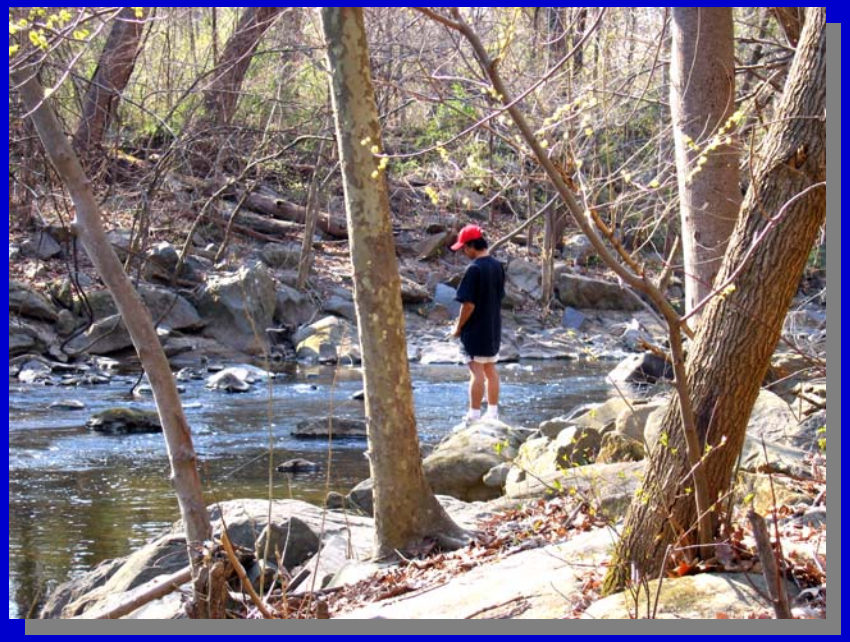
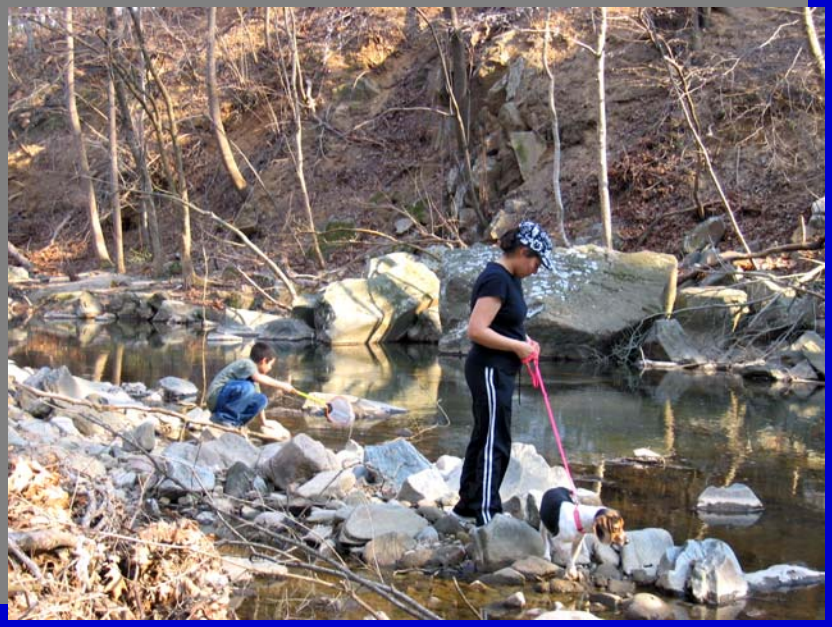
Maryland Anacostia Sediment TMDL - Update for Stakeholders

April 3, 2006

Cherie Schultz, Ross Mandel
Interstate Commission on the Potomac River Basin





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Photos by Masaya Maeda, Courtesy of Anacostia Watershed Society

Anacostia Watershed

- Interstate watershed
- Area = 176 sq miles
- Piedmont and Coastal Plain physiographic provinces
- Upstream tribs drain ~70% of watershed
- ~75% urban

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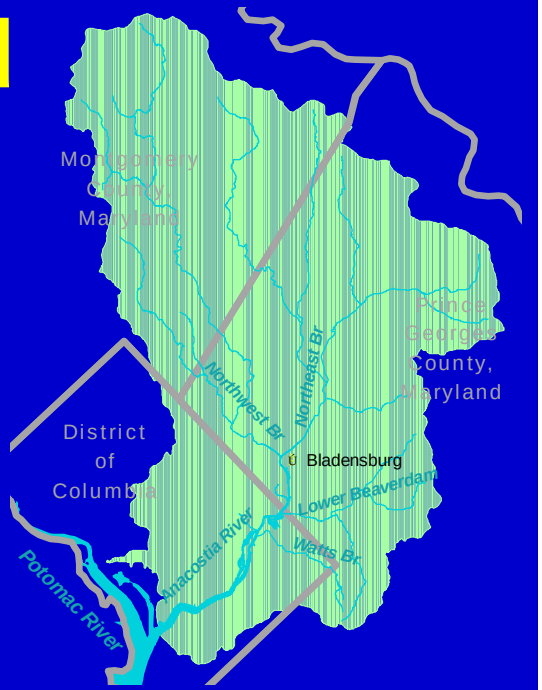
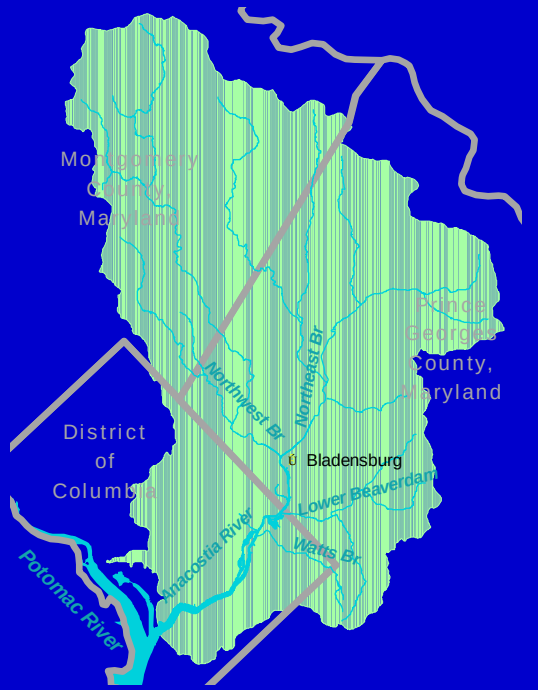
Sediment-Related Problems in the Anacostia Watershed



- **Non-tidal tributaries:**
  - Excessive channel and streambank erosion have degraded stream habitat
  - Sediment-sensitive organisms poorly represented in benthic and fish communities
- **Tidal river:**
  - Poor light conditions have caused disappearance of submerged aquatic vegetation (SAV)

Sources of Sediment in the Anacostia

- Urban runoff (MS4 loads)
- Agricultural runoff
- Construction sites
- Surface mines
- Point sources
- Stream channel erosion due to urbanization/altered hydrology



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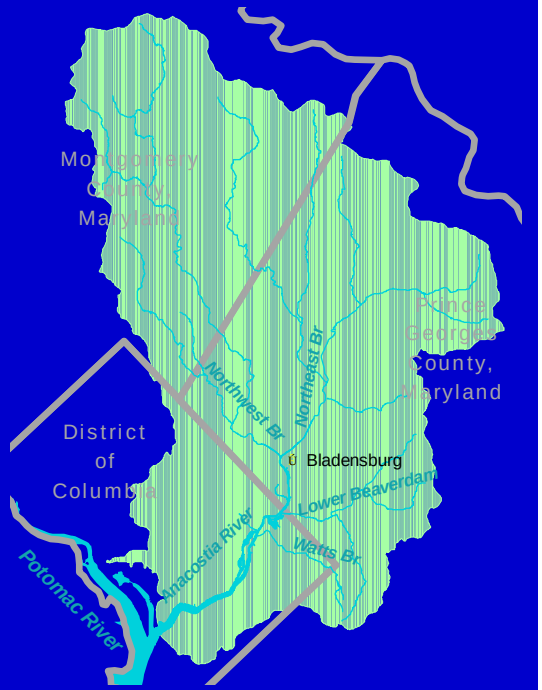
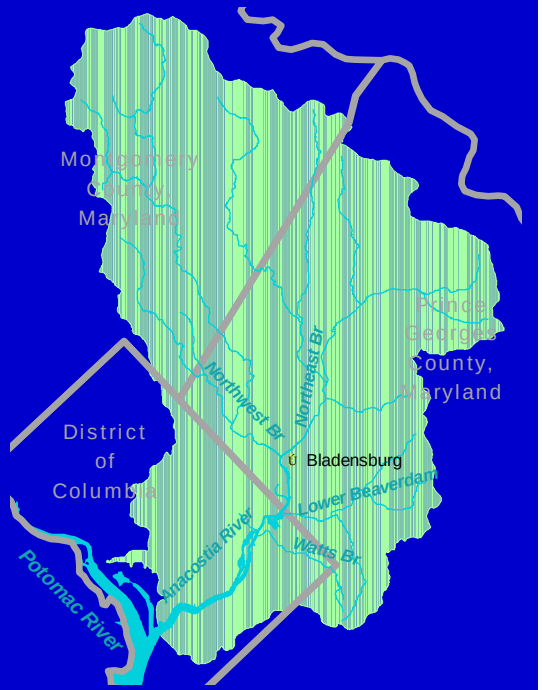


Objectives of Maryland's Anacostia Sediment TMDL

- Protection of aquatic life in non-tidal streams
- Meet MD's water clarity standard in Maryland's tidal shallow waters (median growing season Secchi > 0.4 meters)
- Meet DC's water clarity standard in the District's tidal shallow waters (median growing season Secchi > 0.8 meters)
- Aim for consistency with DCDOH-calculated TMDL loads for DC sources



Total Maximum Daily Load (TMDL) Framework

Watershed model (HSPF)/reference watersheds

Tidal water clarity model (TAM/WASP)

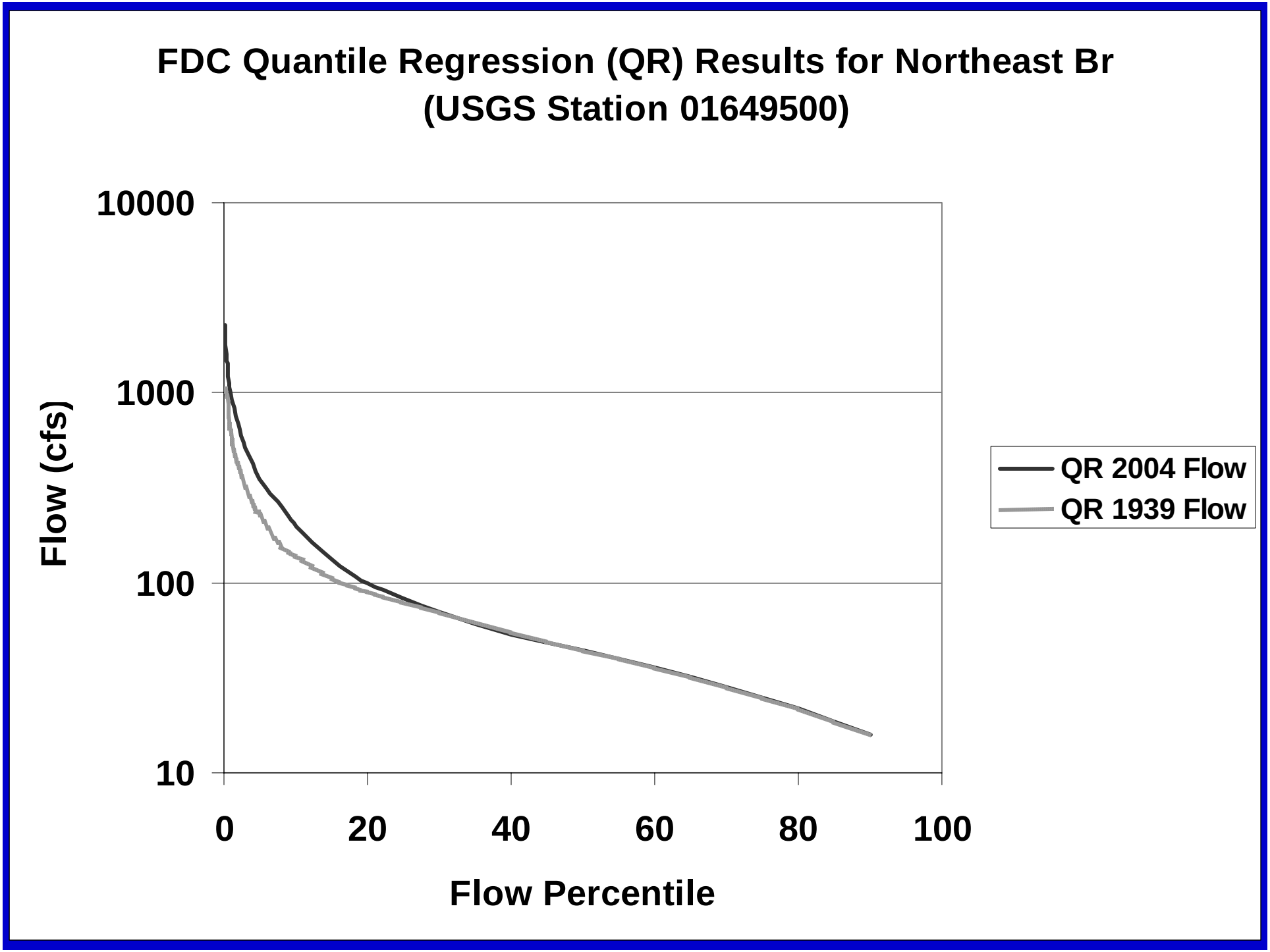
Improvement in health of non-tidal aquatic community to WQS

Reduction in solids loads (tons sediment) from major tribs

Improvement in tidal river water clarity to WQSs

Supporting Analysis for Source Identification

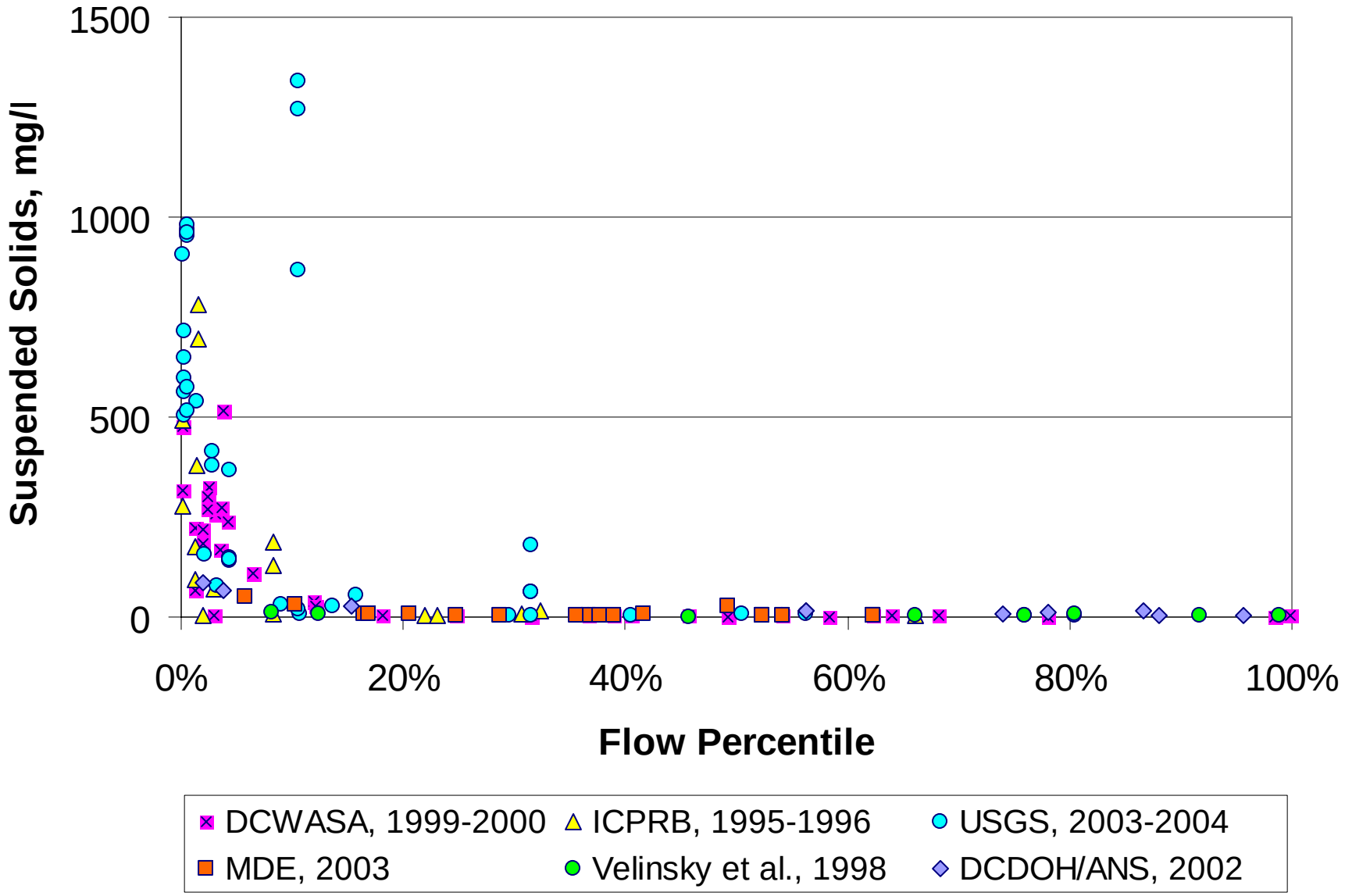
- **<u>Objective</u>: quantify increase in sediment load due to altered hydrology cause by urbanization**
- **<u>Methodology</u>:**
  - use "quantile regression" to quantify changes over time in daily "flow duration curve" (FDC)
  - Use FDC and sediment rating curve to quantify portion of sediment load due to altered hydrology
- **<u>Results</u>: ~75% of today's load due to altered hydrology**


