

# Simulation Results Reaching New Heights

## TMDL Update - October, 2008



# TMDL (Total Maximum Daily Load) regulatory process is driven by fish tissue Me-Hg concentrations being above 0.3 ppm

*How much mercury can get into the South River without raising fish tissue Hg above 0.3 ppm?*

Current load - No. Fish currently have Hg concentrations above 0.3 ppm  
0 kilograms/year – Yes but not feasible.

10 kilograms/year - ??

1 kilograms/year - ??

Goal of TMDL study is to answer the question using best available methods.

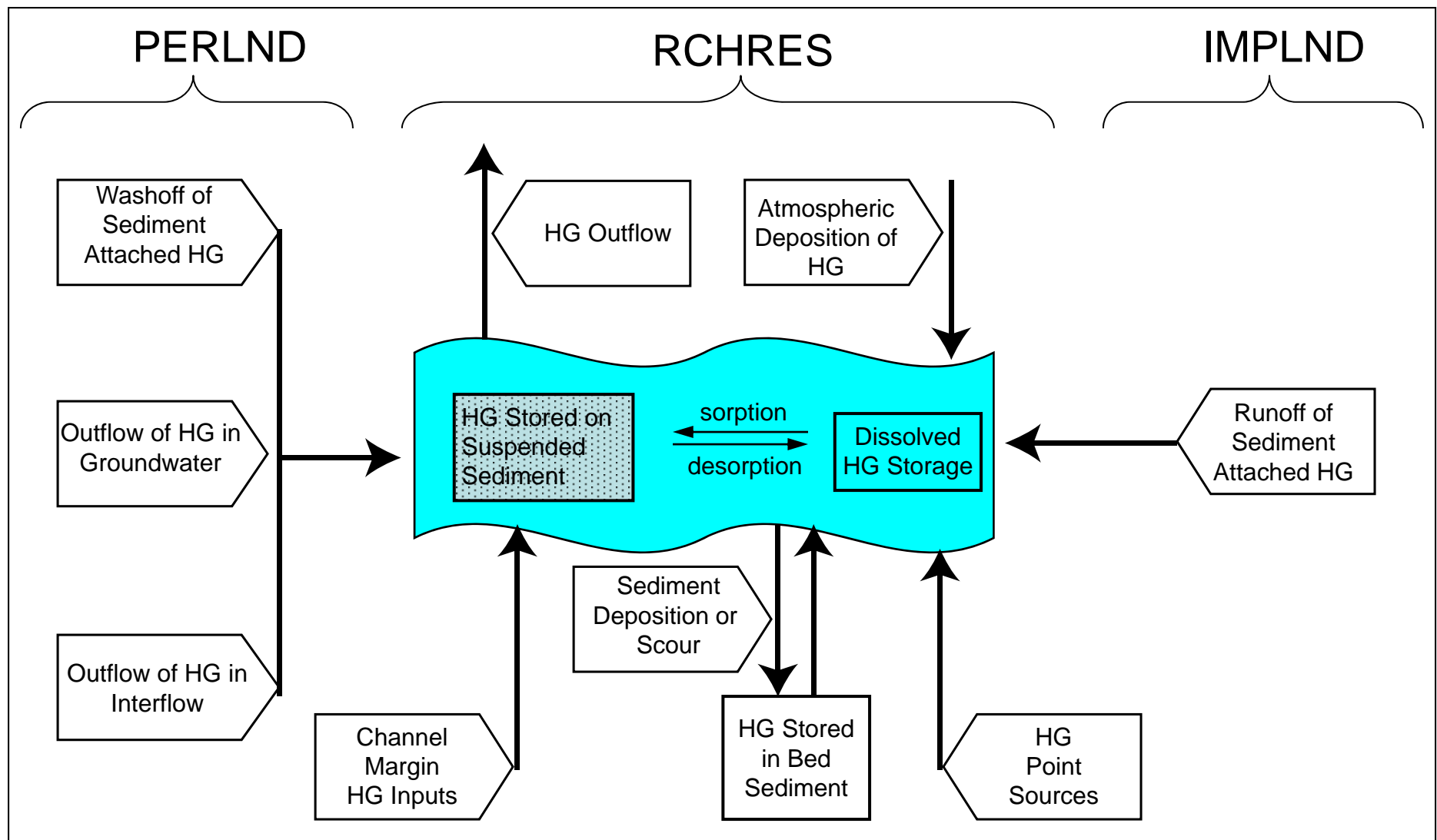
Assumptions:

Mass balance of mercury, Hg bank account must be balanced  
implemented via simulation using HSPF

