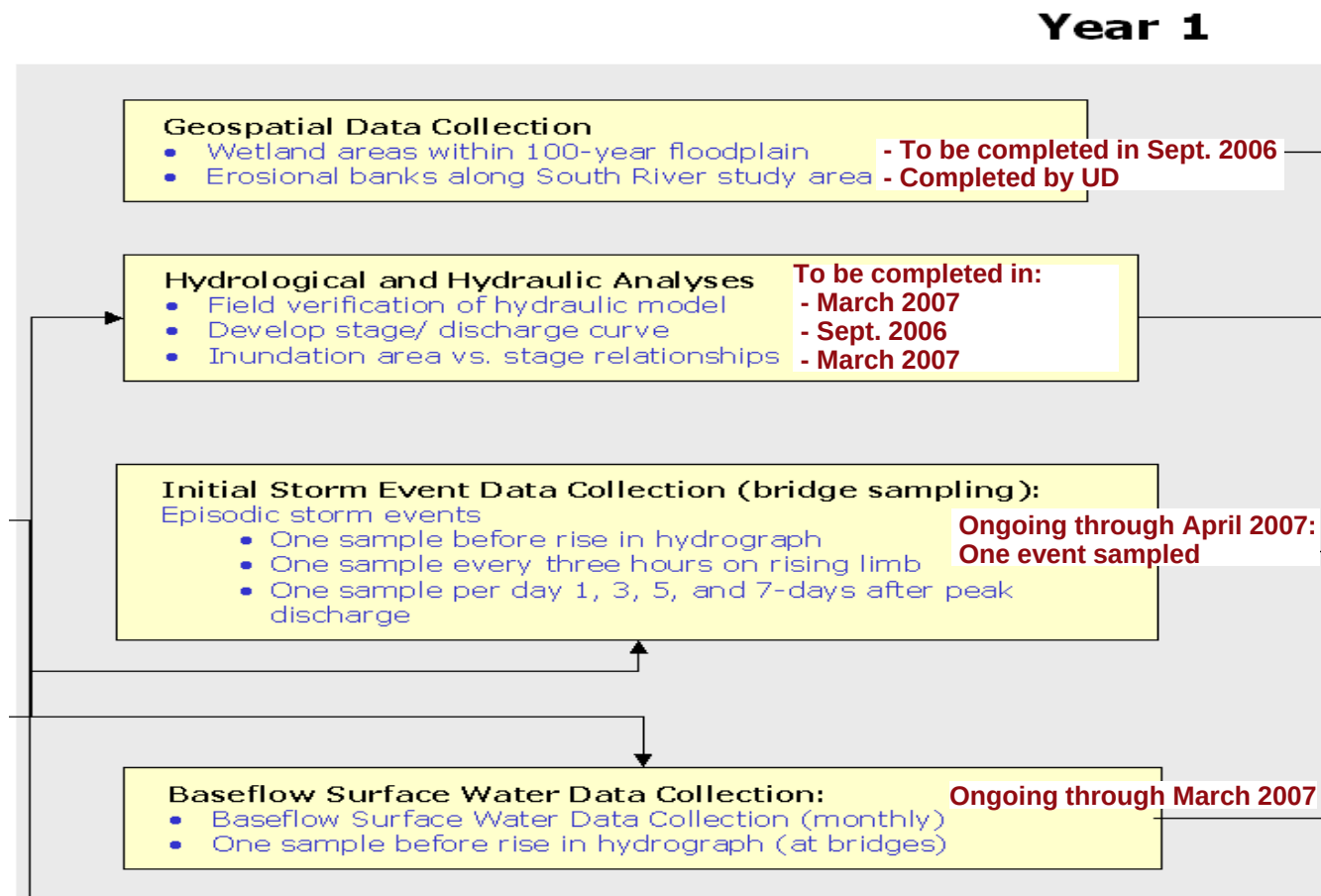
- Phase I - Year 1 Overview
 - Schedule of Remaining Activities
- Phase I - Year 1 Completed Activities
 - Loading Investigations
 - Baseline Physical and Biological Characterizations
- Phase I - Data Integration and Planning for Year 2 Studies