FDC Quantile Regression (QR) Results for Northeast Br
(USGS Station 01649500)
10000
1000
100
10
Flow (cfs)
0
20
40
60
80
100
Flow Percentile
QR 2004 Flow
QR 1939 Flow

MD TMDL Modeling Analyses

- **Continuity with past analyses:**
  - Non-tidal HSPF model is upgrade (Phase 3) of model previously used by MDE
  - Tidal "TAM/WASP" water clarity model is upgrade of model used by DCDOH and EPA for DC's 2002 sediment TMDL
- **New features:**
  - New NWB/NEB TSS data from MDE/PG Co/USGS
  - Use of USGS's ESTIMATOR model for upstream load estimates
  - New land use analysis using Maryland Dept Planning GIS with county data for estimates of imperviousness

Northwest Branch Suspended Solids Data, 1995-2004



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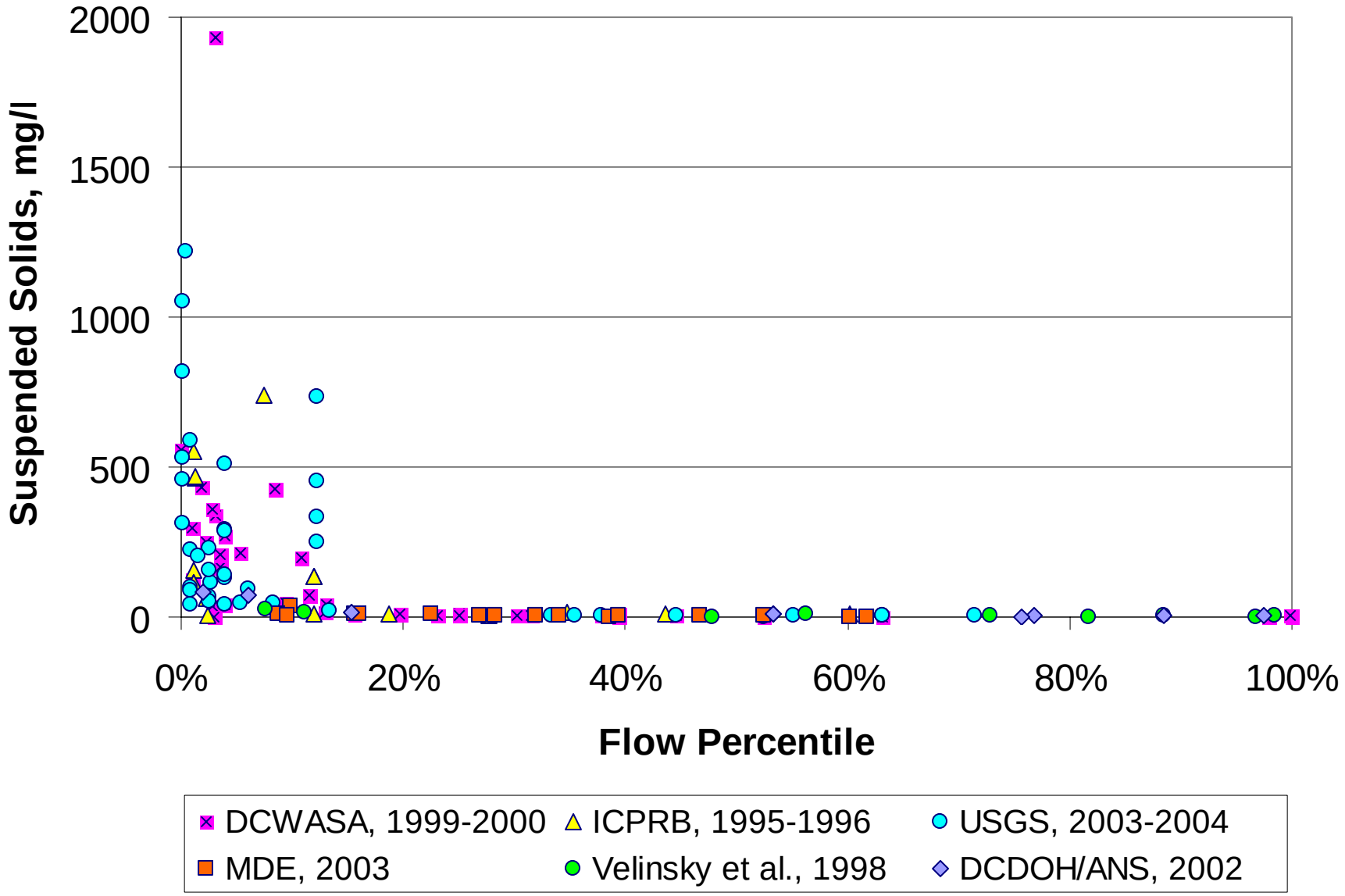


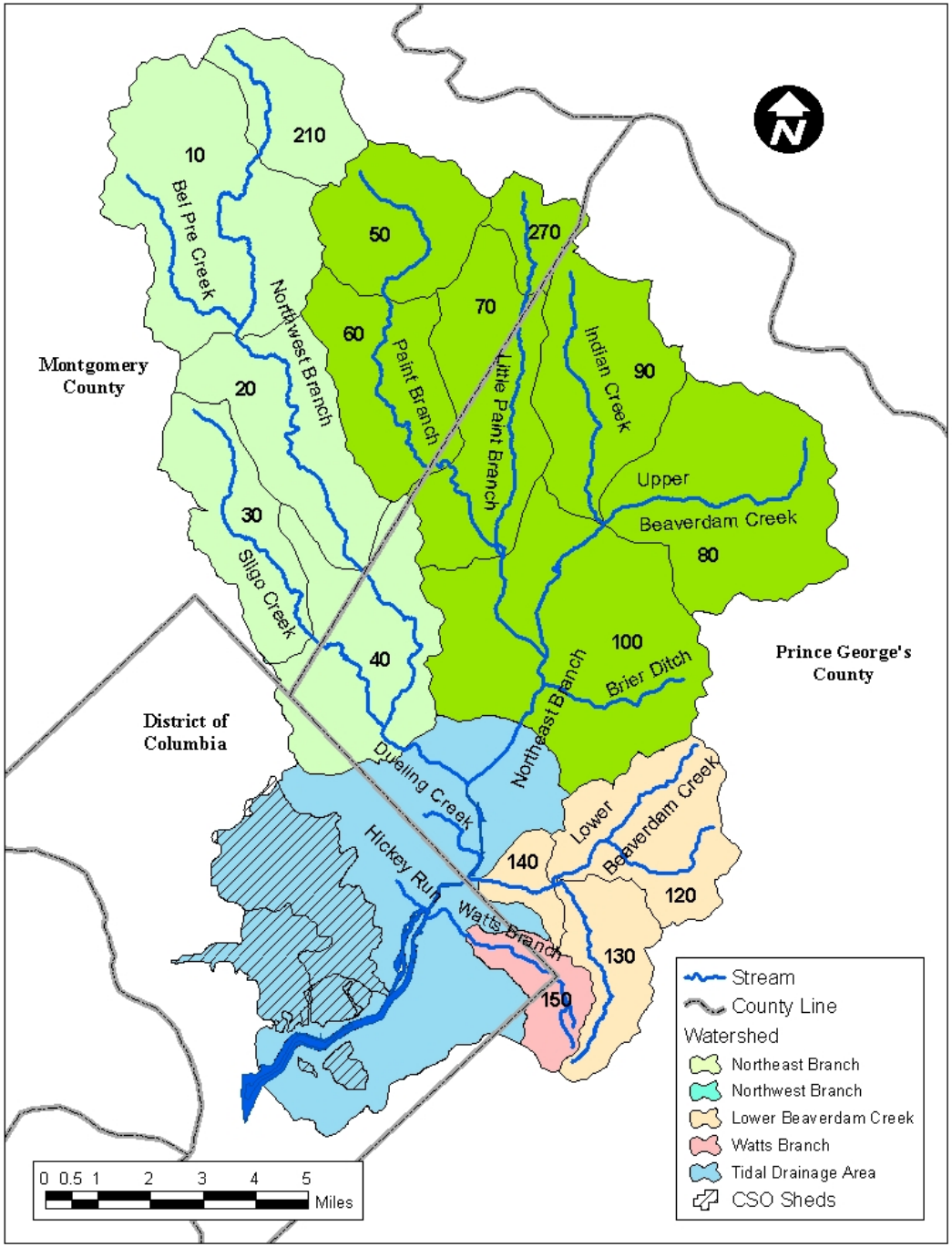
HSPF Non-tidal Anacostia Model

- Simulation period: 1995-2004
- Revised Land Use Based on MDP and MNCPP impervious layers
- Calibrated using monitoring data collected on NE and NW Branches by USGS, MDE, and PG County

Objectives for Non-tidal HSPF Model

- **Source Assessment (sediment loads by land use category)**
- **Determination of TMDL Endpoints Through Reference Watersheds**

Watershed Model Segmentation



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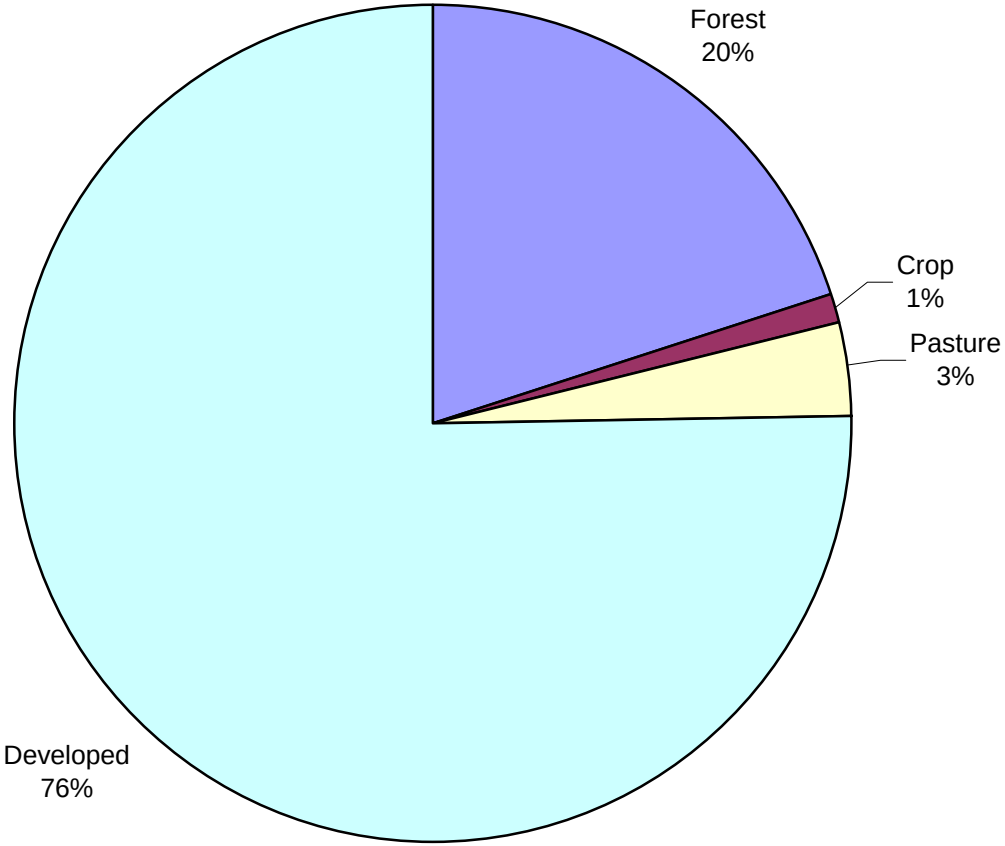
Anacostia Watershed Land Use



Sediment Calibration Targets

- Developed Land EOS: concentrations from NPDES monitoring data
- Forest, Pasture EOS: CBP P5 EOF + Sediment Delivery Ratio
- Crop EOS: modified CBP P5 EOF + SDR
- Overall: Monthly ESTIMATOR loads
- Streambank: ESTIMATOR – EOS, proportioned by segment according to Penn State Streambank Equation

Streambank Erosion Equation
(Evans et al. 2003)

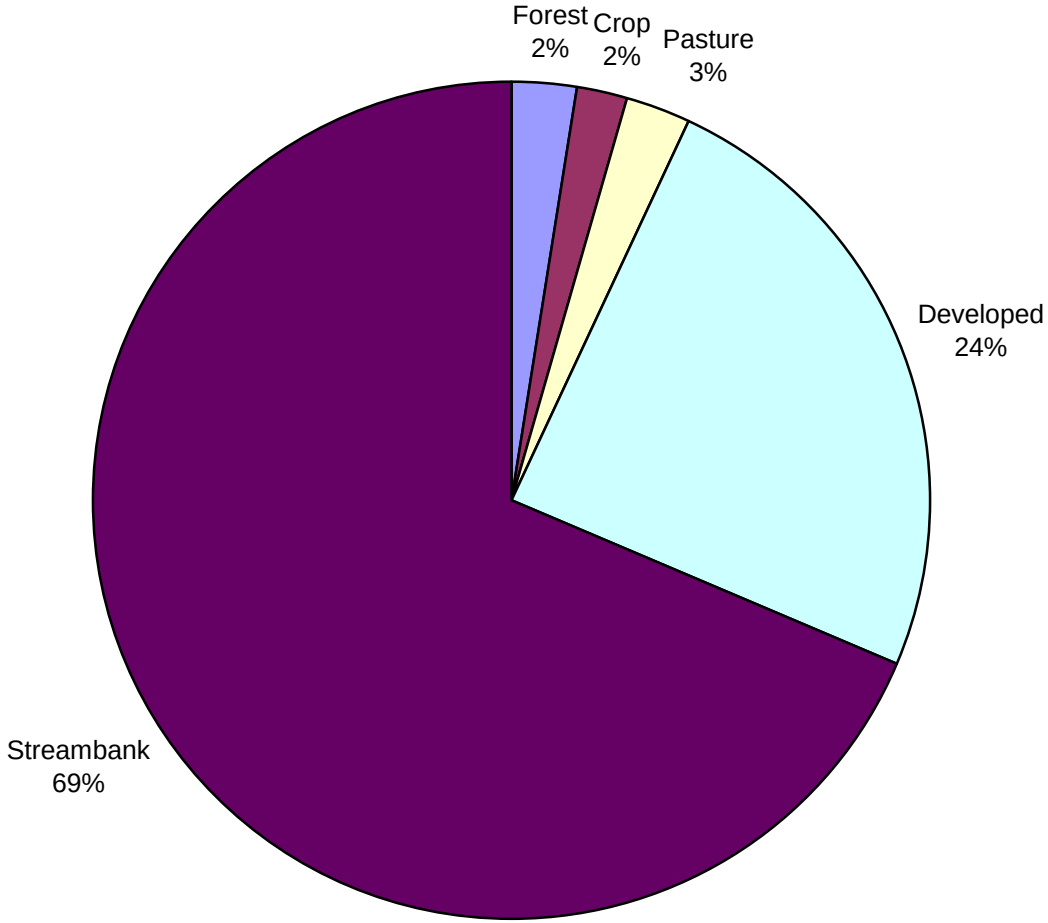
Streambank Erosion =

a-factor * impaired stream length *bank height *average monthly flow$^{0.6}$

where

a-factor ~ percent developed land, average slope, average soil erosivity, average curve number, animal density