Fish tissue Hg conc. derived from correlation with water column Hg  
implemented via bioaccumulation factor model (BAF)



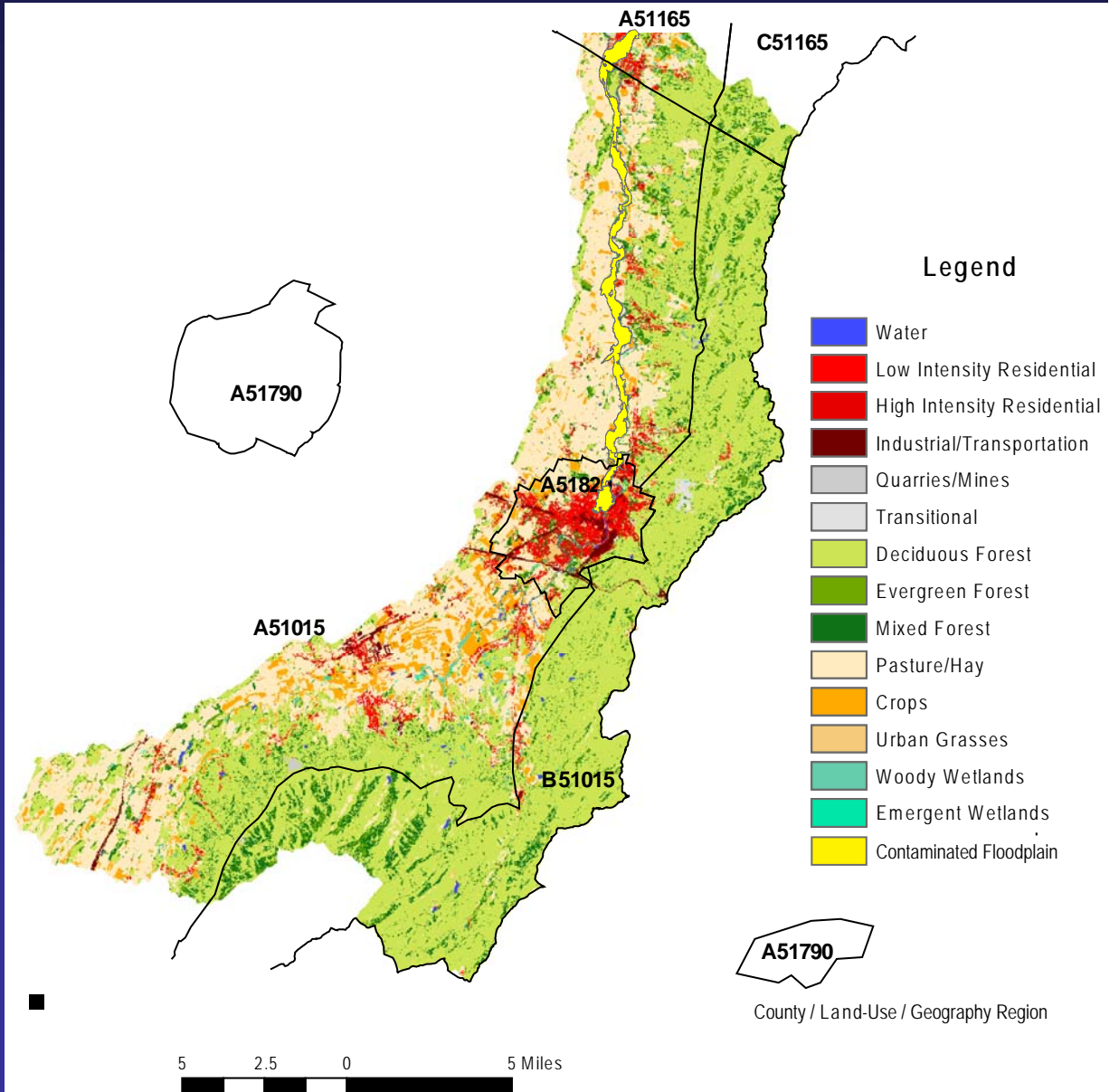
# HSPF Simulation of Mercury in the South River Watershed