Overview: Phase I Ecological Study

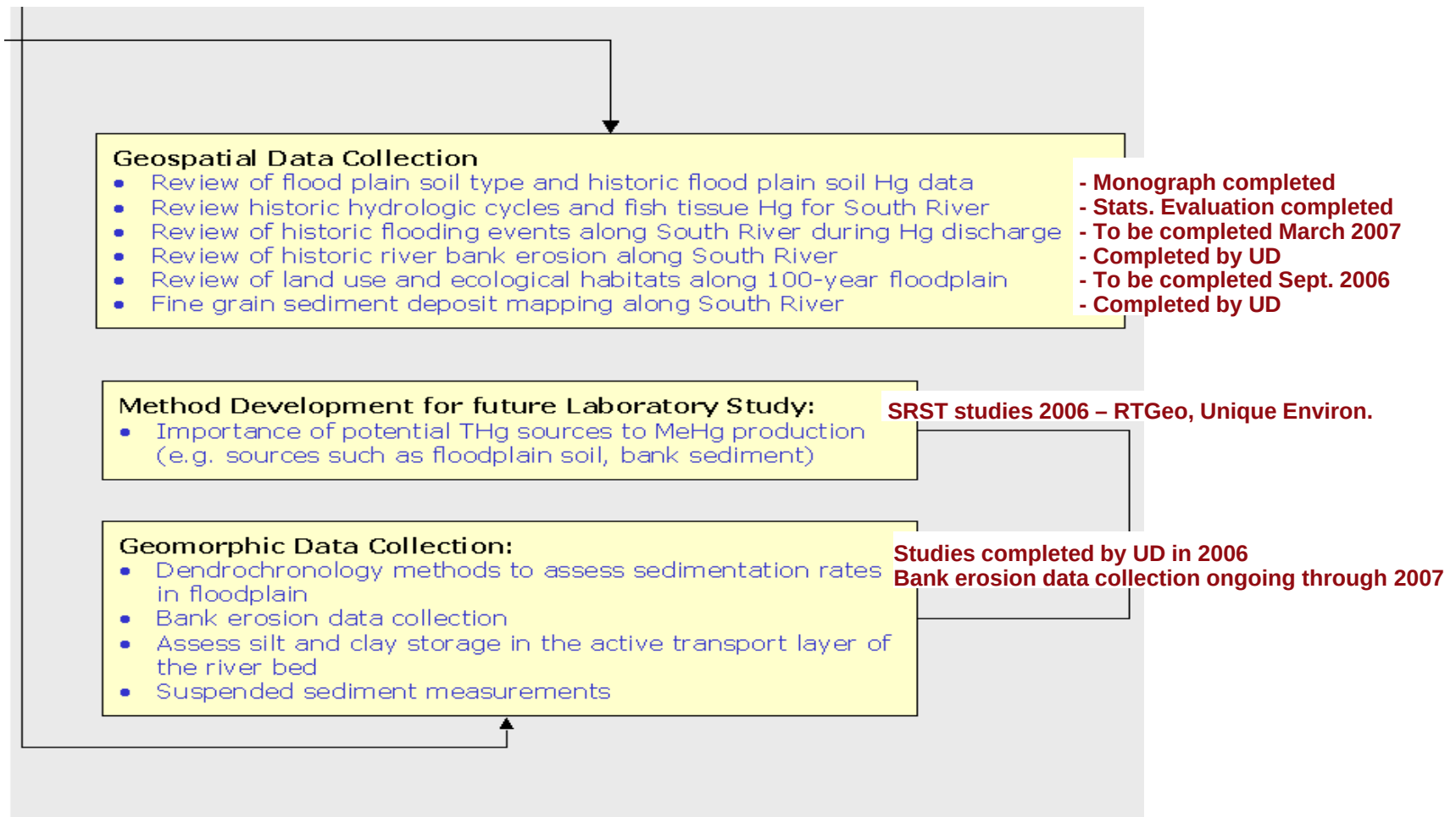
Conceptual Planning Flow Diagram



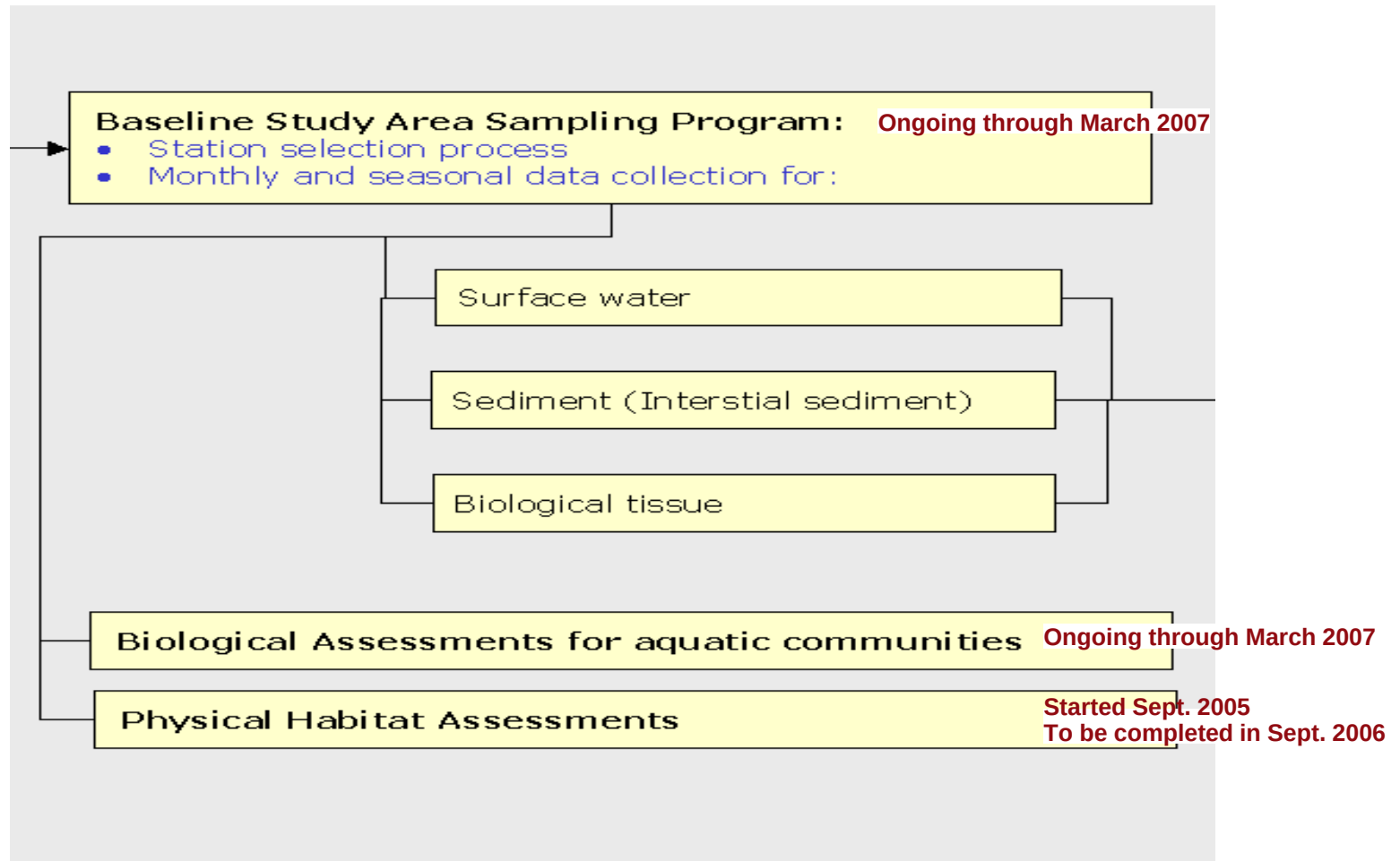
Phase I System Characterization – Year 1