Sediment Loads to Tidal Anacostia River



Reference Watershed Approach

- EPA-accepted methodology for determining TMDL endpoint in the absence of numerical water quality criteria
- Set TMDL sediment load to protect local water quality based on loads in watersheds unimpaired by sediment.
- Adapt PA and VA approach, based on non-calibrated GWLF model, to HSPF calibrated model

Reference Watersheds

Watershed	Upper Paint Branch	Upper Beaverdam Creek
Physiographic Province	Piedmont	Coastal Plain
Reference For	NW Branch Paint Branch	Indian Creek, NE Branch Lower Beaverdam Creek Watts Branch
Rationale	Special Protection Area (DEP) "aquatic resource of national importance" (DOI)	Anacostia Tributary Streambank Erosion Pilot Study (MWCOG, 2004)

Determination of Reference Load

- Reference EOS Load = Reference Watershed Load * Impaired Watershed Area/Reference Watershed Area

- Streambank Erosion = $a_{reference}$ * impaired stream length *bank height *average monthly $flow^{0.6}$ resized reference watershed

Where

resized reference watershed = Reference Watershed * Impaired Watershed Area/Reference Watershed Area

Preliminary Estimate of Sediment Load Reductions Necessary to Protect Non-Tidal Water Quality

Watershed	Reduction
Northwest Branch	32%
Northeast Branch	37%
Lower Beaverdam Creek	35%*
Watts Branch	10%*

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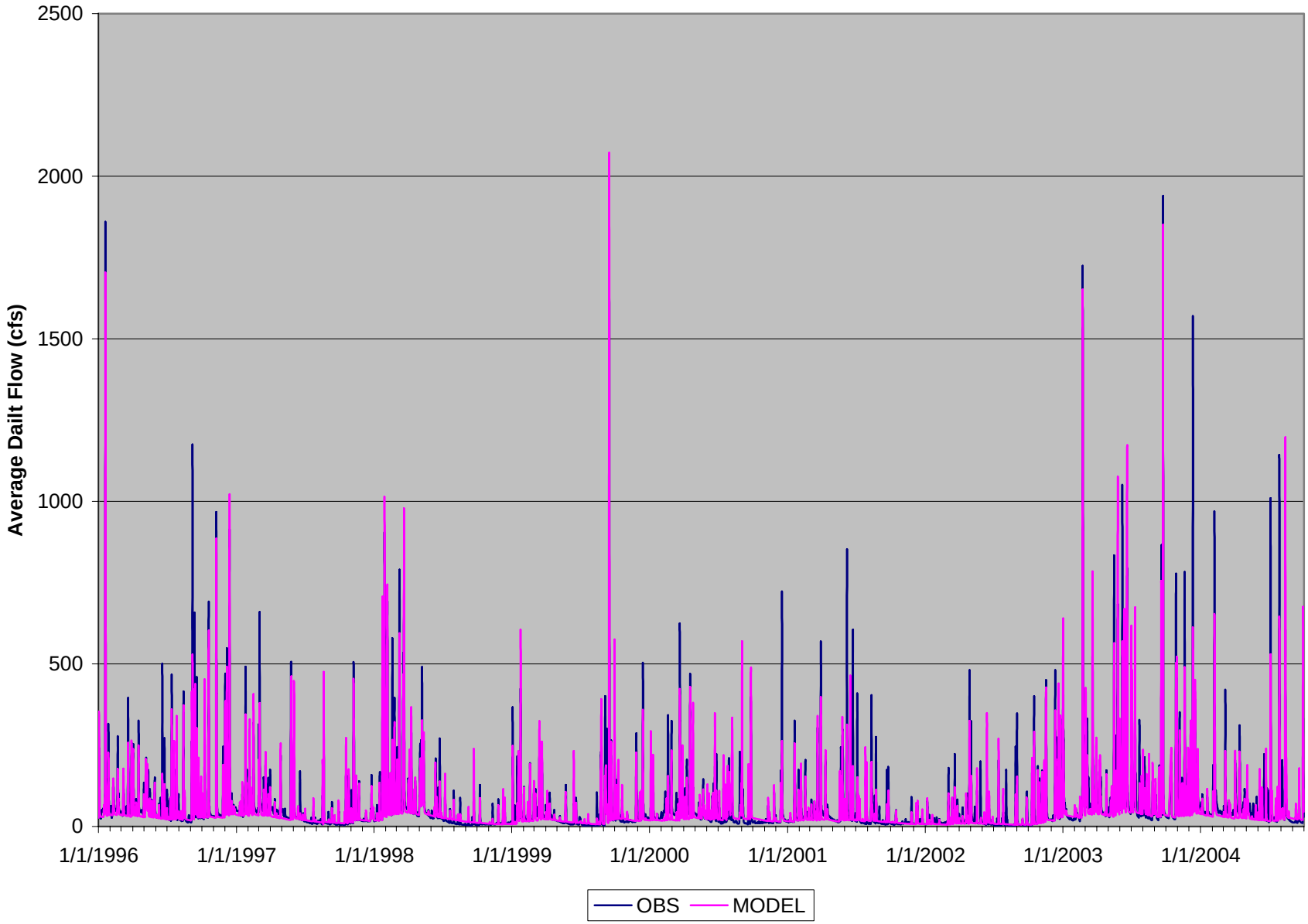
* Under review

NW BRANCH



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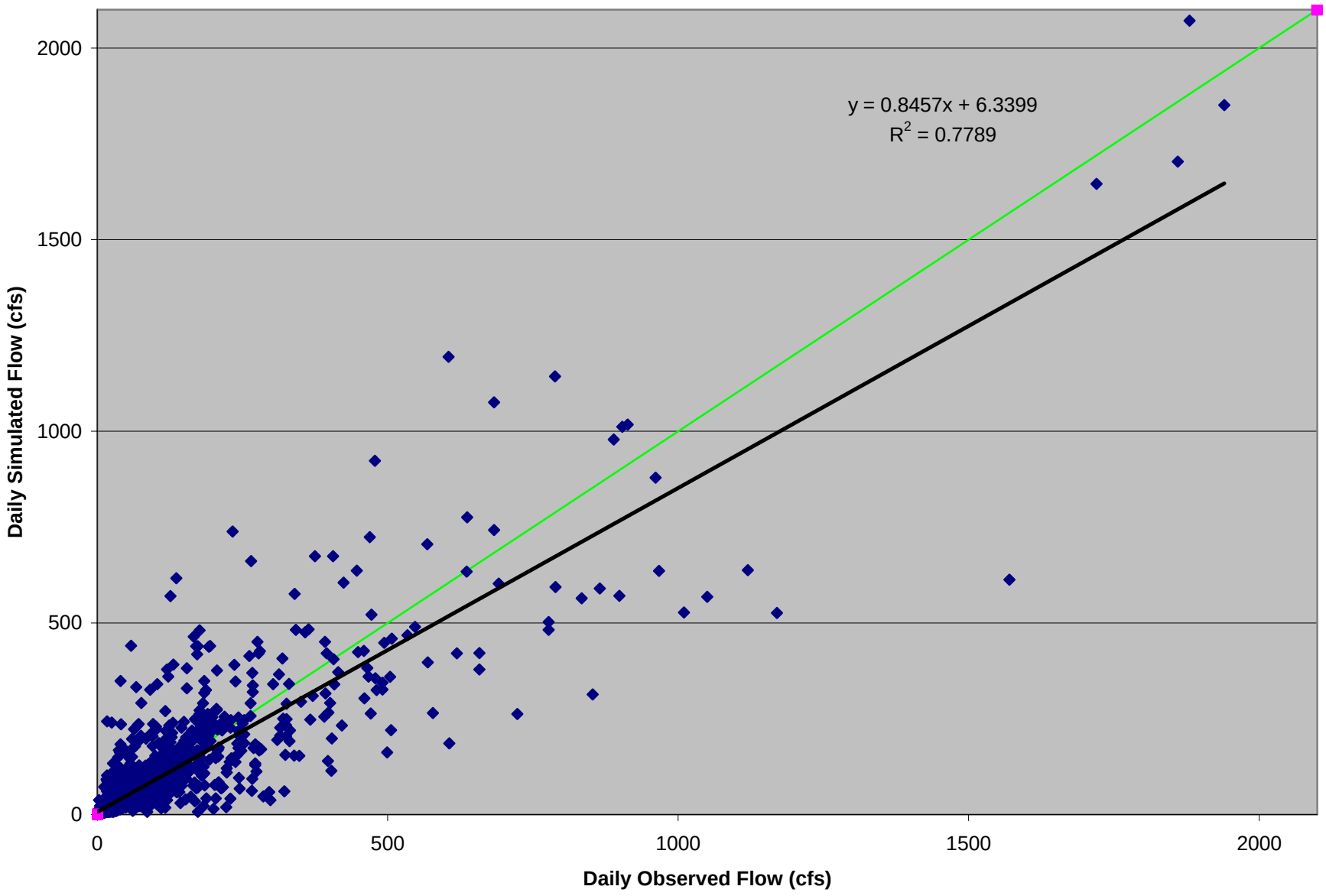

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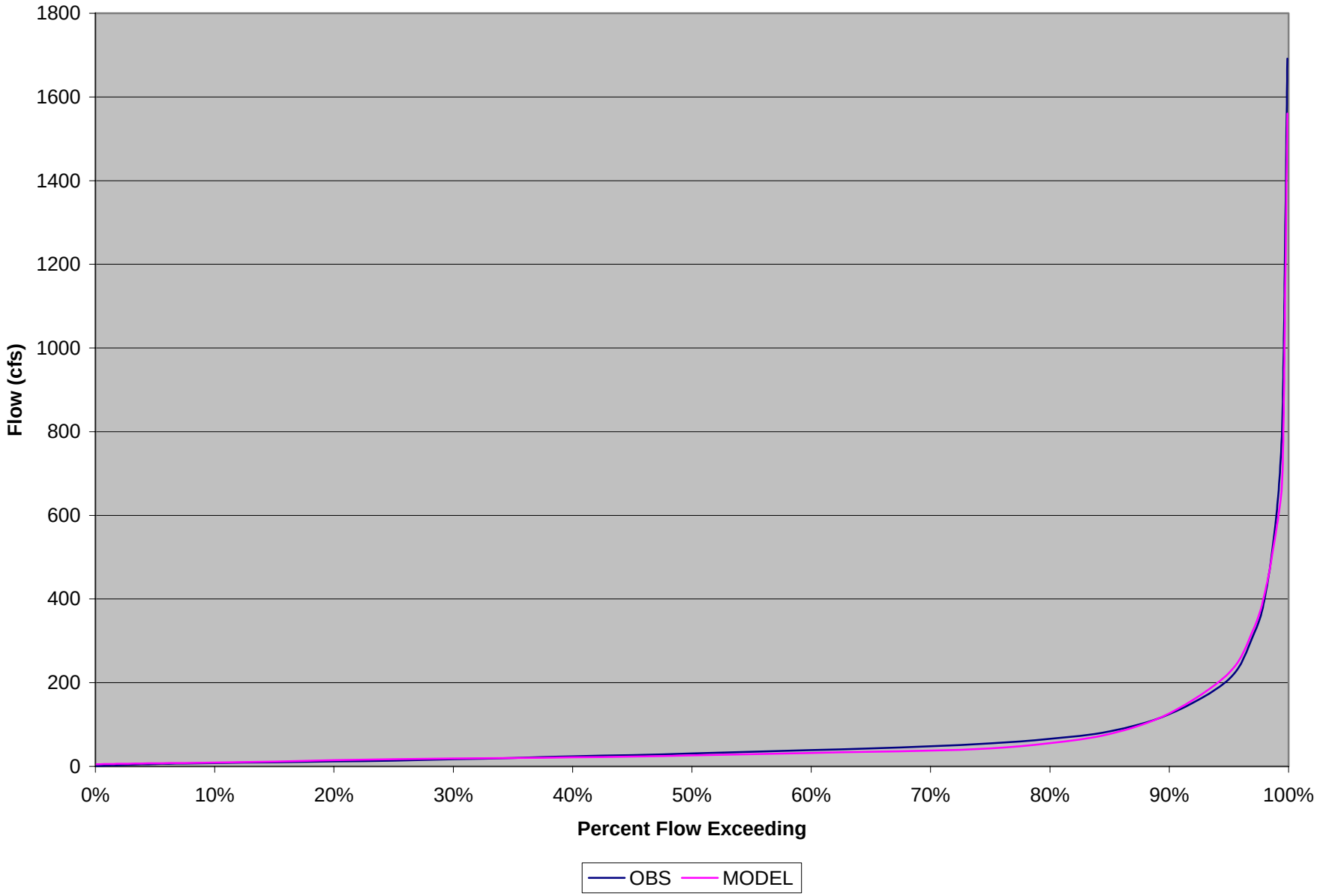

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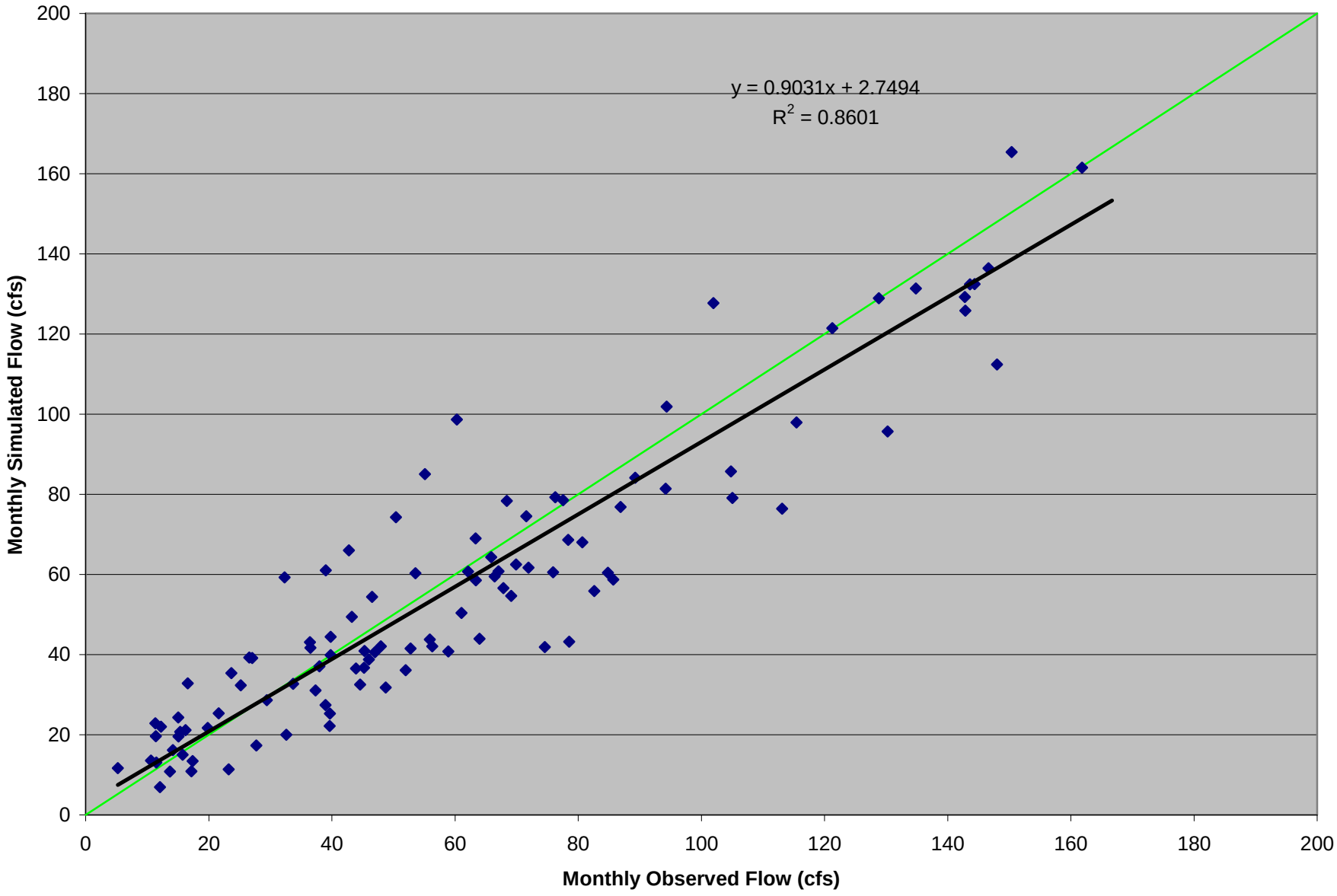