# Hydrologic Response Units in Model :

Determined by :  
Land Use  
County  
Geography

26 land use categories  
5 county/geography regions = 125 HRUs



# Model Reaches

## Legend

X USGS Monitoring Station

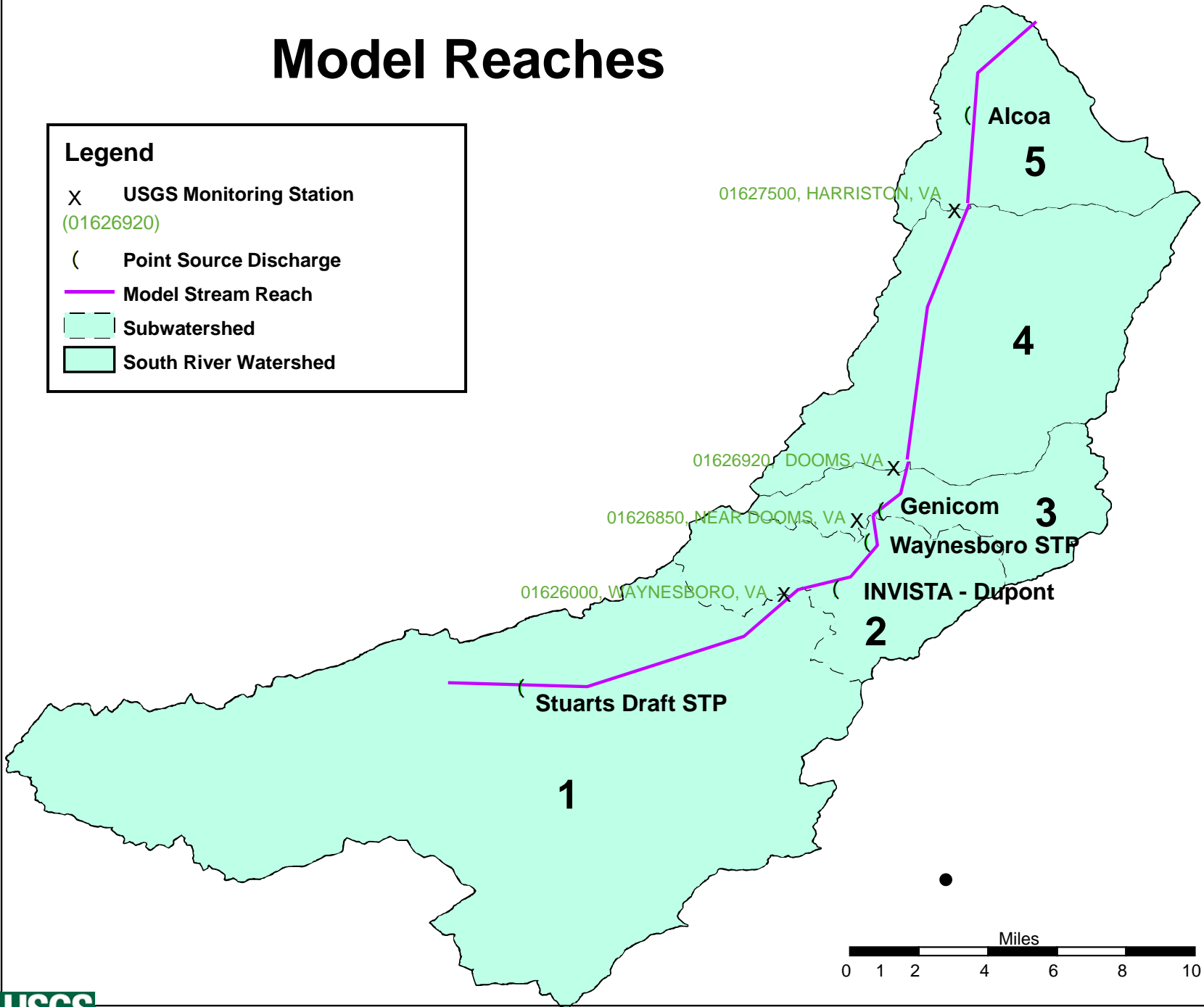
(01626920)