Phase I System Characterization – Year 1



Phase I System Characterization – Year 1



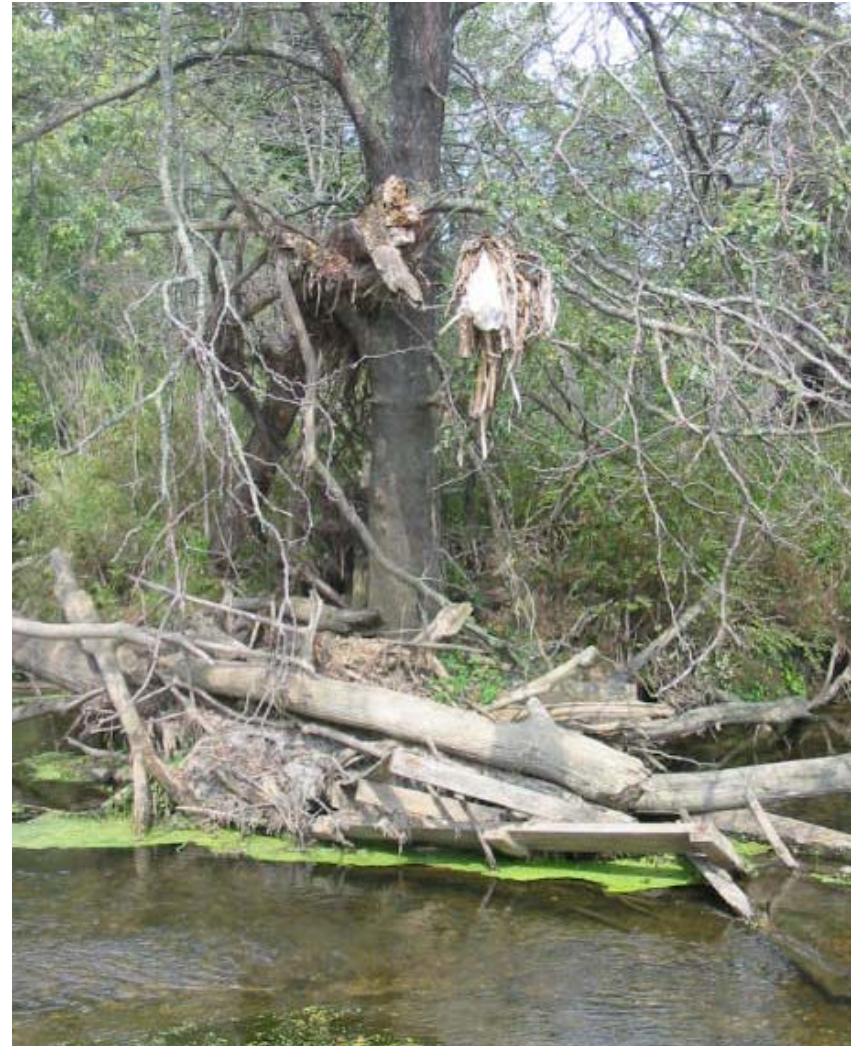
Phase I Loading Investigations

- Hydrologic and Hydraulic Modeling
- Storm Event Sampling Results
- Loading Calculations
 - Storm Flows – June
 - Baseline Flows – March – June

Hydrologic and Hydraulic Analyses

Progress Update:

- Field surveys of river cross-sections (27 total cross sections) are 95% complete.
- Development of elevation-discharge relationships (rating curves) for storm and baseline sampling locations on schedule for end of Sept. completion
- Predictive hydraulic model for the South River to be developed by January 2007



Hydrologic and Hydraulic Analyses

Figure depicting cross-section survey locations

Hydrologic and Hydraulic Analyses

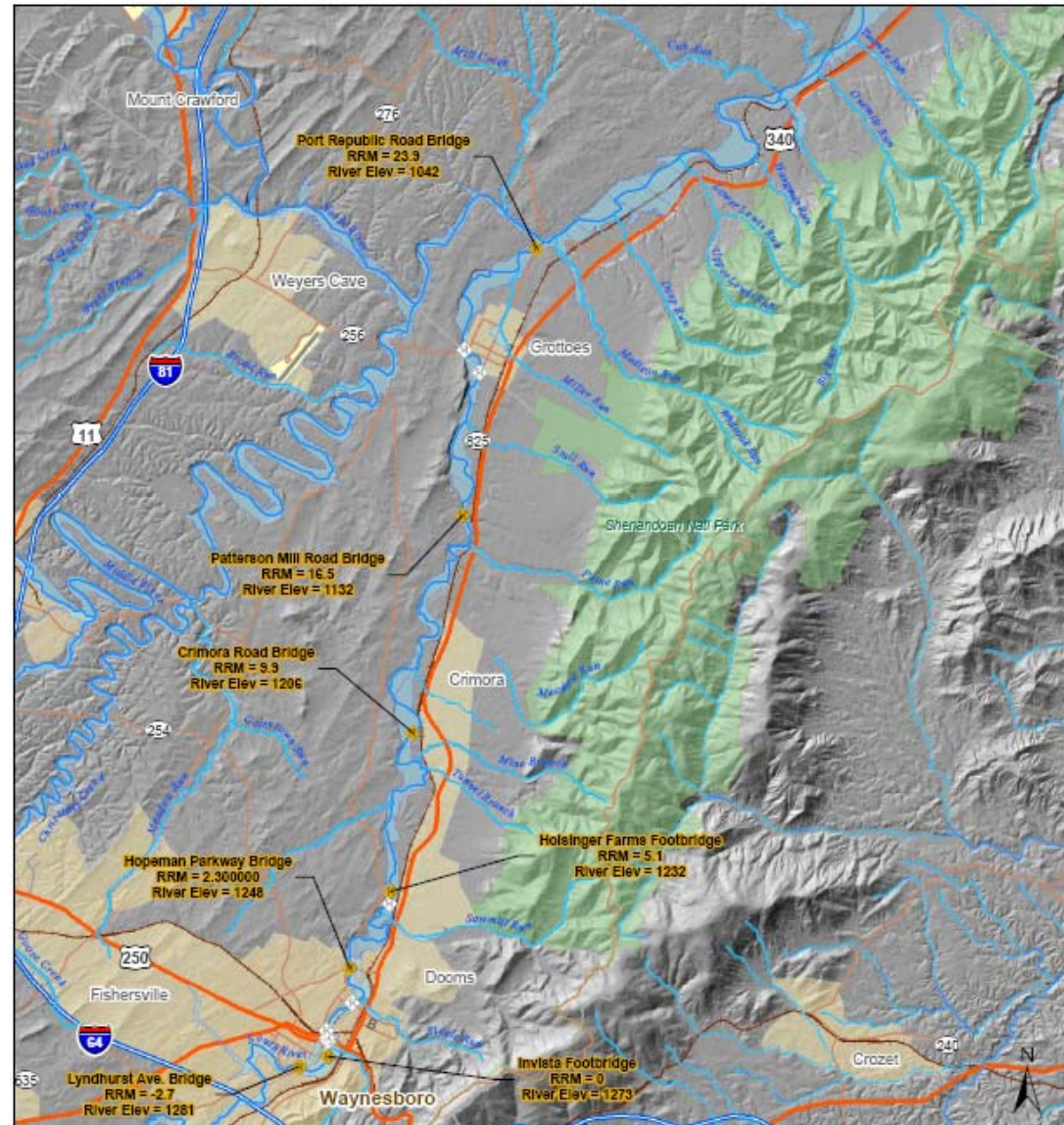
Figure depicting rating discharge curves for:

- Bridges
- Baseline sampling stations

Storm Event Sampling

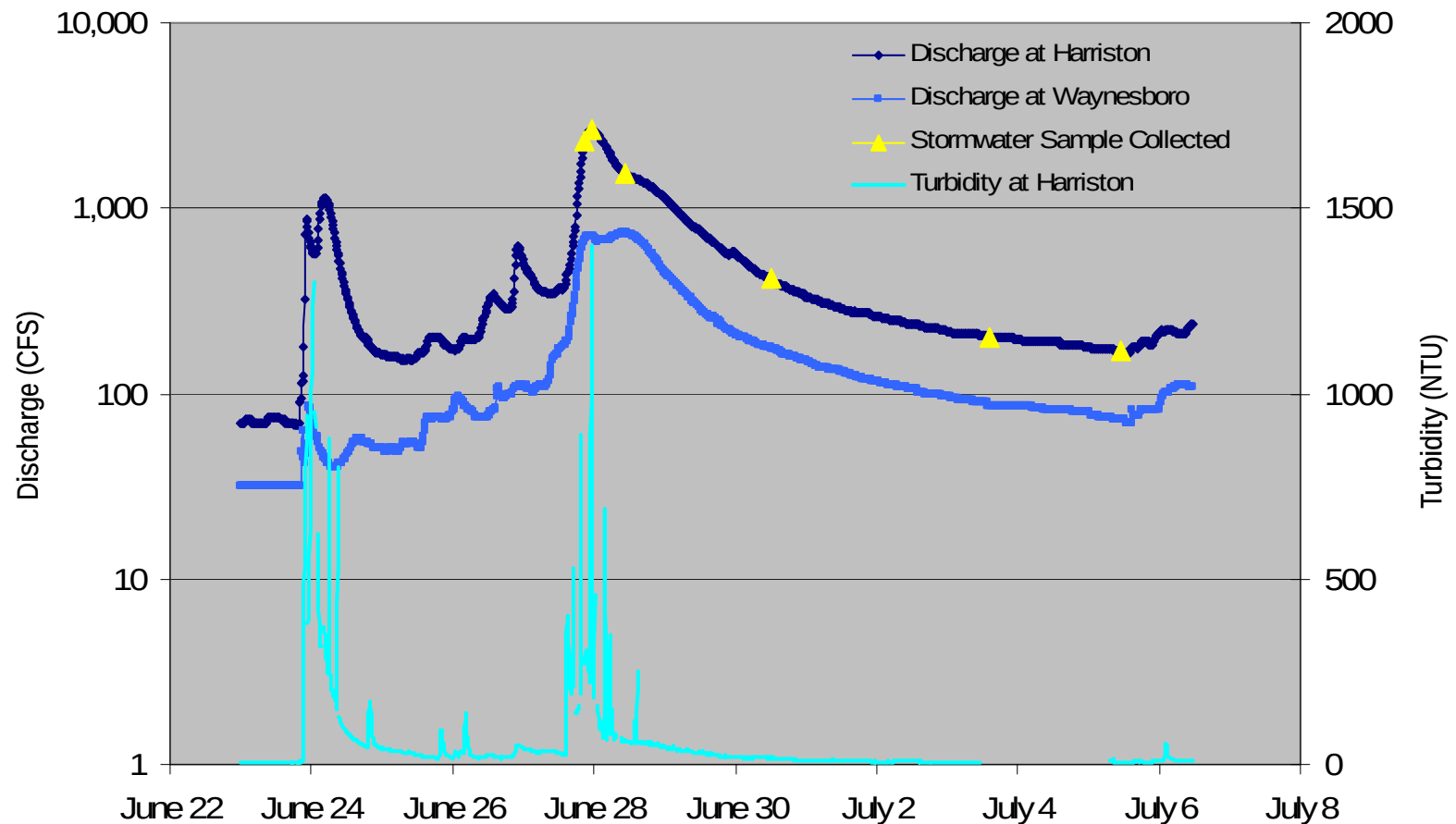
Sampling Goals:

- One storm event of > 500-cfs flow each season at 7 bridge locations
- Manual collection of discrete surface water samples over various intervals on the hydrograph
 - baseline conditions
 - 3-hr intervals during rising discharge
 - 1, 3, 5, and 7-days during falling discharge



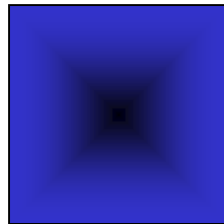
Storm Event Sampling, June 28

South River Real Time Discharge and Turbidity During Storm Event Sampling



Storm Event Data

June 2006



Storm Event Sampling – Discussion of June Results

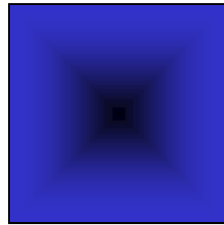
Total Mercury:

- Concentrations of total mercury in unfiltered samples increase over river length
 - Concentrations decrease by a factor of ~7 on the falling limb
- Concentrations of total mercury in filtered samples are generally lower than those detected under baseline conditions (flow volumes approximately 20X greater than baseflow)

Methylmercury:

- Unfiltered methylmercury concentrations initially high, decrease rapidly on falling limb due to association with particles
- Concentrations of methylmercury in filtered samples increase as water levels decrease due to lack of dilution

Storm and Baseline Flow Loading Calculations



Storm Flow Loading Discussion

Total Mercury:

- To be determined based on rating discharge curves to be developed during hydrologic modeling by end of Sept.