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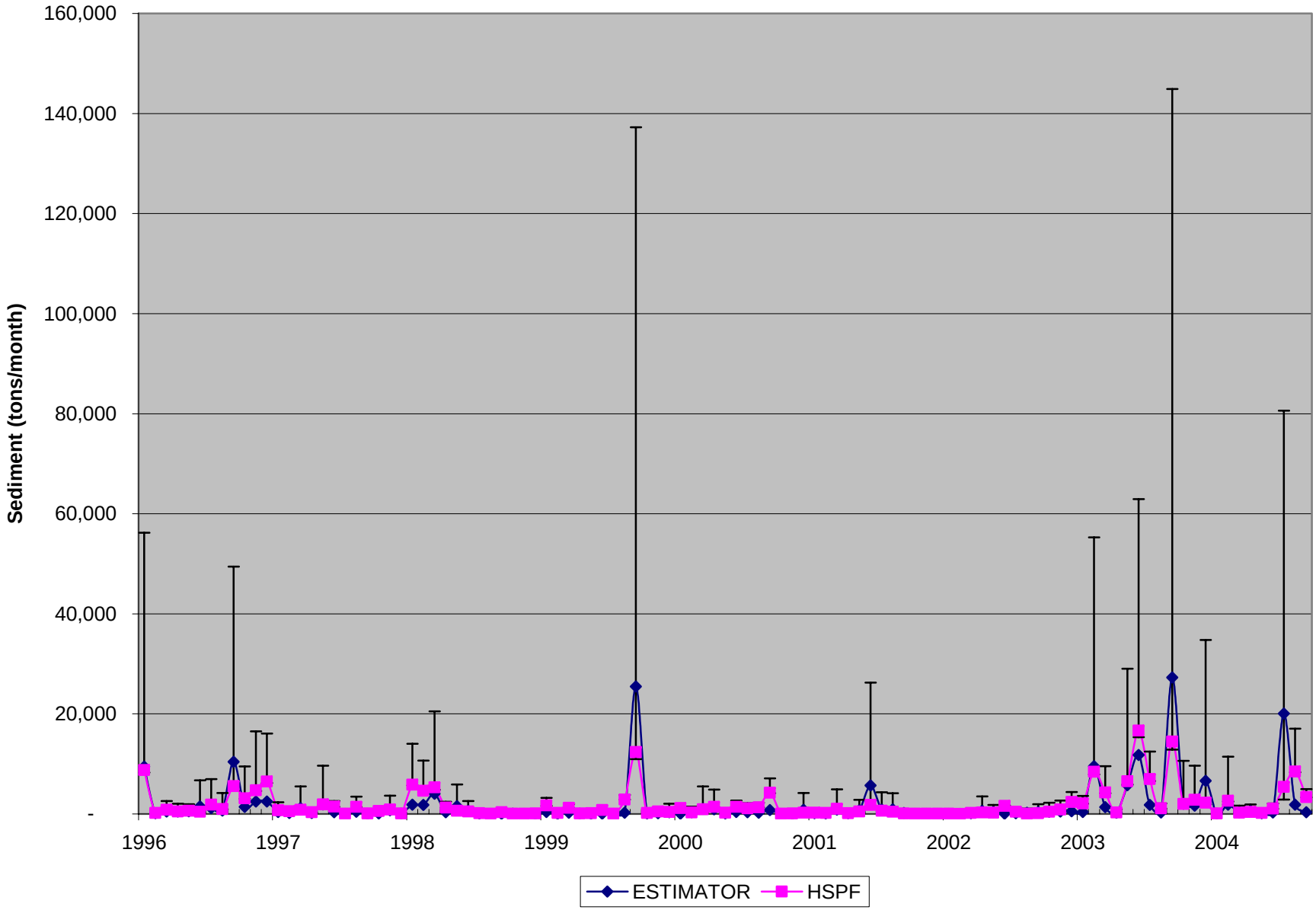

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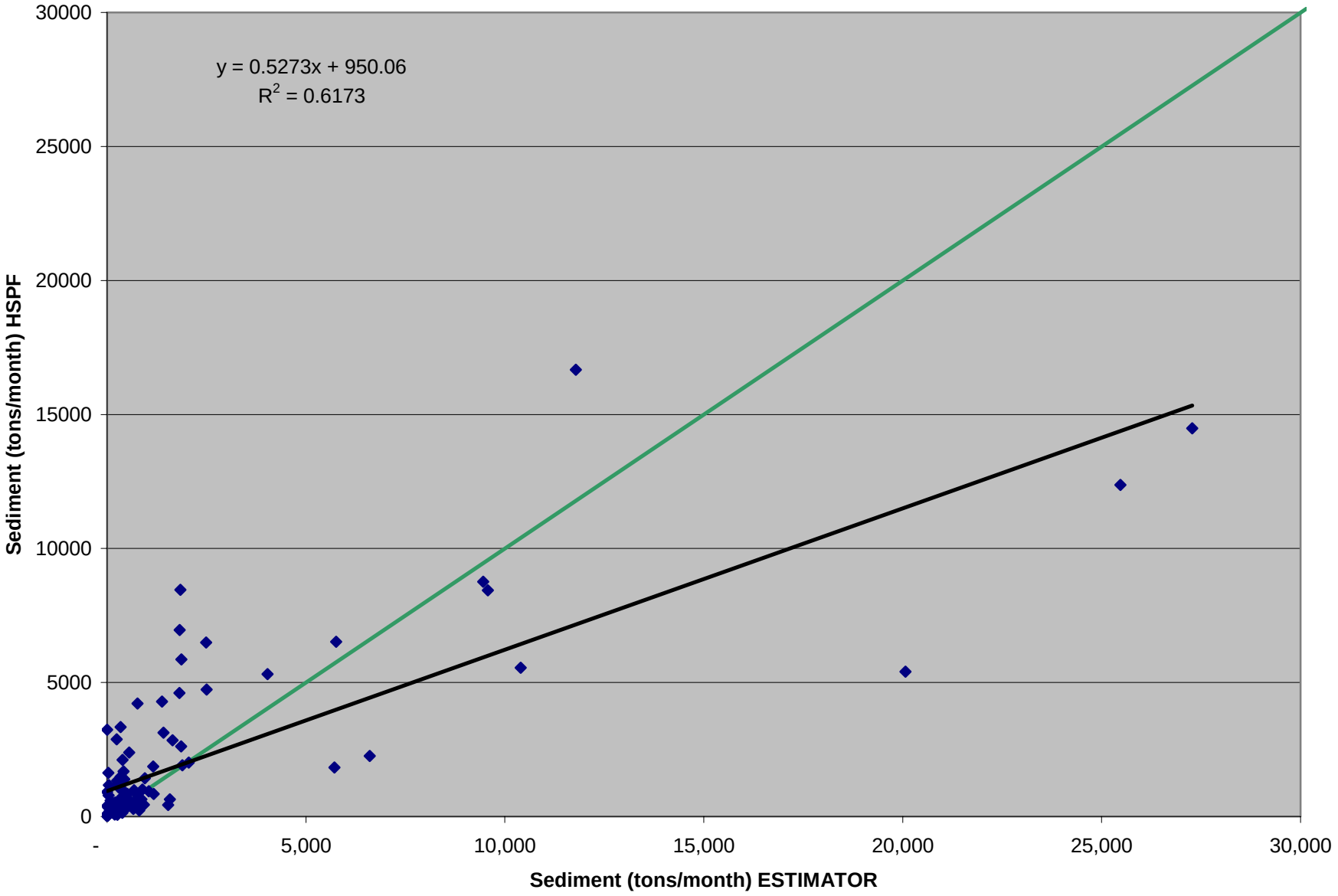

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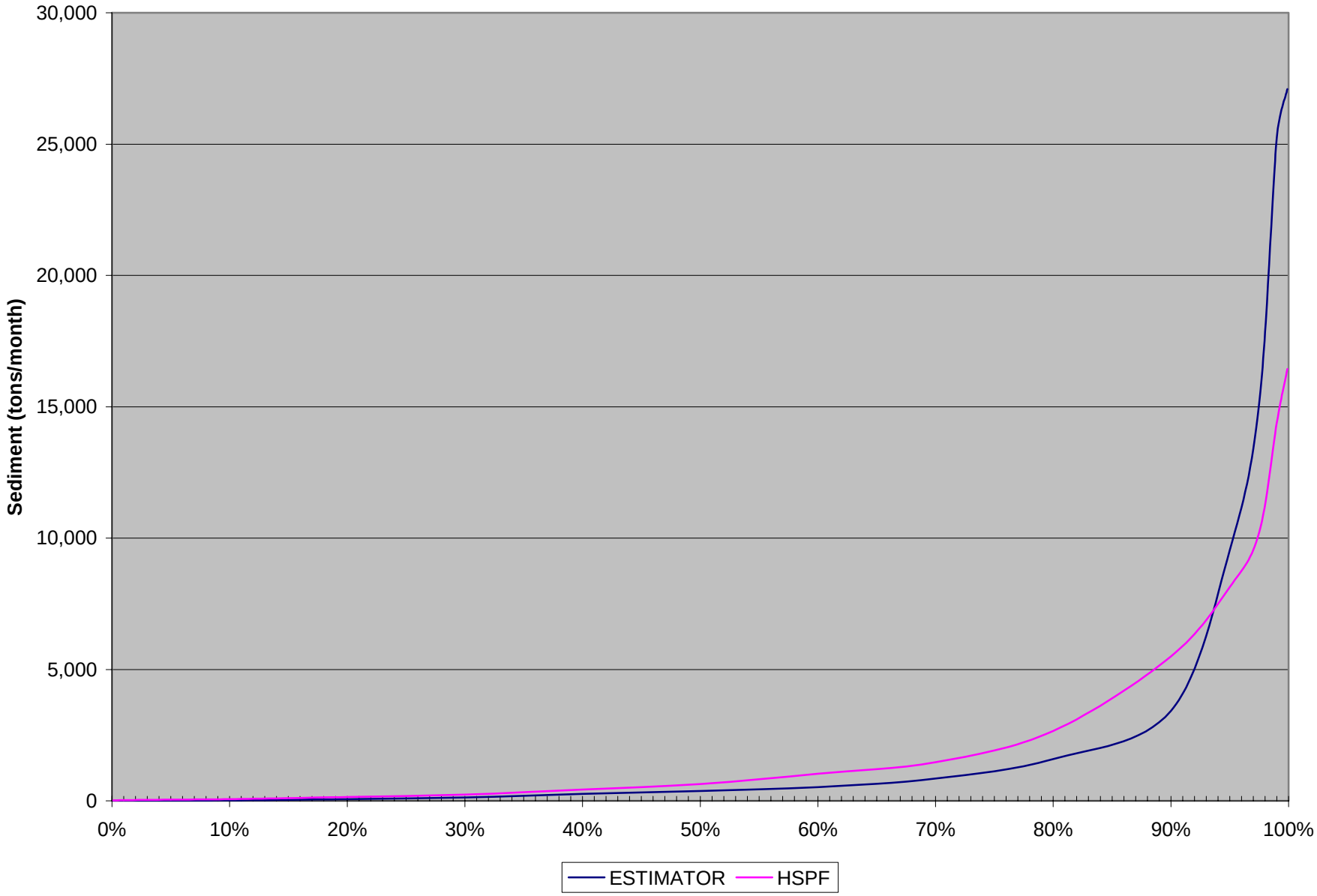

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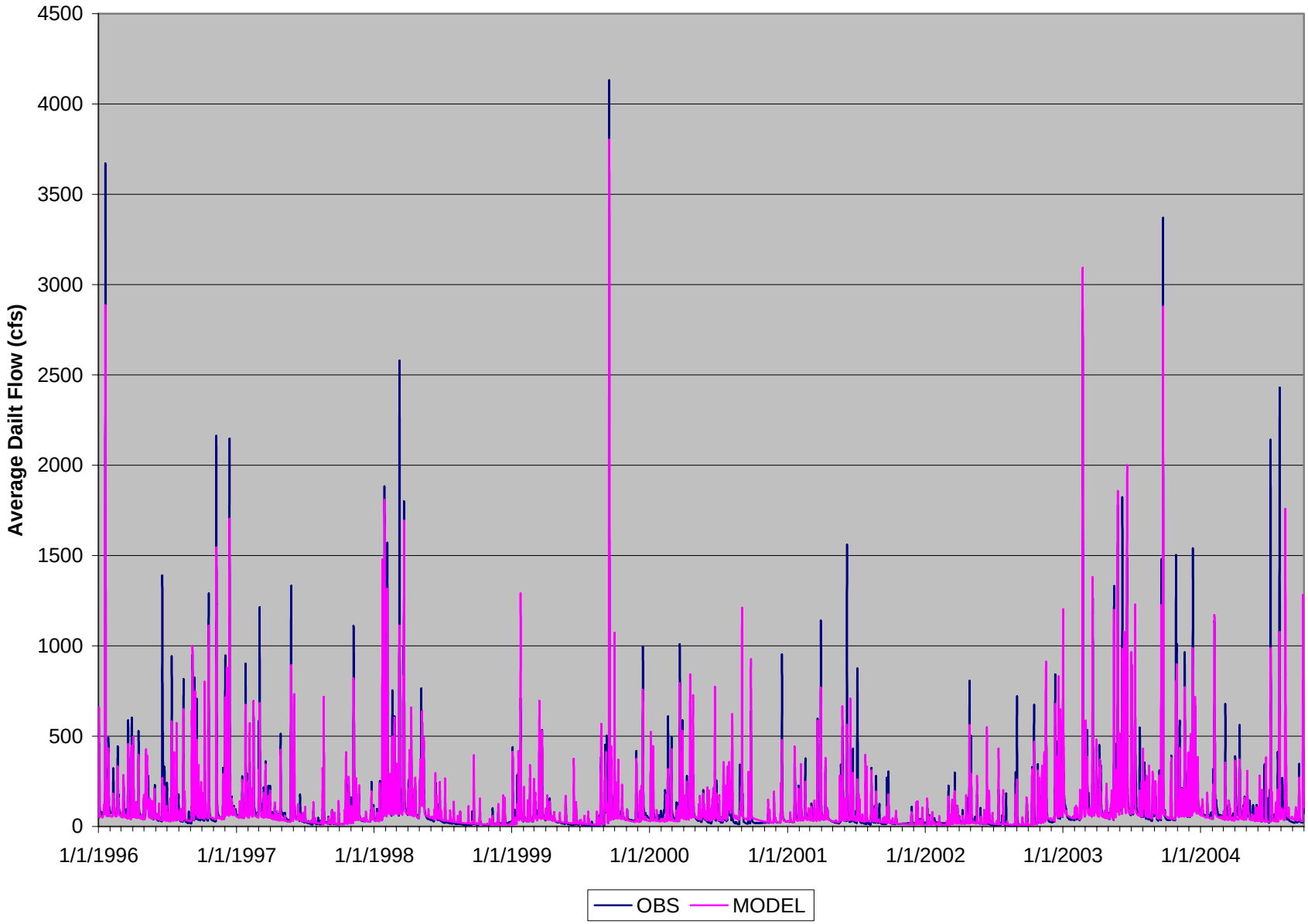
NE BRANCH