( Point Source Discharge

— Model Stream Reach

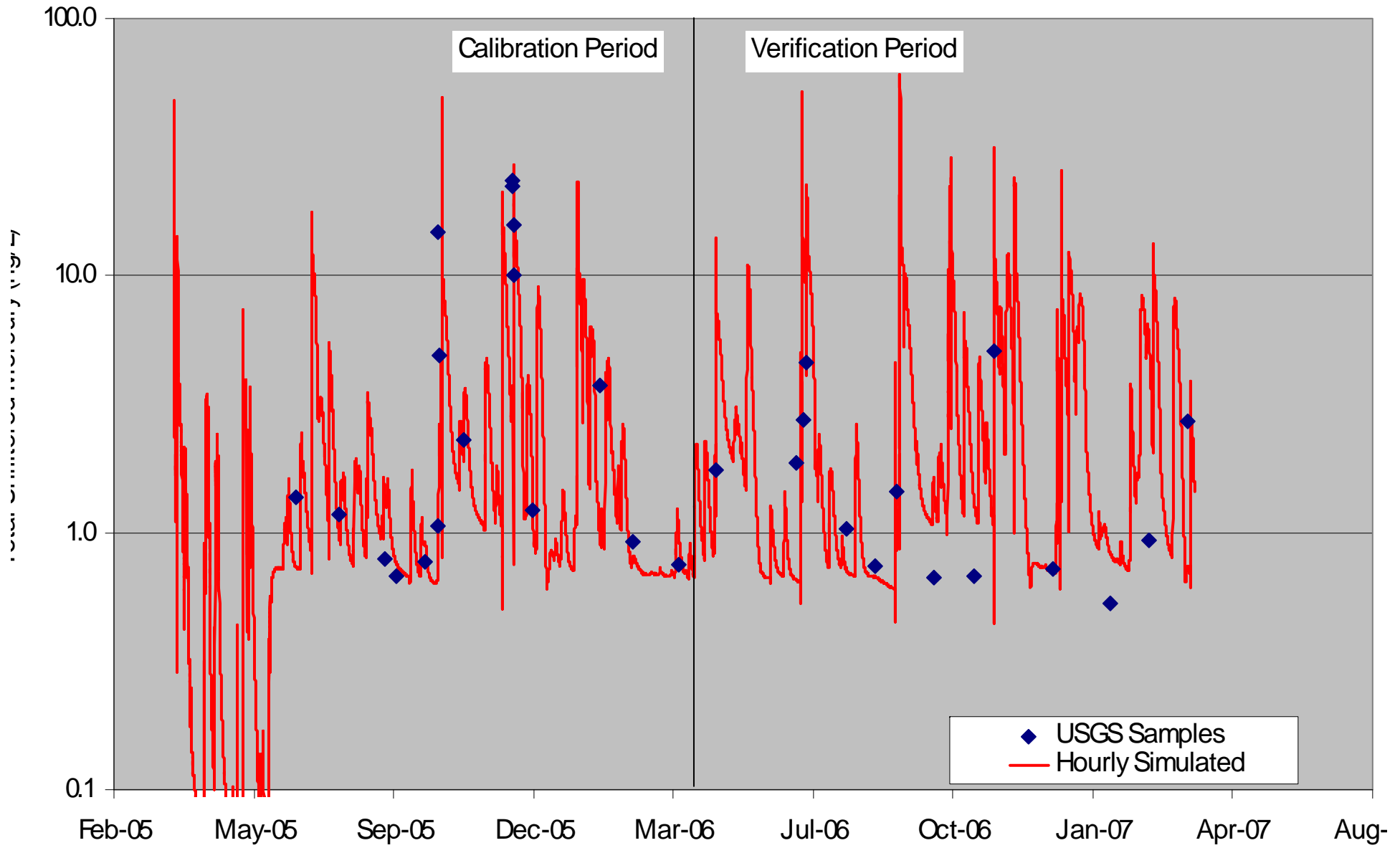
Subwatershed

South River Watershed