Methyl Mercury:

- To be determined based on rating discharge curves to be developed during hydrologic modeling by end of Sept.

Baseline Flow Loading Discussion

Total Mercury:

- To be determined based on rating discharge curves to be developed during hydrologic modeling by end of Sept.

Methyl Mercury:

- To be determined based on rating discharge curves to be developed during hydrologic modeling by end of Sept.

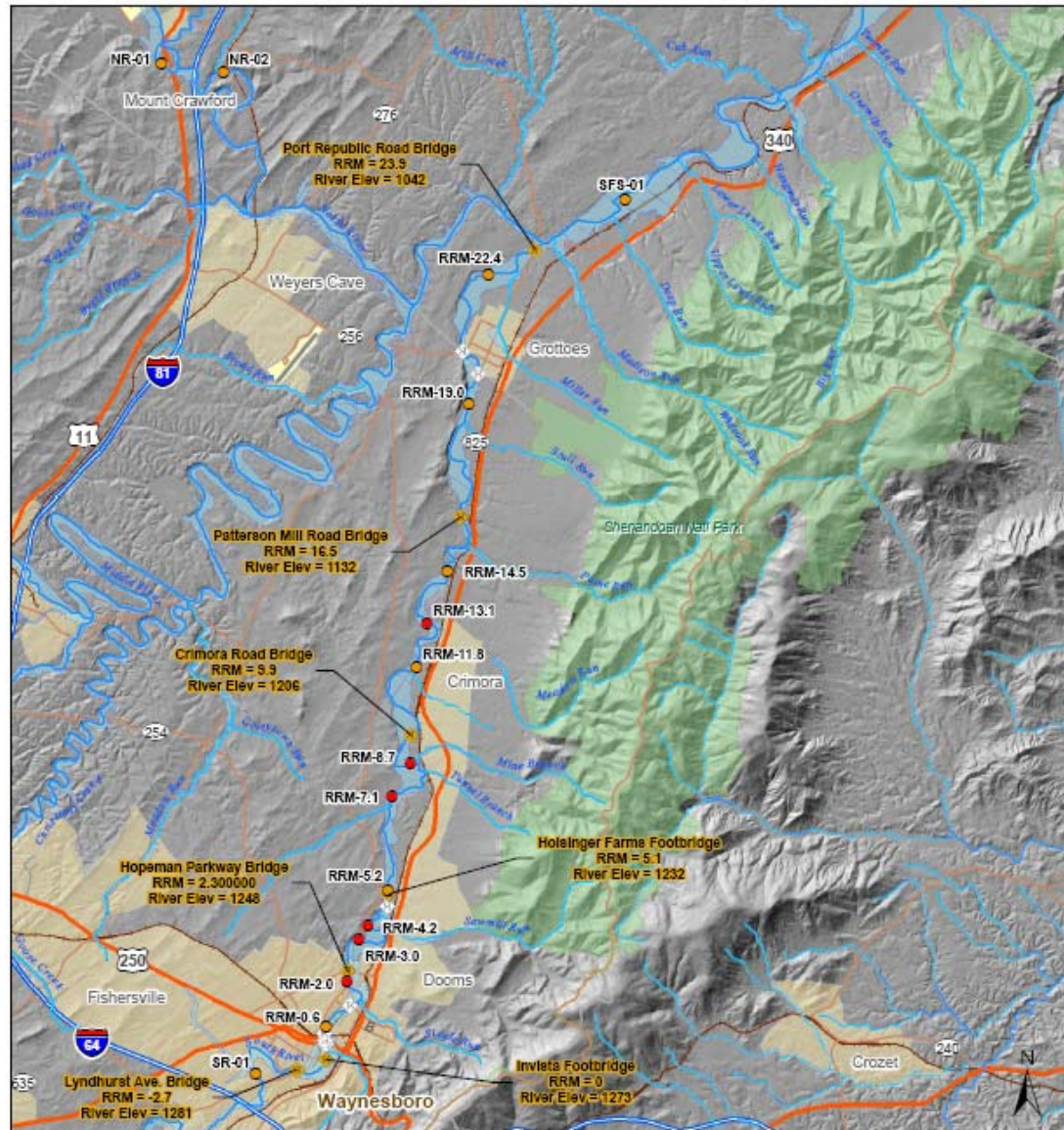
Phase I Baseline Physical and Biological Characterizations

- Surface Water, Sediment, and Biota Tissue Mercury Data
- Invertebrate and Fish Community Assessments
- Other Constituent Data
- Process for Reducing Baseline Analytes

Baseline Physical and Biological Characterization

Sampling Goals:

- 13 baseline stations in study area; 3 reference stations
- Monthly collections of surface water, sediment, and crayfish tissue
- Quarterly collections of other biological tissue
- Quarterly assessments of biological communities (fish biannually)