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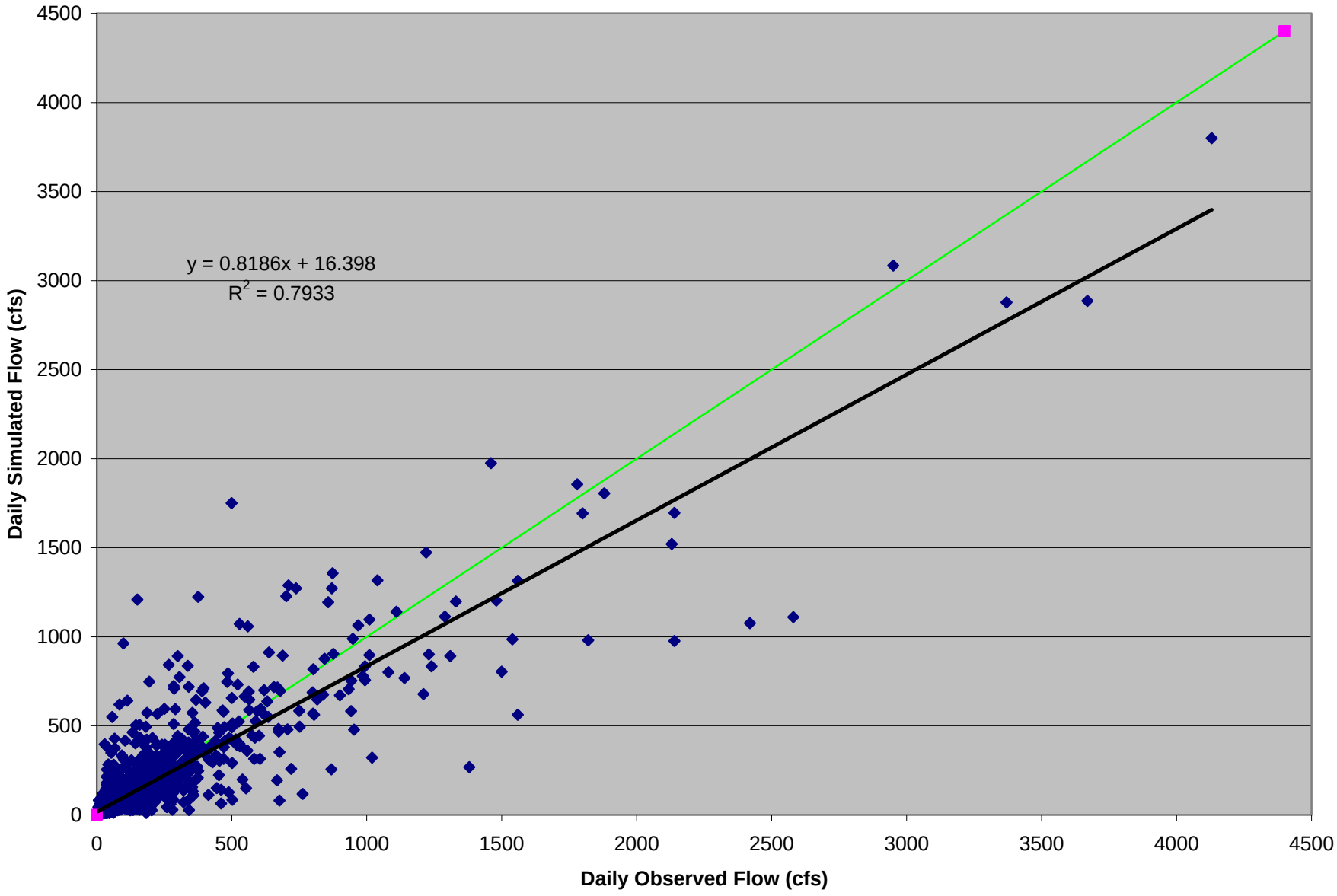

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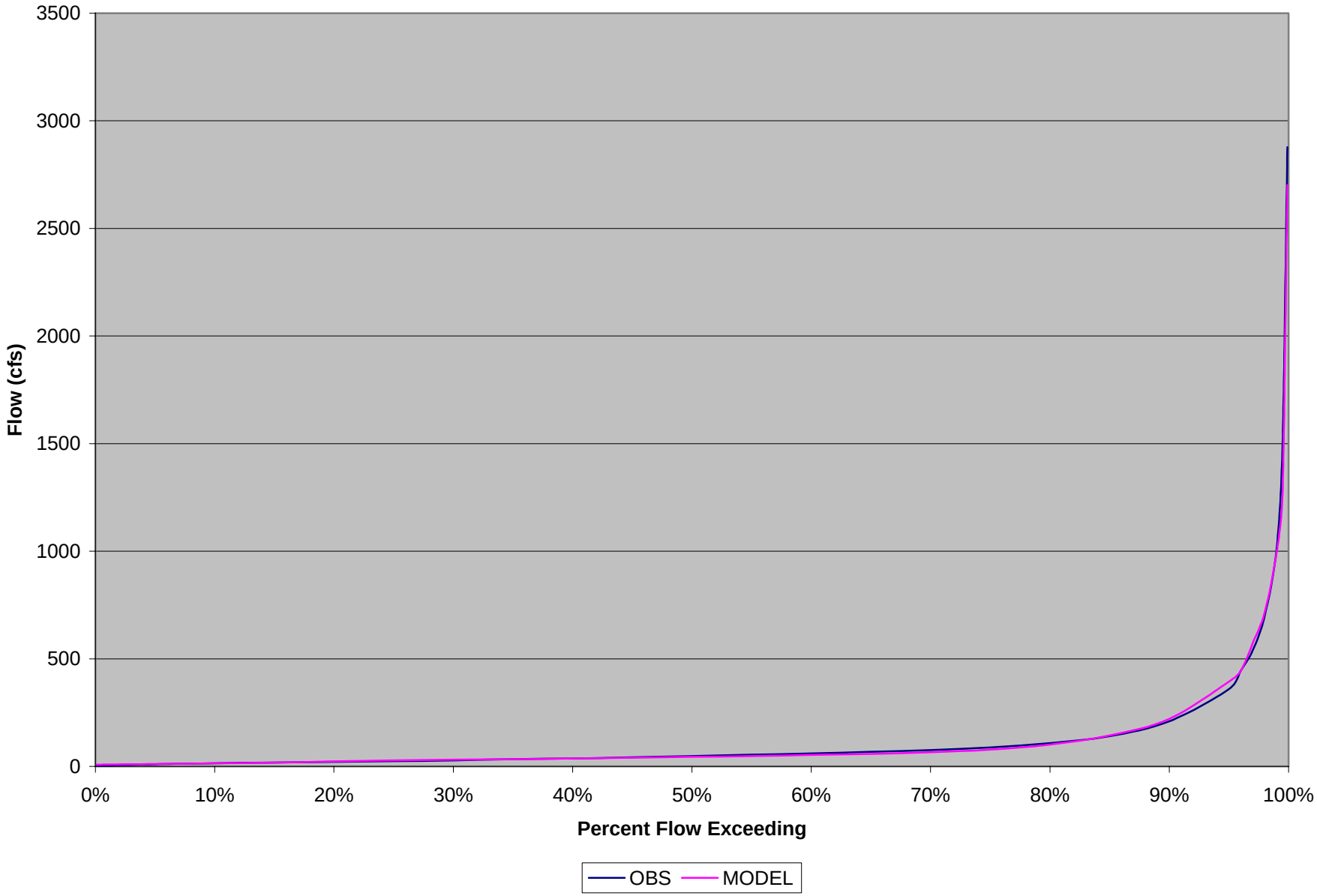

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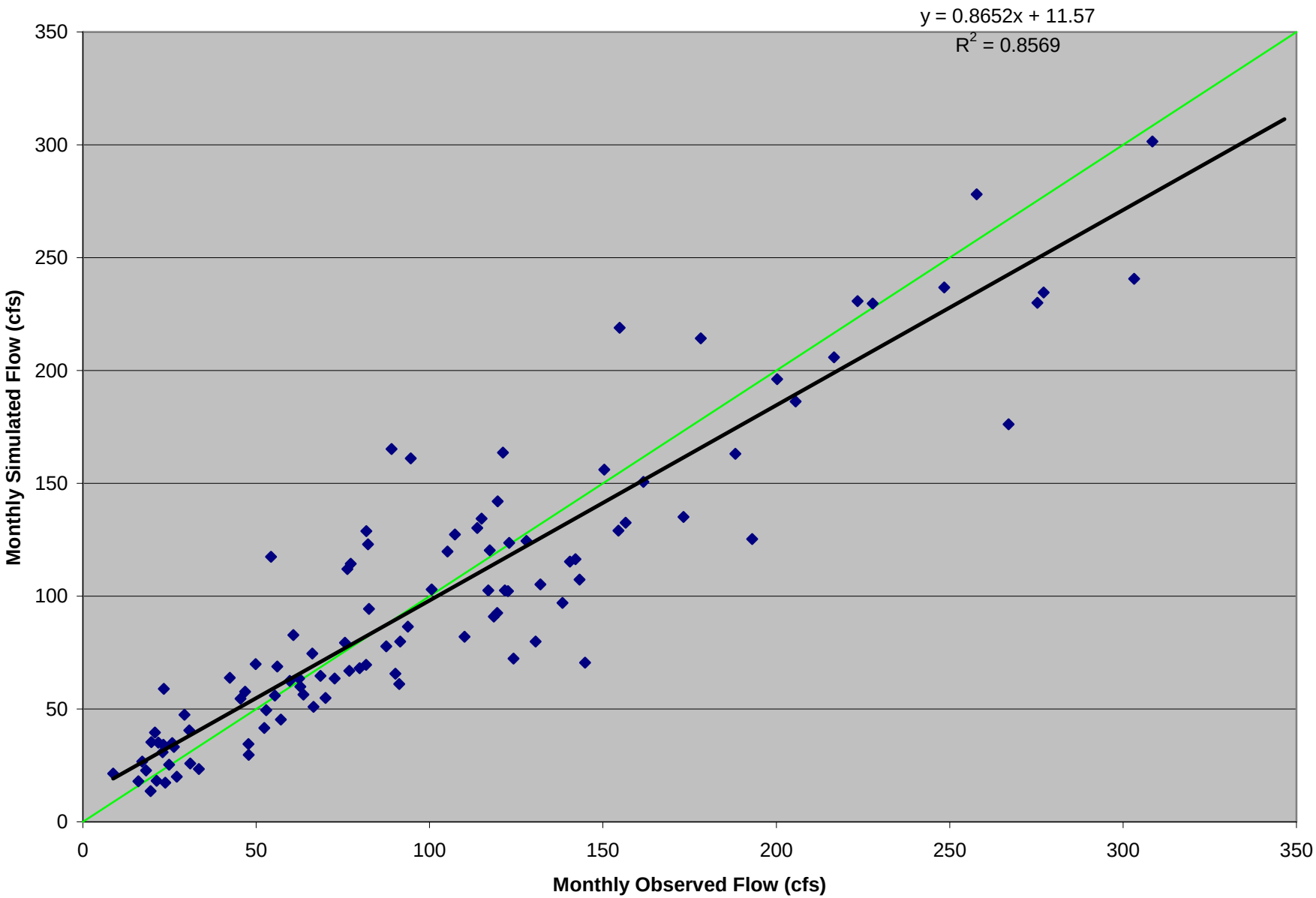

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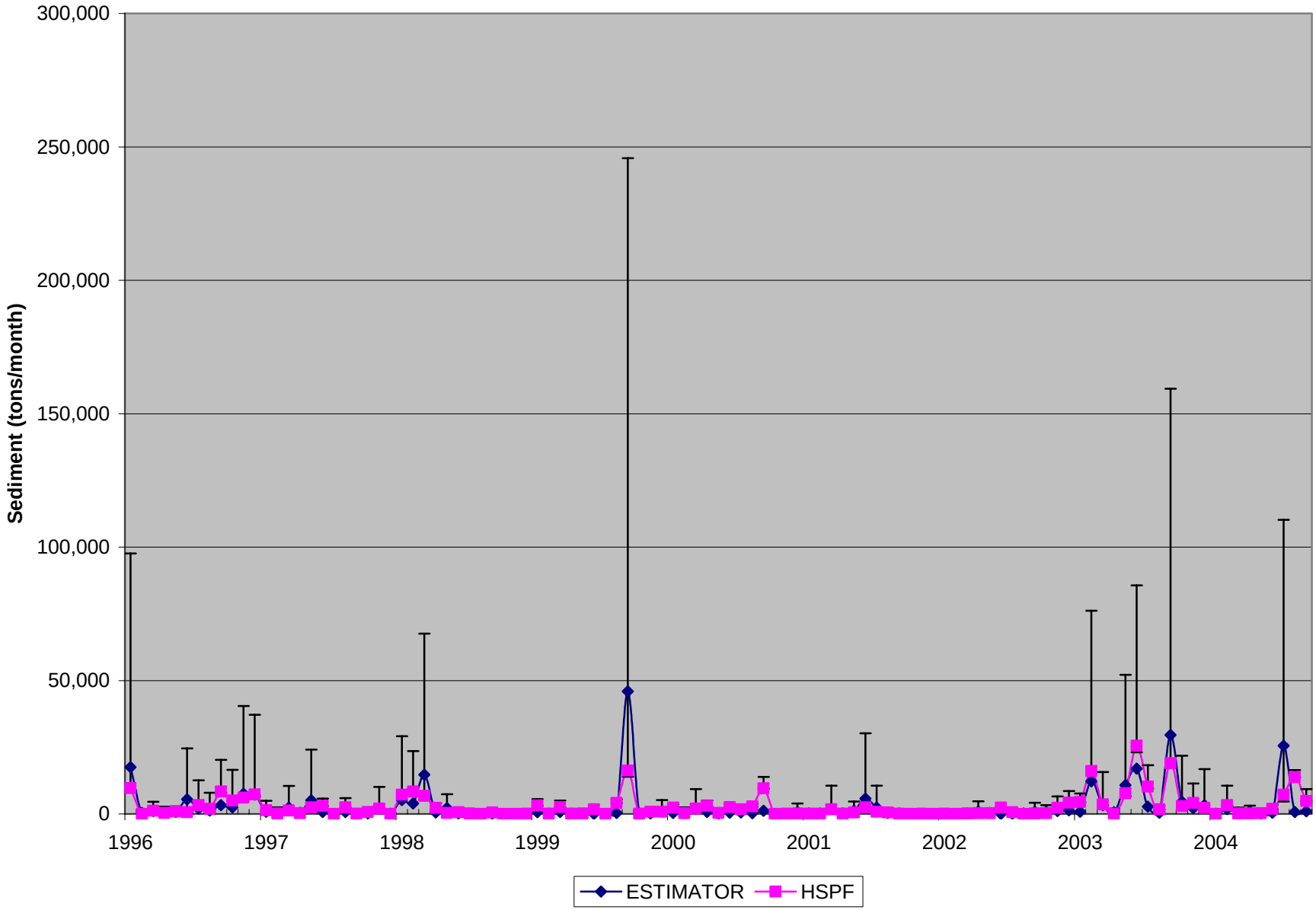