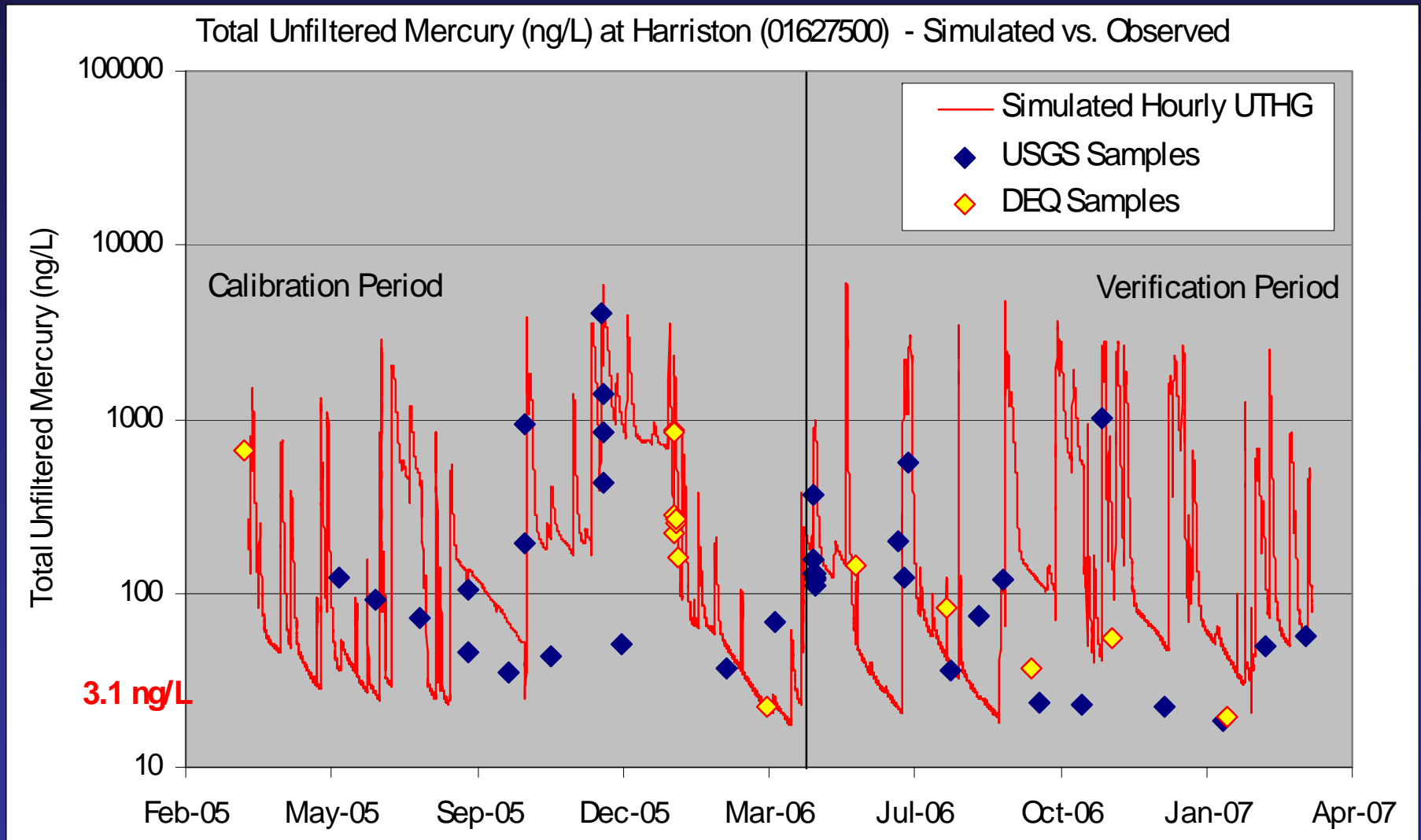
# Calibrated Model Results - Waynesboro

Total Unfiltered Mercury (ng/L) at Waynesboro (01626000) - Simulated