Baseline Physical and Biological Characterization

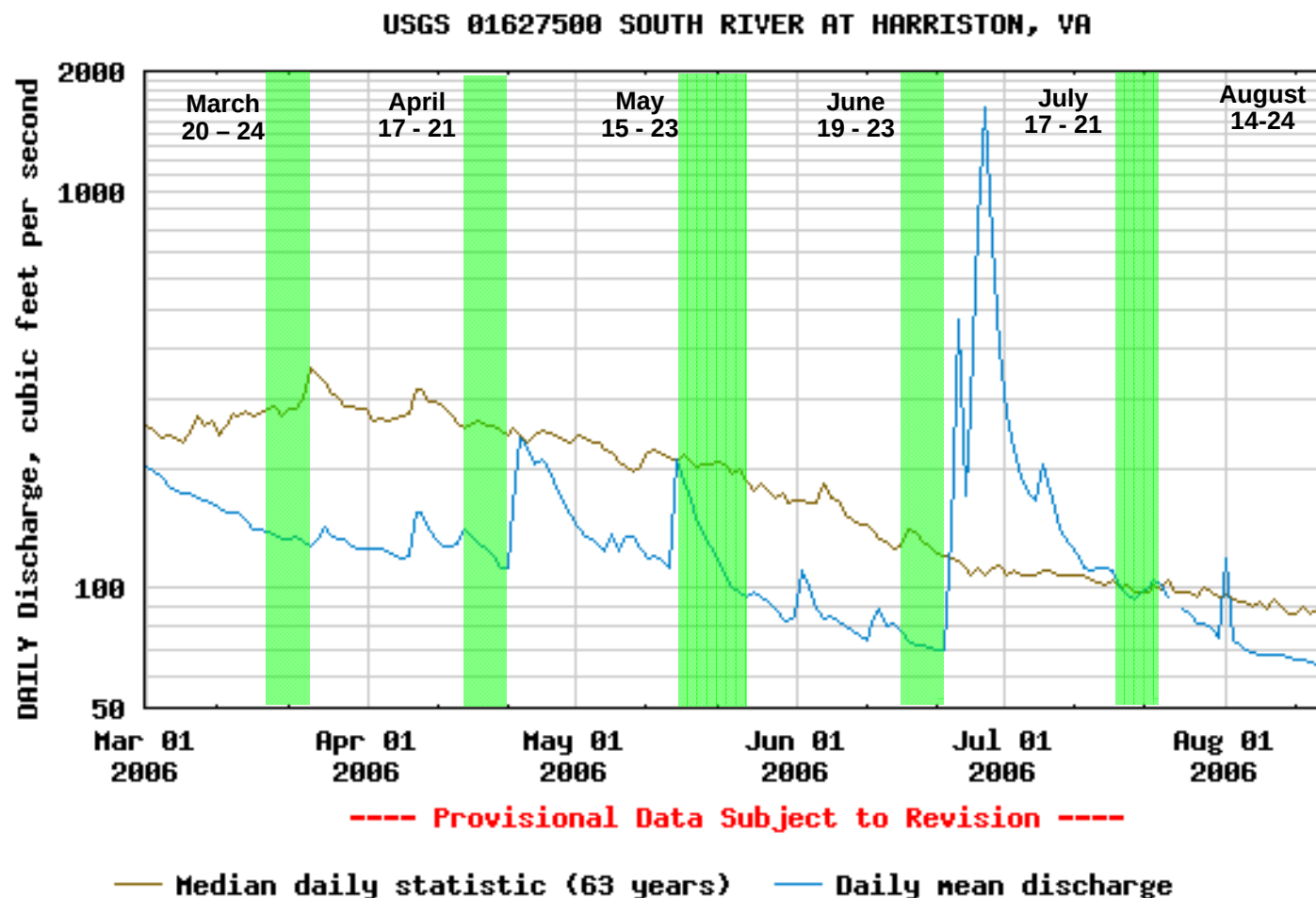
Progress Update:

- All sample parameters successfully collected at most locations
 - Physical habitat constraints at RRM-3.0 & 4.2
- March, April, June 2006: monthly collections of surface water, sediment, and crayfish tissue
- May and August 2006:
 - Surface water and sediment
 - Increased crayfish replication (n = 3)
 - Additional biological tissue samples (SAV samples in August)
 - Fish and Invertebrate Community assessments at selected locations

Matrix/Type	March	April	May	June	July	August
<i>Physical Media</i>						
Surface Water	✓	✓	✓	✓	✓	✓
Sediment	✓	✓	✓	✓	✓	✓
<i>Biological Tissue</i>						
Filamentous algae			✓			✓
Vascular Plants						✓
Crayfish	✓	✓	✓	✓	✓	✓
Corbicula			✓			✓
Diptera			✓			✓
Ephemeroptera			✓			✓
Trichoptera			✓			✓
Centrarchidae (Sunfish spp.)			✓			✓
Cyprinidae (Minnows)			✓			✓
Percidae (Darters)			✓			✓
<i>Community Assessments</i>						
Aquatic Invertebrates			✓			✓
Fish			✓			✓

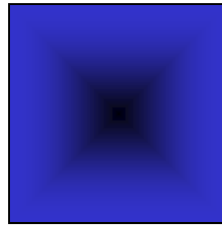
Baseline Physical and Biological Characterization

South River Daily Mean Discharge During Sampling



Surface Water Mercury Data

March - June 2006



Surface Water Discussion of Results

Total Mercury:

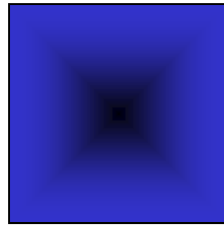
- Concentrations of total mercury in unfiltered samples generally similar among months with the exception of May
- Concentration generally reach a maximum around RRM-5.2 and maintain those concentrations until the confluence
- Concentrations of total mercury in filtered samples generally increase until RRM-19.0; Lower flows potentially account for higher concentrations observed in June samples
- Total mercury is strongly associated with particles between RRM-0 and ~RRM-5.2; association is weaker downstream of that point

Methylmercury:

- Methylmercury concentrations in filtered and unfiltered samples are lowest in March and generally similar April-June
- Methylmercury is less strongly bound to particles than total mercury and this association also decreases along river length

Sediment Mercury Data

March - June 2006



Sediment Discussion of Results

Total Mercury:

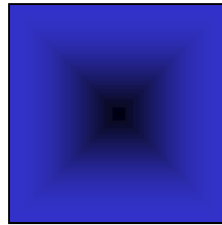
- Concentrations of total mercury in sediment are similar between months at each location
- Concentrations generally reach maximum between RRM-5.2 and 11.8 and decrease thereafter
- The percentage of KOH-extractable total mercury appeared to increase along the length of the South River