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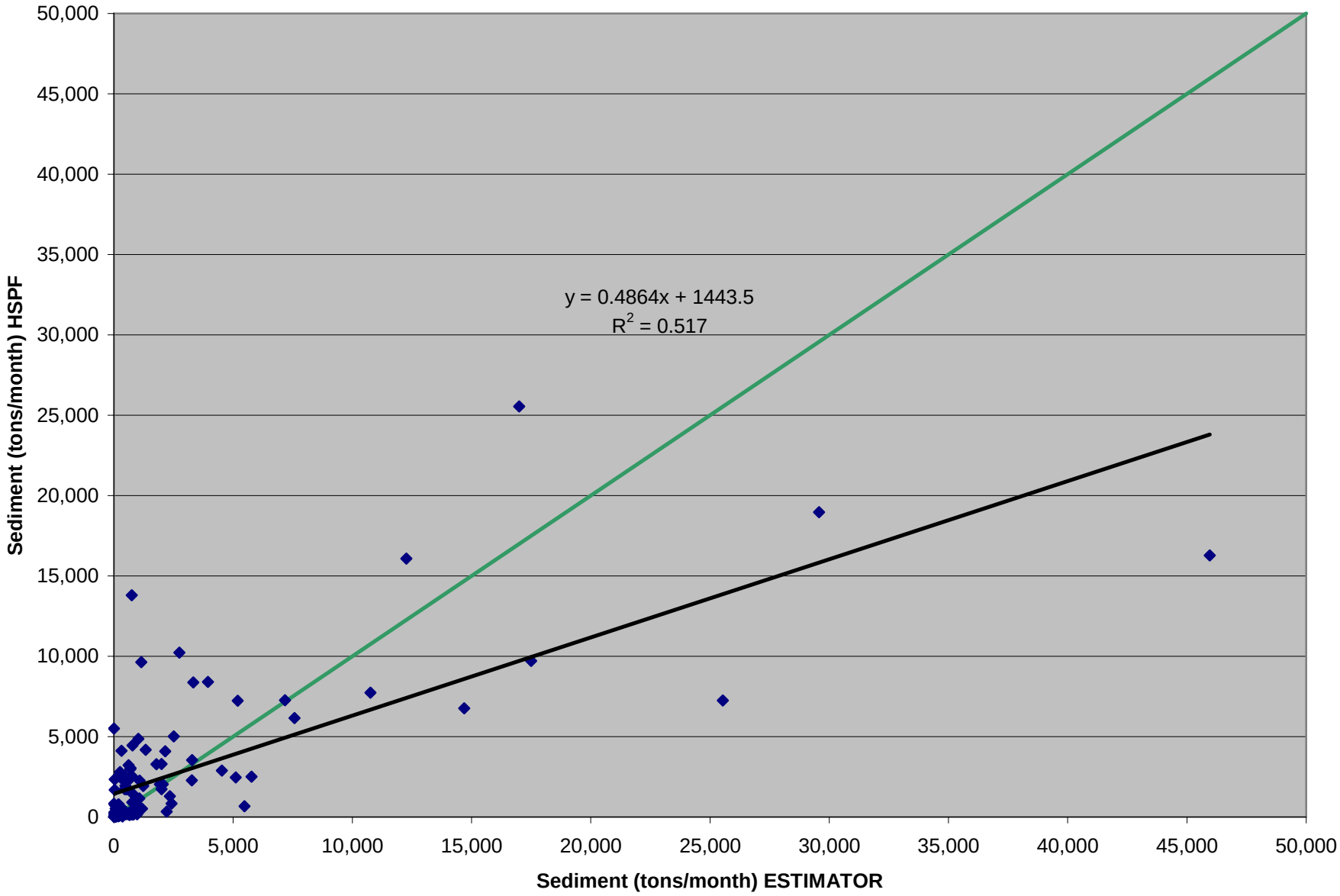

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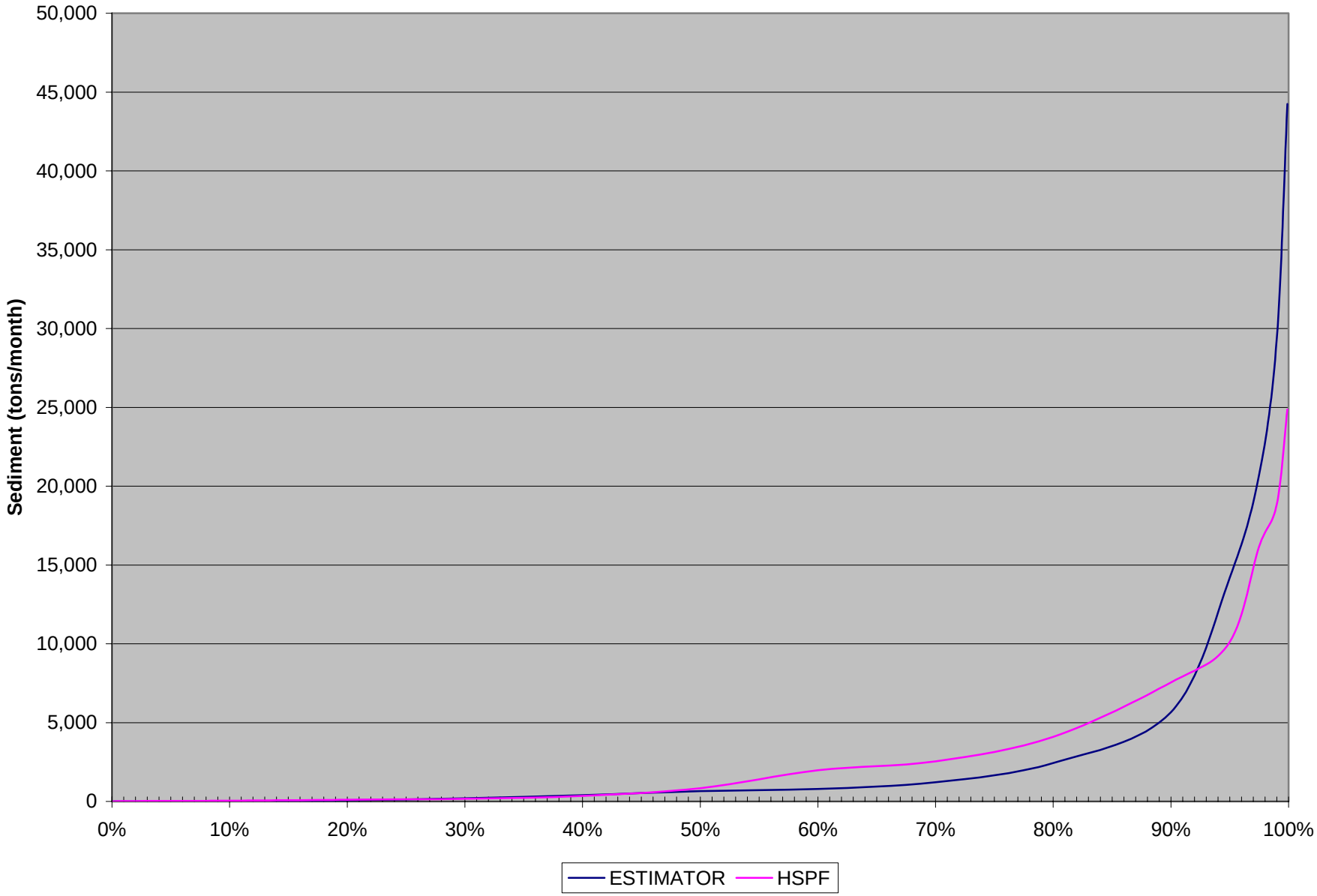

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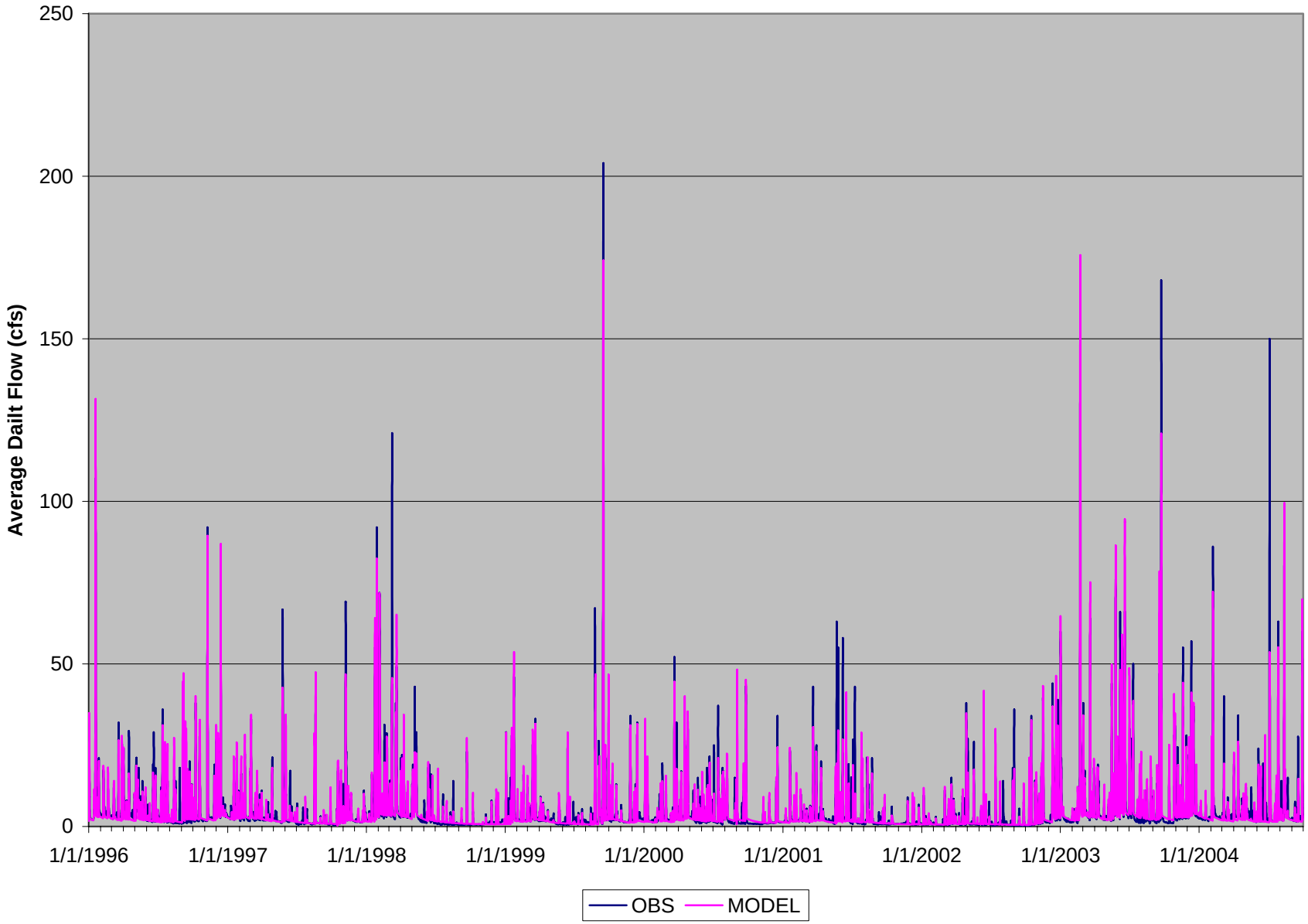
WATTS BRANCH

Hydrology Only



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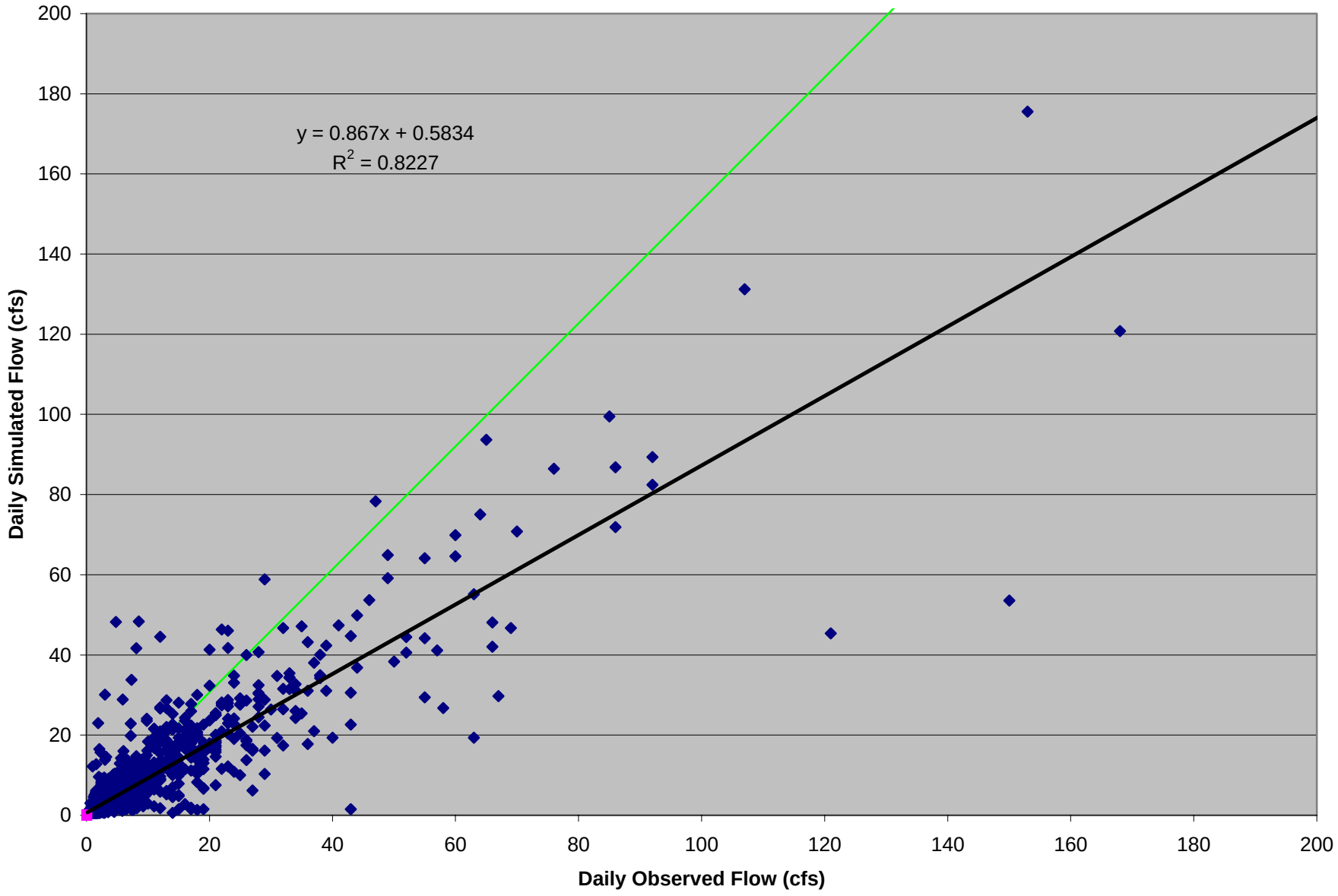

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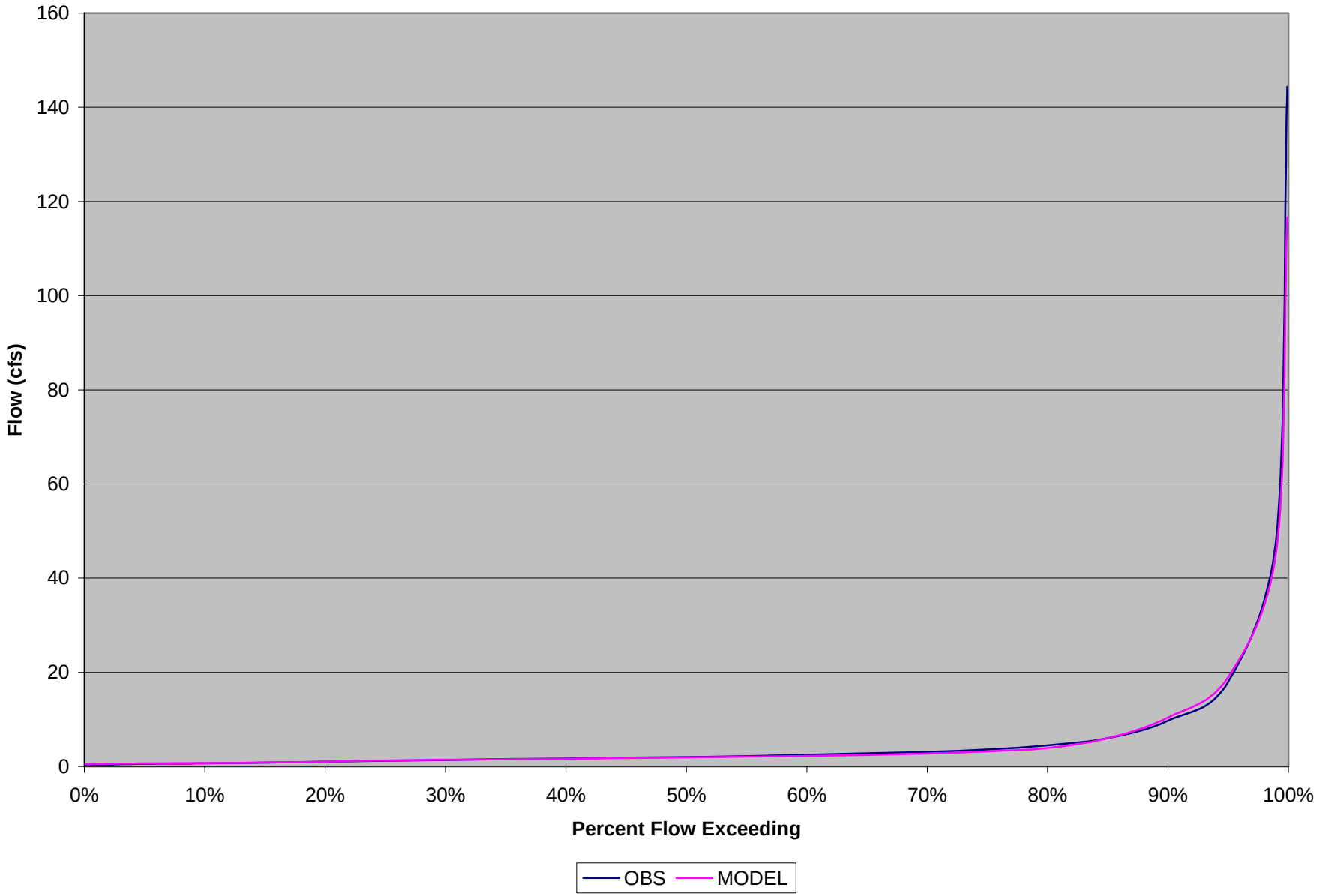