vs. Observed Total Mercury (ng/L)



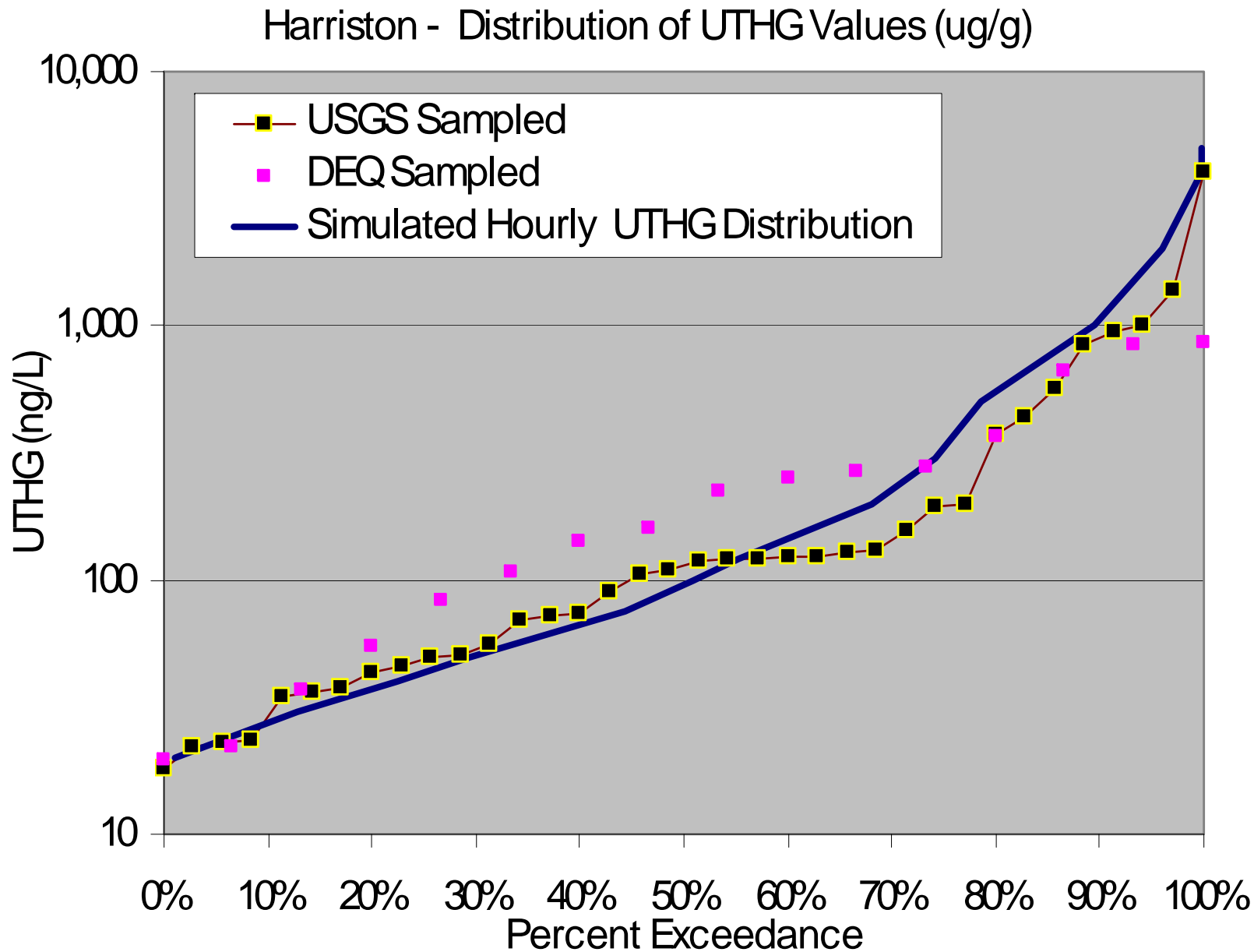
Preliminary data subject to revision, July 2008