Methylmercury:

- Concentrations of methylmercury were significantly lower in March and May and increased in April and June at almost all South River sampling stations
- Maximum concentrations were generally attained near RRM-8.7 and 11.8, although the percent methylmercury generally increases with distance downstream

Biota Tissue Mercury Data

March - June 2006



Biota Tissue Discussion of Results

Crayfish:

- Concentrations of total mercury and methylmercury are similar among months upstream of RRM-7.1 and are more variable downstream

Forage Fish and Insects:

- The different groups of fish and insects generally display similar patterns of methylmercury and total mercury accumulation over the length of the river
- Percentage of methylmercury appear to vary less in fish but both fish and insects showed little change over the length of the river

Clams:

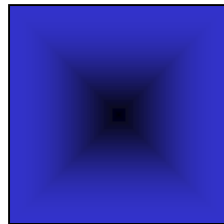
- Concentrations of total mercury are variable due to particulate trapping
- Concentrations of methylmercury increase similar to other tissue types with seemingly less variability between stations

Algae:

- Highly variable results due to differences in algal types at each location.
- Low percentages of methylmercury in tissue

Invertebrate and Fish Community Assessments

May 2006



Invertebrate and Fish Community Preliminary Data

Invertebrate Community:

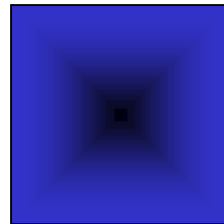
- Taxa richness was generally consistent along the South River and South Fork Shenandoah River; richness was generally lower at North River stations
- Invertebrate densities were generally consistent in the South River; higher densities were observed at sampling station NR-02 in the North River
- Community trophic structure is generally defined by gatherers and filterers
- Community tolerance metrics generally remained consistent among all sampling stations

Fish Community:

- Fish abundance and richness were highest at SR-01, however, electrofishing efficiency was also highest at this location (SR-01 has the lowest flow compared to other stations)
- The fish community shifts from primarily Cottidae and Cyprinidae near Waynesboro to Cyprinidae and Centrarchidae downstream
- Invertivores dominate the feeding groups at most stations and intolerant fish species account for the highest percentage of catch at most stations

Data for Other Constituents

March - June 2006



General Characterization of OCP Results

Surface Water:

- Two constituents detected; heptachlor and lindane at low concentrations (<0.01 ug/l)
- Slight exceedance of VAWQC for heptachlor in one sample; no VAWQC for lindane
- Maximum heptachlor and lindane concentrations below respective ORNL Lowest Chronic Values

General Characterization of PAH Results

Surface Water:

- No detections

Sediment:

- PAH concentrations in the study area increase immediately downstream of Waynesboro (RRM-0.6 and 3.0) and then rapidly decline
- TPAH levels for sediments are below organic carbon normalized screening benchmark (OME LEL)

Crayfish Tissue:

- PAH concentrations are variable between months and concentrations in crayfish tissue in the study area are similar to reference concentrations

General Characterization of Trace Metal Results

Surface Water:

- Maximum concentrations of metals in surface water do not exceed VAWQC chronic freshwater values

Sediment:

- Maximum metal concentrations are generally lower when compared to the NOAA (PEL) screening benchmark
- Metal concentrations in the study area increase downstream of Waynesboro and again at the confluence with Mine Creek
- Maximum concentrations of metals in the study area are generally less than 2X maximum reference concentrations

Crayfish Tissue:

- Metal concentrations in crayfish tissue in the study area are similar to reference concentrations, except copper
- Copper is an essential trace metal and regulated; concentrations responding to sediment zinc levels (co-interactions with zinc)

Process for Reducing Baseline Analytes for Surface Water

Weight of Evidence for OCP, PAH, and Trace Metals:

- Detection frequency and concentration range within the study and reference areas
- Comparisons of maximum detected concentrations to VAWQC chronic freshwater values and other conservative screening values (e.g. ORNL Lowest Chronic Values)

Process for Reducing Baseline Analytes for Sediment

Weight of Evidence for Trace Metals and PAHs:

- Detection frequency and concentration range within the study and reference areas
- Data represent conservative understanding of analytes because:
 - Biased collection technique targets fine-grained sediments and a subset of river substrate
 - Fine-grain sediment fraction generally contains highest constituent concentrations
- Comparisons of maximum concentrations of metals in the study area with 2X maximum reference concentrations
- Station specific average metal concentration comparisons with NOAA TEL and PEL values
- Comparison of station specific TPAH levels to organic carbon normalized screening benchmark for TPAH (OME LEL)

Process for Reducing Baseline Analytes for Crayfish Tissue

Weight of Evidence for Crayfish Tissue:

- Detection frequency and concentration range within the study and reference areas
- Comparisons of maximum concentrations in tissue in the study area with 2X maximum reference concentrations
- For regulated and essential trace metals; if trace metal is not present at levels in sediment and surface water that would potentially be of concern, then detections in tissues are also not likely to be of concern

Phase I Data Integration and Study Planning for Year 2

Phase I Loading Sample Program:

- Continue bridge and baseline flow SW sampling with refinements as needed
- Refinement of hydraulic model as needed
- Measure contribution from target river reach(es):
 - Deploy stormwater samplers to measure SW Hg in river and tributaries during bankfull and overflow storm events

Phase I Source Characterization Sample Program:

- Measure THg and MeHg concentration from specific features within target reach(es) such as:
 - Flood plain soils **Evaluations of floodplain soils will be conducted during Phase II**
 - Erosional bank soils
 - Wetland SW and soil
 - Fine grain sediment deposits within wetted perimeter
- Continue bank erosion rate data collection **Bank erosion studies by UD ongoing through 2007**
- Evaluate potential for methylation using anoxic incubations and/or sequential extraction (Bloom and Preus 2003) **Methylation potential and SSE methods as outlined in the WP will be applied to Source Characterization Studies**

Phase I Baseline Study Area Sample Program:

- Station selection process for target reach(es)
- Development of monitoring stations and target species/analytes

Year 2 Loading Studies: Continued from Year 1

Storm Event Sampling:

- Continue monitoring baseline, rising limb and falling limb of storm events
- Reduce bridge stations and modify timing and frequency of sample collection based on Year 1 data

Refine Hydraulic Model:

- Identification of high-water marks during storm sampling after over-bank storm event



Year 2 Loading Studies: Integrated Storm Event Sampling

Year 1 Data Integration for Study Identification:

- SRST evaluations for island side channels identified areas of potential MeHg production (RTGeo Sci. and Unique Environ.)
- Geomorphology studies identify:
 - Areas of historical/active bank erosion
 - Sections of the river with higher fine-grain sediment storage
- Wetland physical assessment identifies and quantifies wetland types along river
- Baseline/episodic data identifies reaches with enhanced THg and MeHg loading

Integrated Storm Event Sampling:

- Deploy passive stormwater sampling devices to measure rising limb THg and MeHg contributions from selected river features within targeted reaches



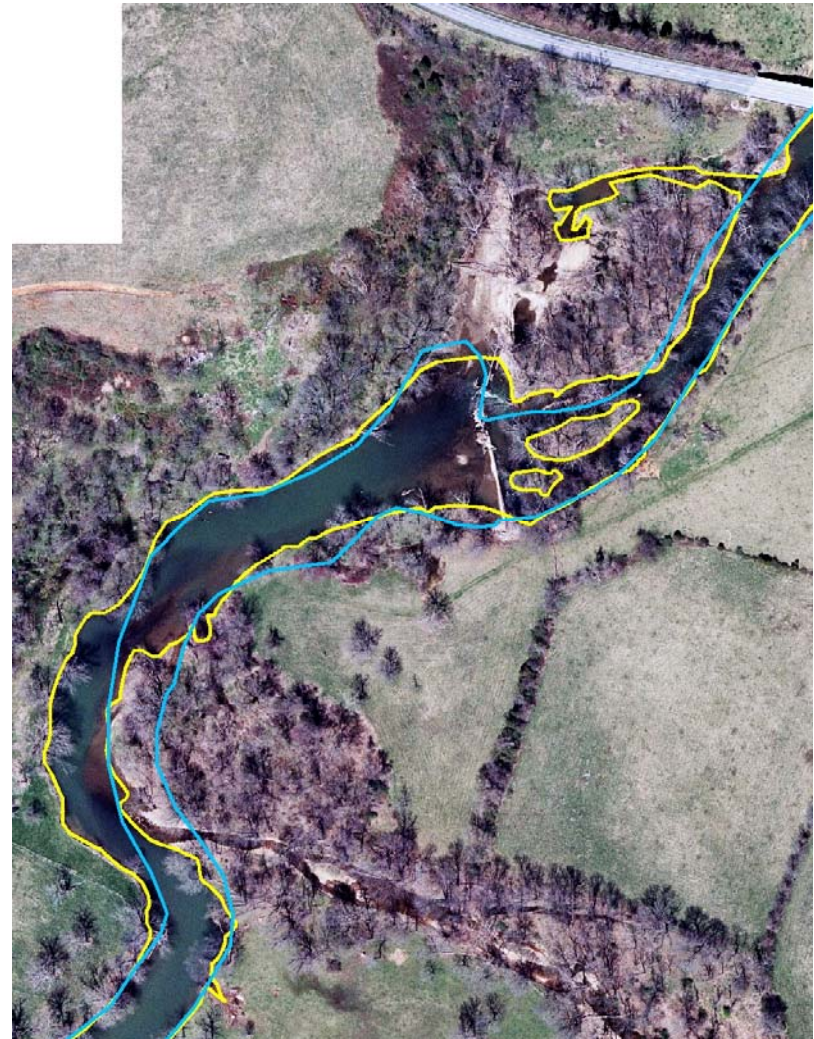
Year 2 Source Characterization: Eroding Banks

Year 1 Data Integration for Study Identification:

- SRST evaluations for near bank sediments identifies soils as important inputs to river (UD, RTGeo Sci., and Unique Environ.)
- Geomorphology studies identify:
 - Areas of historical/active bank erosion
 - Bank attached flood plains which may hold historic mercury deposits
- Baseline/episodic data identifies reaches with enhanced THg loading

Eroding Bank Study:

- Composite samples at 2 intervals for eroding banks (THg, LOI, MeHg subset)
- Bank soil Hg concentration combined with erosion rate data to calculate loading rates
- SSE and methylation potentials for soils to assess role in internal loading



Year 2 Source Characterization: Wetlands

Year 1 Data Integration for Study Identification:

- SRST evaluations for island side channels identified areas of potential MeHg production (RTGeo Sci. and Unique Environ.)
- Baseline/episodic data identifies reaches and seasons with enhanced MeHg loading
- Wetland physical assessment identifies and quantifies wetland types along river
- Hydraulic modeling identify wetland areas attached to the river during various river flow regimes:
 - baseline,
 - bank-full,
 - and overflow on floodplain

Wetland Study:

- Composite sediment samples and surface water samples collected within a variety of wetland types, twice during year 2 (THg, LOI, and MeHg)
- Methylation potentials for sediment to assess role in internal loading



Year 2 Source Characterization: Depositional Features

Year 1 Data Integration for Study Identification:

- Geomorphology studies identify and characterize:
 - Fine grain sediment deposits along the river
 - Sections of the river with higher fine-grain sediment storage
 - Several deposits for THg and age of deposit
- Baseline/episodic data identifies reaches with enhanced THg loading

Fine-grain Sediment Deposit Study:

- Collection of sediment core at various fine-grain deposits along the South River study area (THg, LOI, MeHg subset)
- SSE and methylation potentials to assess role in internal loading



Year 2 Baseline Study Area

Baseline Monitoring:

- Evaluate Year 1 data collections, potential data gaps, and objectives for Phase II studies
- Continue monitoring at selected locations identified as potential study or reference areas; reduce sampling program based on Year 1 findings