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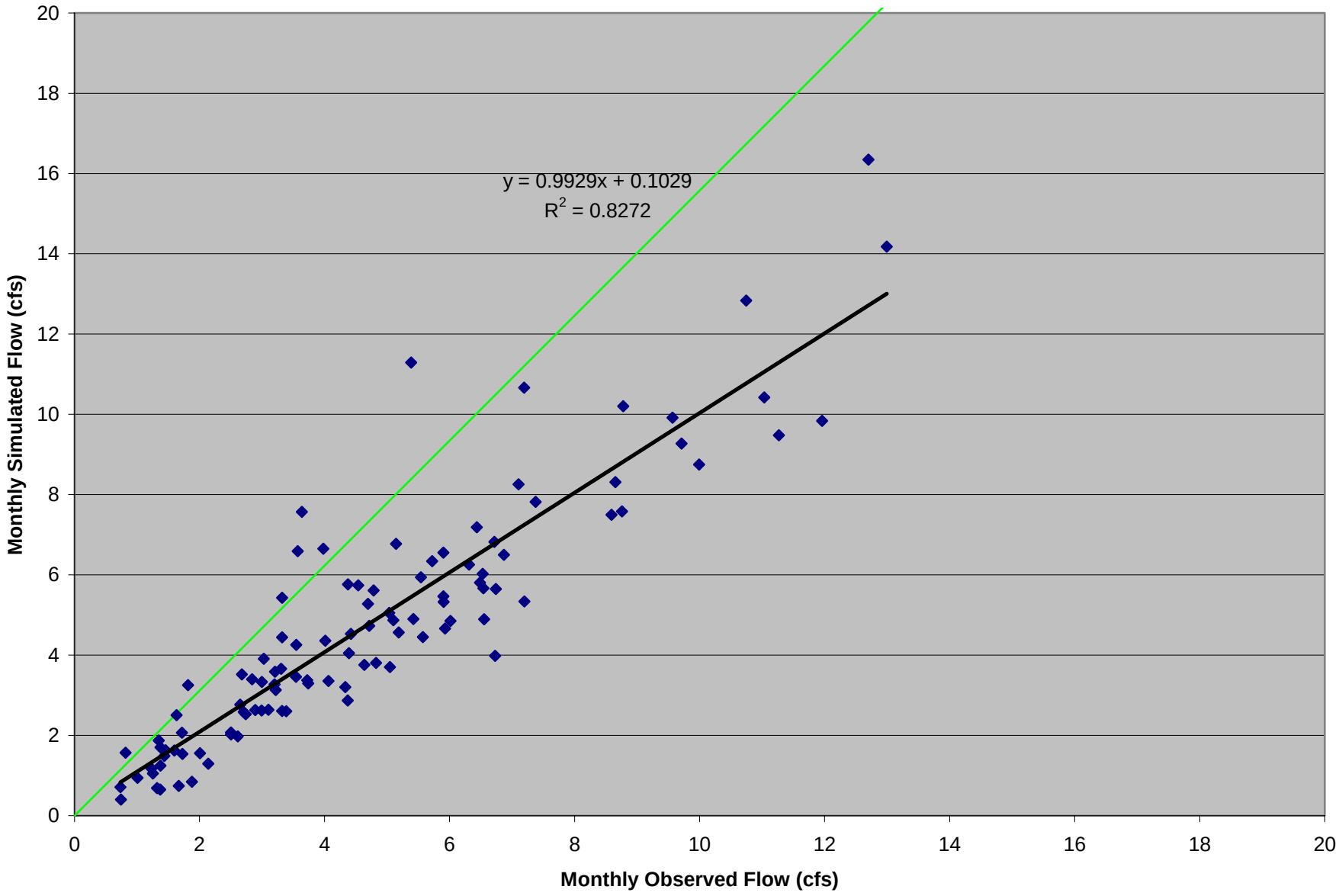

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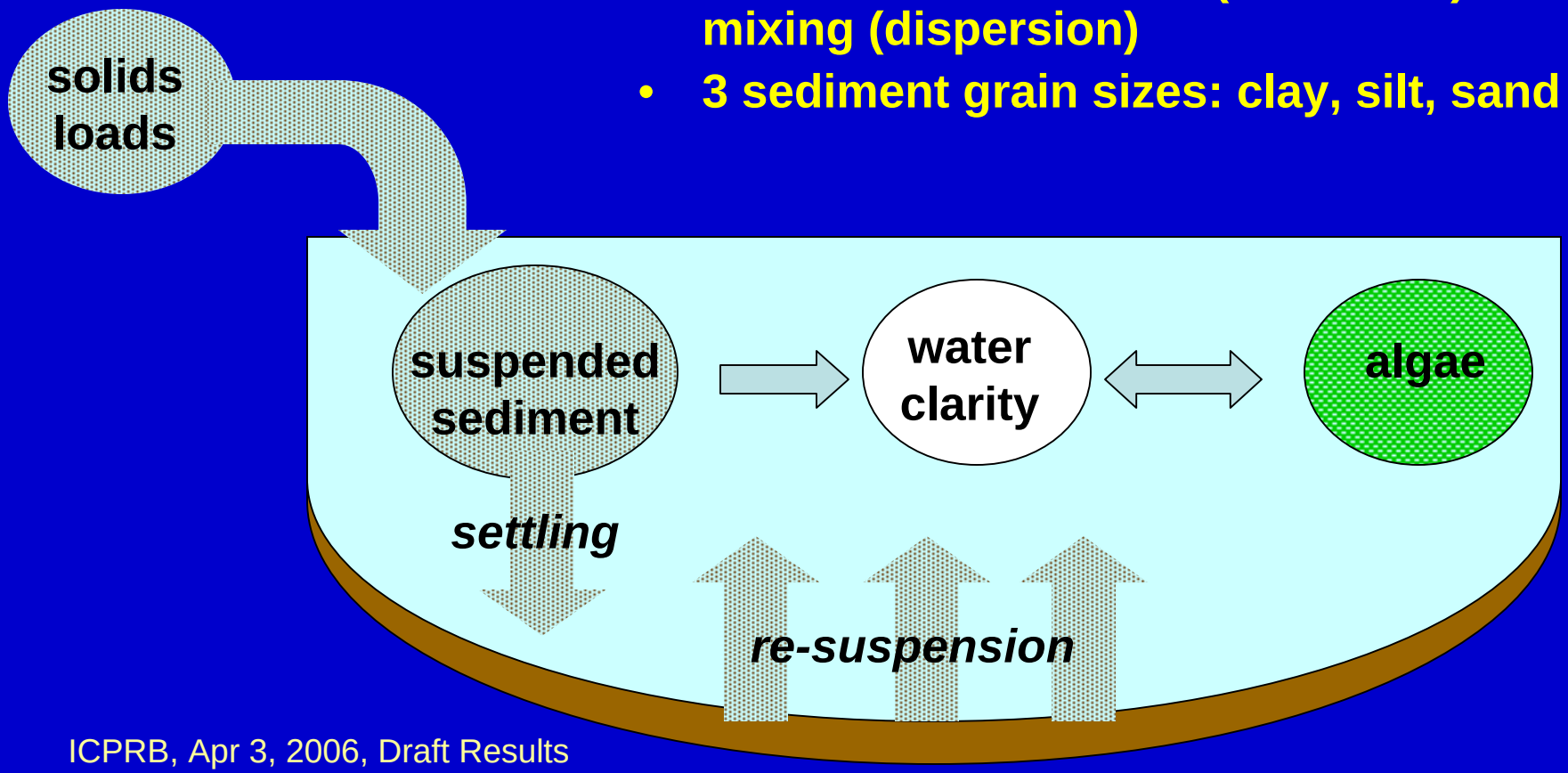
TAM/WASP Water Clarity Model

Simulation also includes:

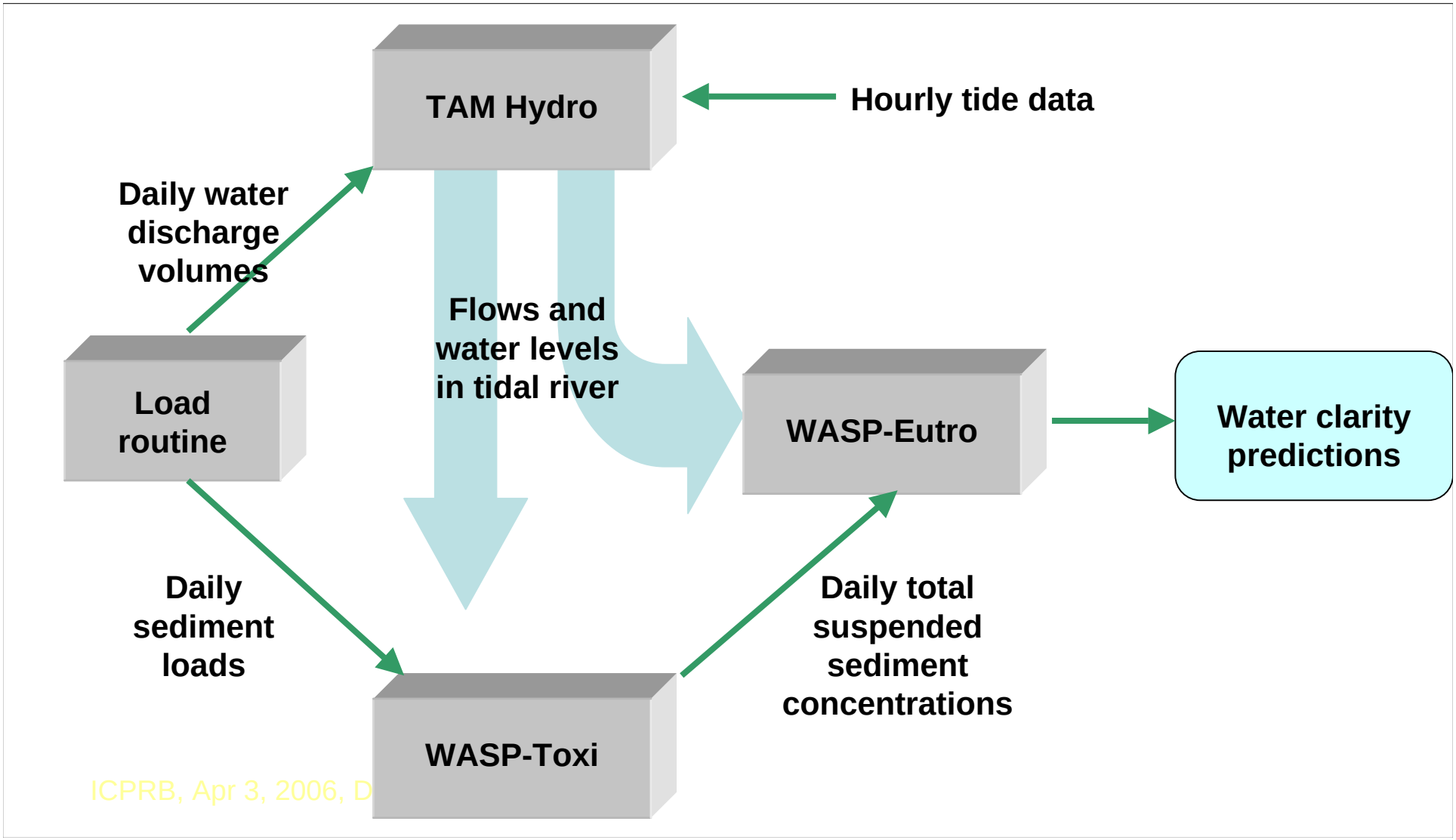
- **Movement due to flow (advection) and mixing (dispersion)**
- **3 sediment grain sizes: clay, silt, sand**



Tidal Water Clarity Model (TAM/WASP V3)

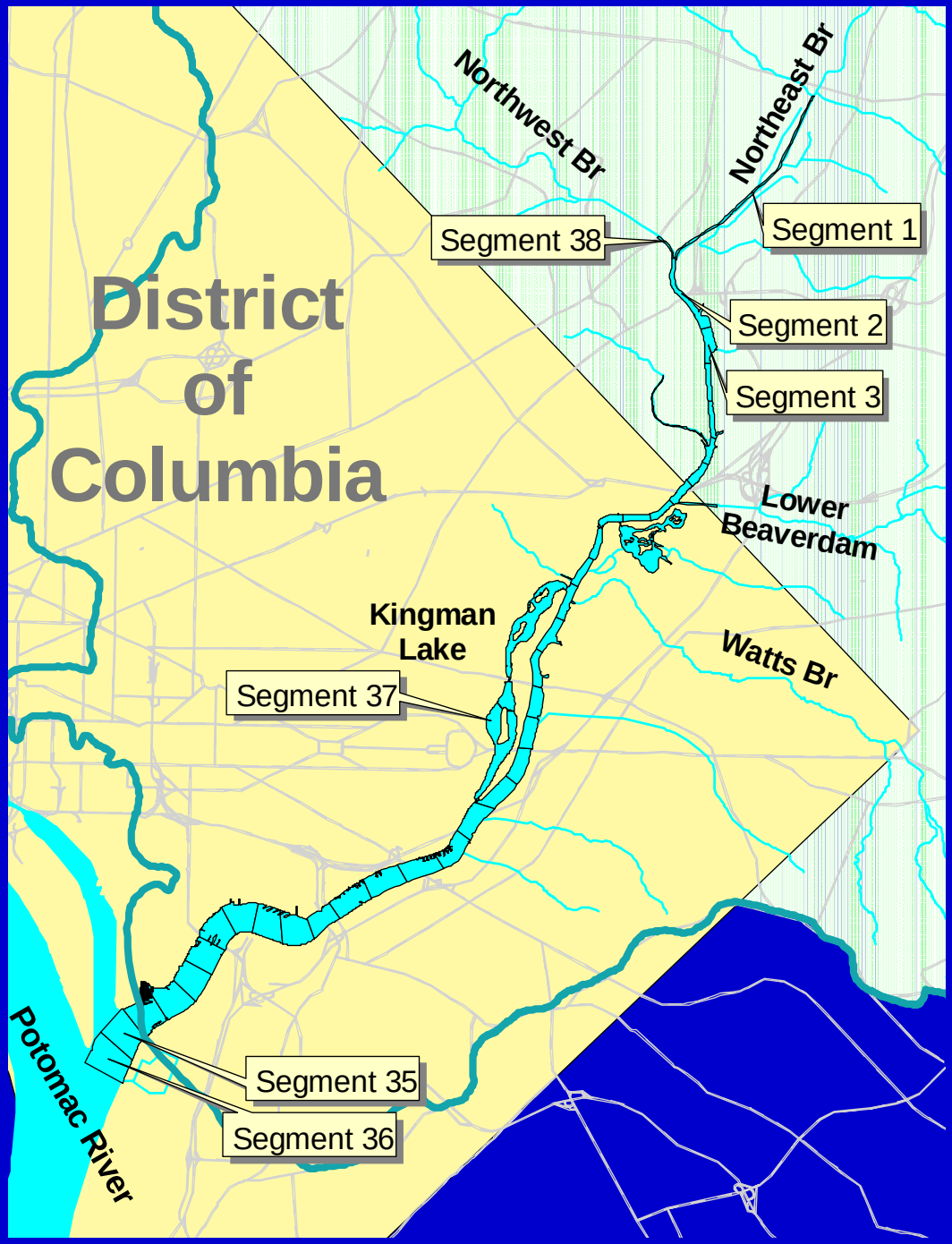
- **New features**
  - Daily sediment loads from NWB/NEB from ESTIMATOR
  - Daily loads from tidal area from HSPF model
  - Simulates water clarity conditions (Secchi depth) based on solids and algae concentrations
  - New calibration/verification periods: 1999-2001/1995-97
- **Tidal model limitations**
  - Doesn't include "sediment aging" – implicit conservative assumption
  - Sediment transport and algae model not fully coupled