# Calibrated Model Results - Harriston



Preliminary data subject to revision, July 2008

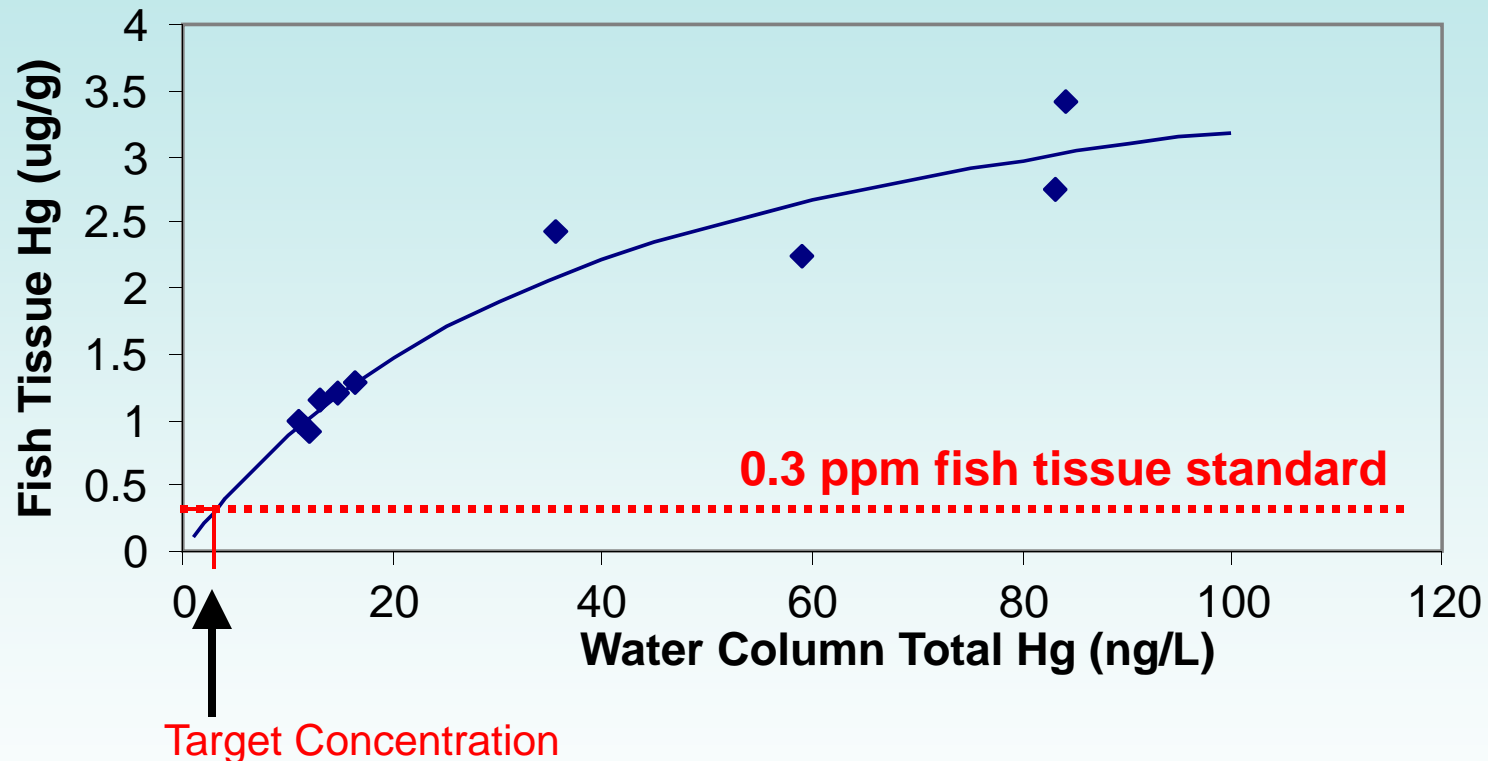
# Calibrated Model Results - Harriston



Preliminary data subject to revision, July 2008



# BAF model relates fish tissue Hg to water column Hg



- Relationship is not linear
- This non-linear relationship can be used to predict a protective water column concentration

## Target Concentrations Vary by River

**Bigger fish have higher tissue Hg concentrations.  
So rivers with bigger fish need lower aqueous Hg  
concentrations for fish to stay below 0.3 ppm Hg in fish tissue**

Water body	Normalized Fish Size (g)	Target THG Concentration ng/L
South River	218	3.8
SF Shenandoah River	253	3.2
Shenandoah River	321	2.5

**Simulated total Hg concentrations below the target are assumed to  
be protective of the 0.3 ppm fish tissue criterion**

## Simulated Existing Conditions, 2005-2007

Model River Reach	Reach End Node	Miles Downstream from Plant Site	THG Concentration (ng/L) Simulated median
1	Waynesboro (01626000)	-2.8	1.2
2	Hopeman Parkway (01626850)	2.3	21.7
3	Dooms (01626920)	5.3	69.6
4	Harriston (01627500)	16.5	91.4
5	Port Republic	24.0	93.4

## Simulated Existing Conditions, 2005-2007

Model River Reach	Endpoint	USGS Station ID	Distance Downstream (mi)	Total HG Flux (kg/year)
1	Waynesboro	01626000	-2.8	1
2	Hopeman Pkwy	01626850	2.3	61
3	Dooms	01626920	5.3	148
4	Harriston	01627500	16.5	184
5	Port Republic	NA	24.0	189

Preliminary data subject to revision, October 2008

## Hg Loads under existing conditions

Reach	Total Mercury (grams/year)					Total all Reaches
	1	2	3	4	5	
Point Sources	1	604	0	0	41	646 (0.34%)
Direct Precip to River	28	7	2	11	8	55 (<0.1%)
Interflow Discharge	382	46	48	151	41	667 (0.35%)
Groundwater Discharge	54	8	7	24	6	99 (<0.1%)
Runoff	573	144	3,998	21,205	3,316	29,237 (15%)
Channel Margin Inputs	0	59,179	82,742	14,551	2,241	158,713 (84%)
Totals	1,038 (1%)	59,989 (32%)	86,797 (46%)	35,942 (19%)	5,653 (3%)	189,418 (100%)

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# Channel Margin Inputs

**Source of channel margin input mercury is contaminated bank materials along the river**

## Transport Mechanisms :

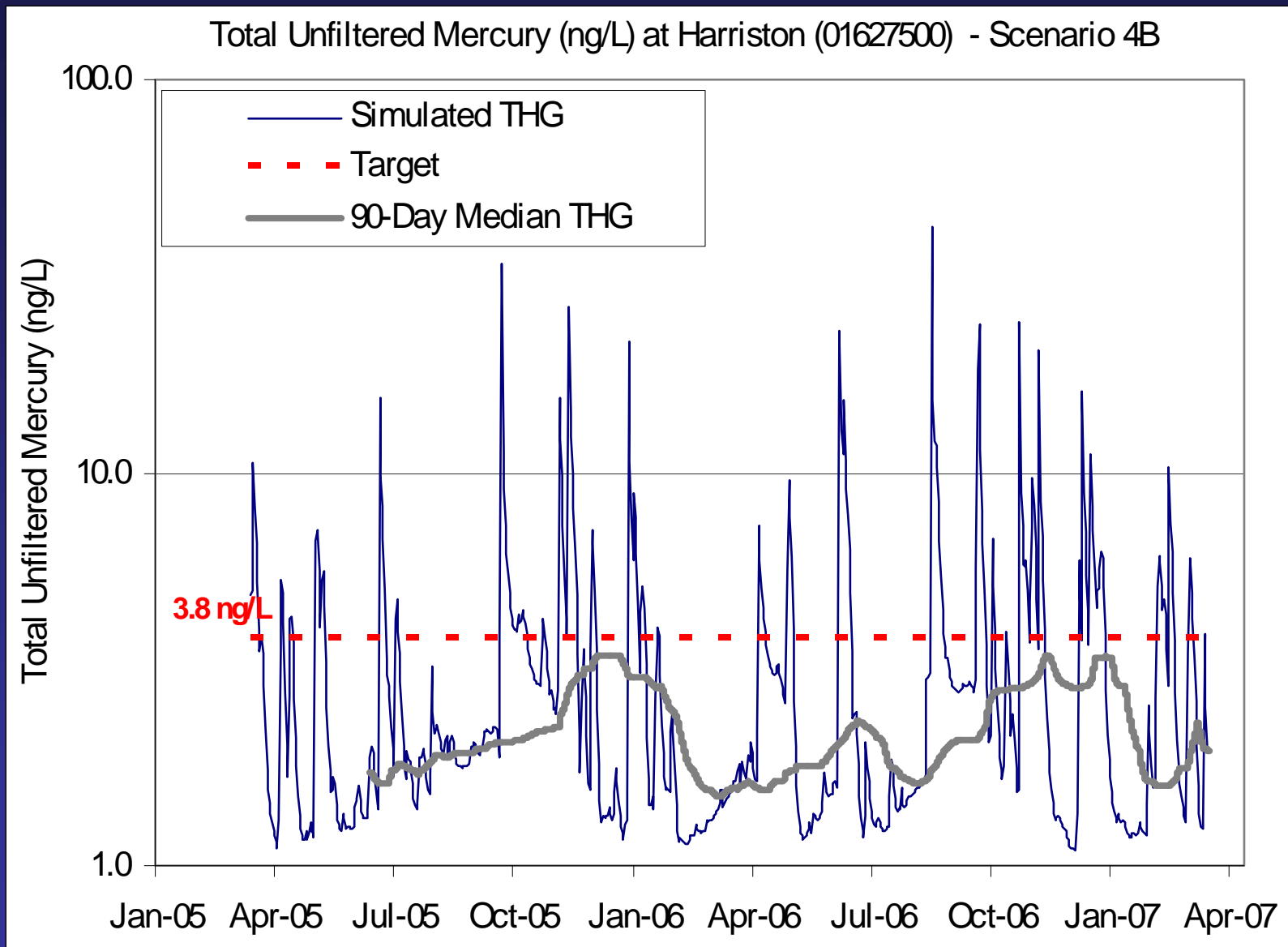
- Bank collapse (~100 kg/yr Rhoads, Oneal, Pizzuto 2008)
- Diffusion from contaminated channel bed (<1 g/yr)
- Ecological extraction of mercury, for example through periphyton growth (?)
- Disturbance of banks by animals, fishermen, boaters, researchers (~0.5 kg/yr)
- Diffusion into interflow and groundwater discharge (?)
- Displacement of contaminated material by interflow and groundwater discharge (?)
- Other mechanisms (?)

# Model Scenarios involving changes to Hg loading

Type	Scenario #	Changes to mercury loading	
Existing conditions	1	All current HG loads included	
Future conditions	2	Point sources increased to maximum permitted discharge, outfall 011 added, precipitation and interflow concentrations reduced	All other future conditions maintained
Single source reductions	3A	Pt. sources reduced to target stream concentrations	
	3B	Channel margin inputs eliminated	
	3C	Runoff cleaned up to background conditions	
Multiple source reductions	4A	Channel margin loads eliminated and runoff cleaned to background conditions	
	4B	Channel margin loads eliminated, runoff cleaned to background conditions, and pt sources reduced to 3.8 ng/L	

TMDL Scenario

# Scenario 4B: Channel margins, runoff, and pt sources cleaned up



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## Scenario 4B: TMDL Scenario

	Existing Load	TMDL	Load
	grams	grams	Reduction
			%
Point Sources	646	107	-83%
Direct Precipitation to River	55	45	-18%
Interflow Discharge	667	544	-18%
Groundwater Discharge	99	99	0%
Runoff	29,237	1,216	-96%
Channel Margin Inputs	158,713	0	-100%
Total	189,418	2,010	-99%

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