TAM/WASP Components

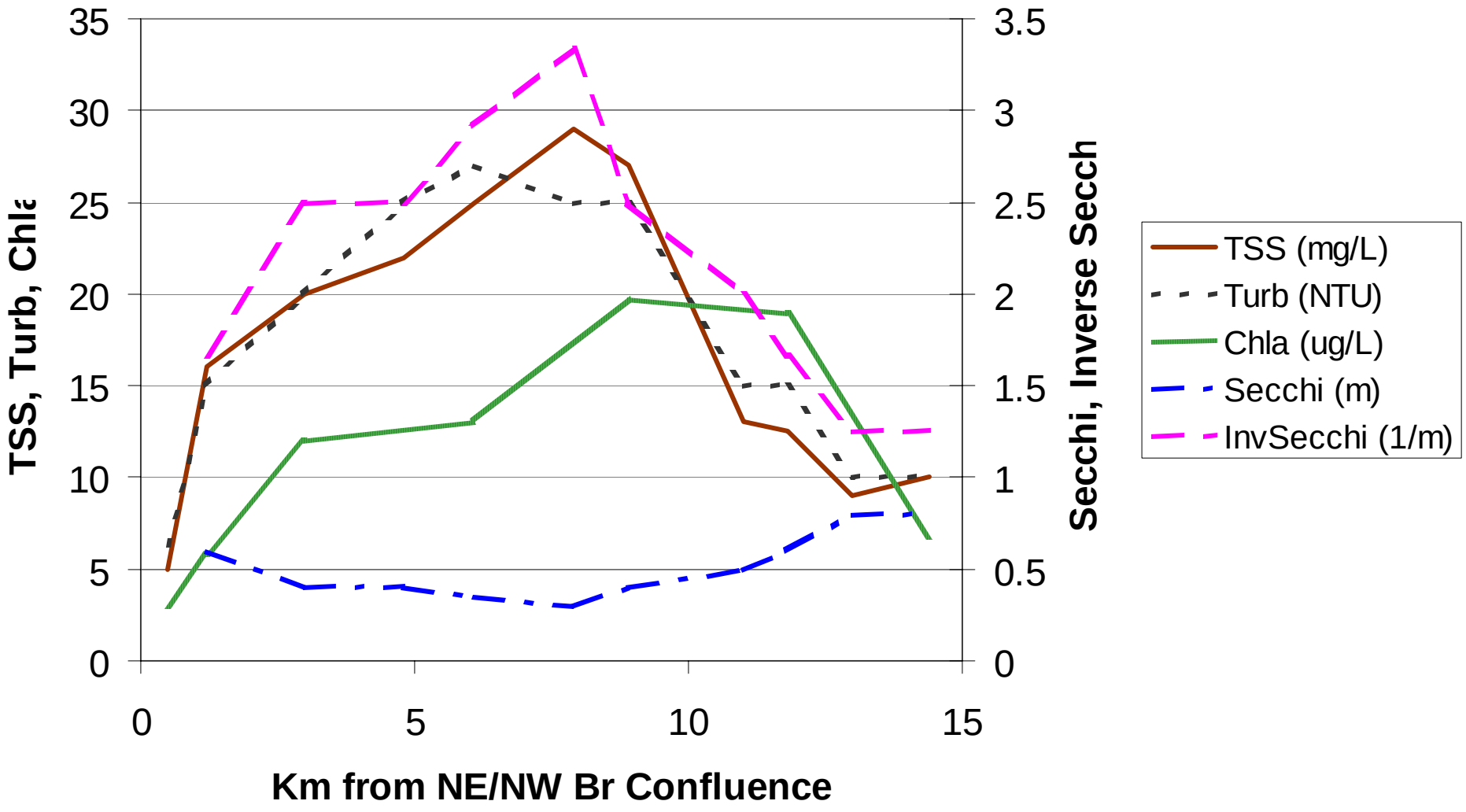


TAM/WASP Tidal Model Segmentation

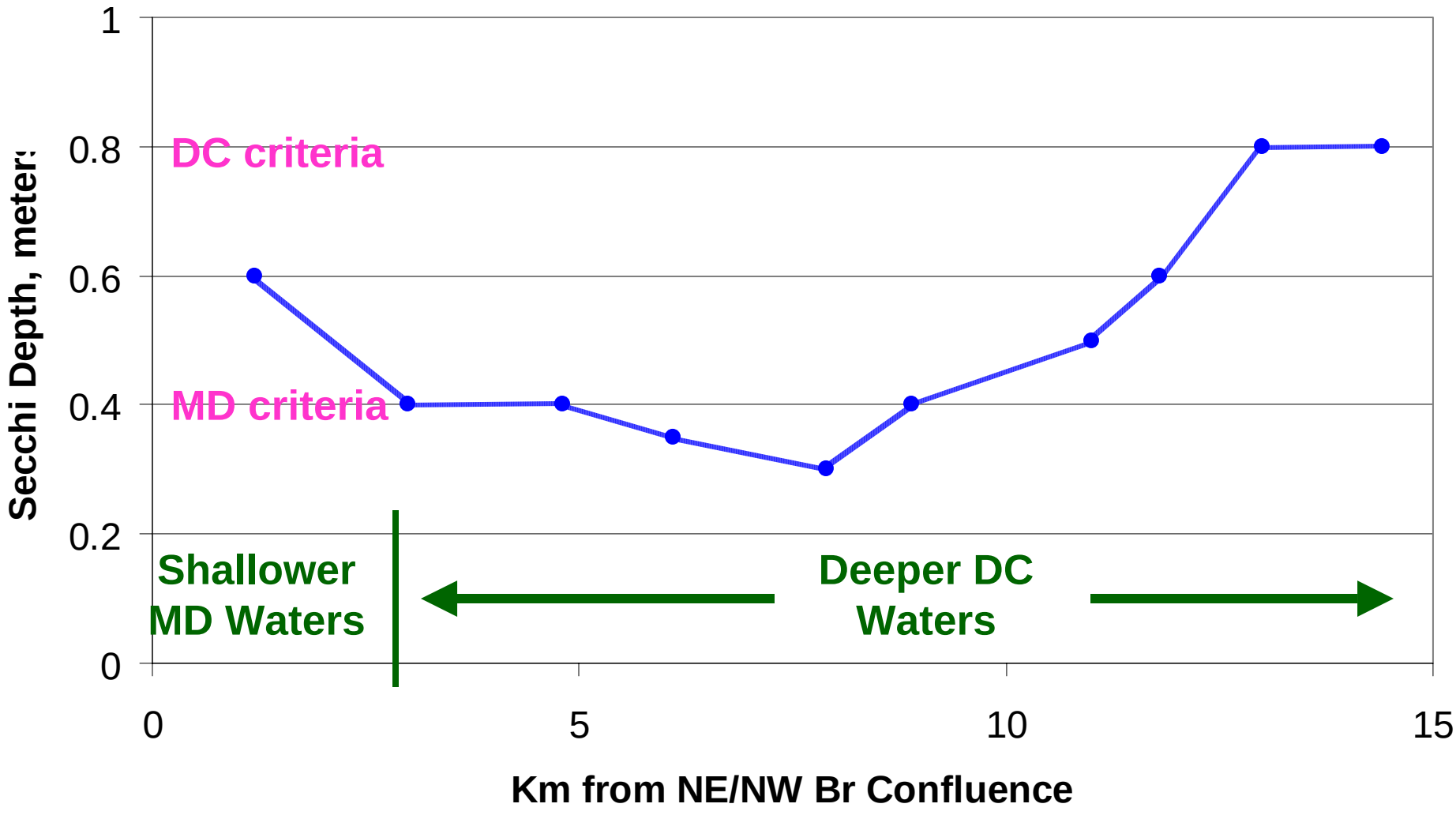
- **"Version 3" has 38 segments**
  - Adding tidal NEB (segment 1)
  - Adding tidal NWB (segment 38 – as side-embayment)



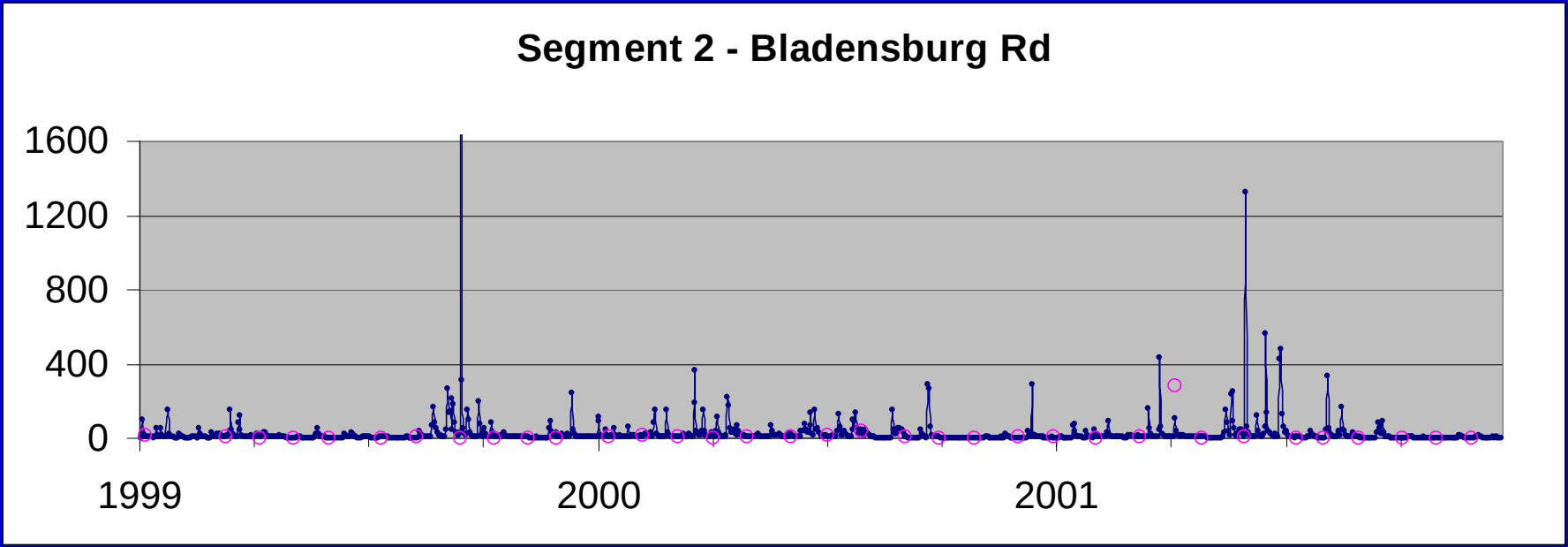
Long-Term Growing Season Medians (1995-2002)

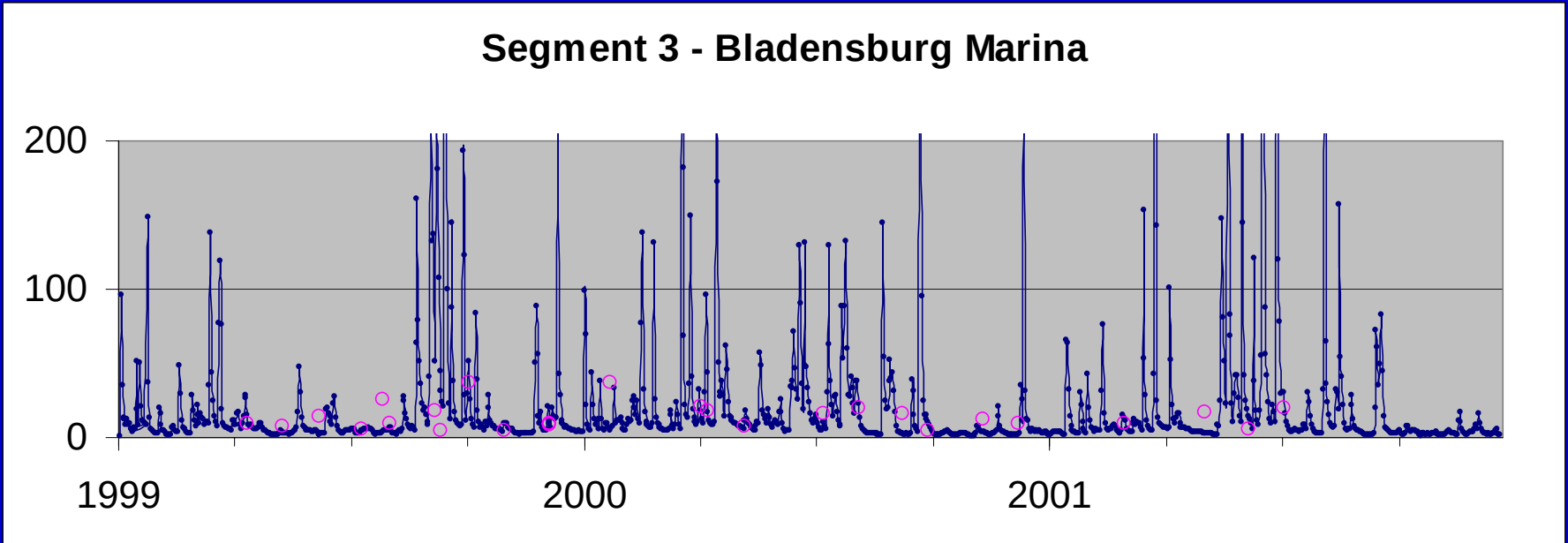


Long-Term Growing Season Median Secchi Depths



TSS Predictions, 1999-2001





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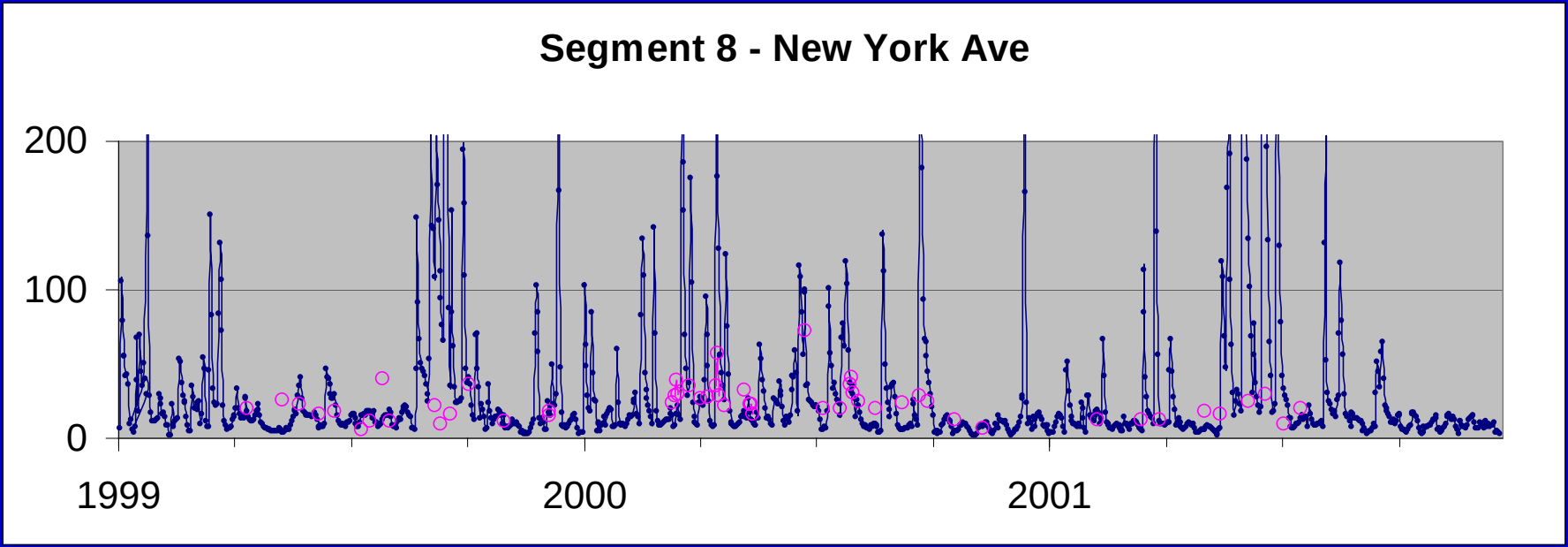

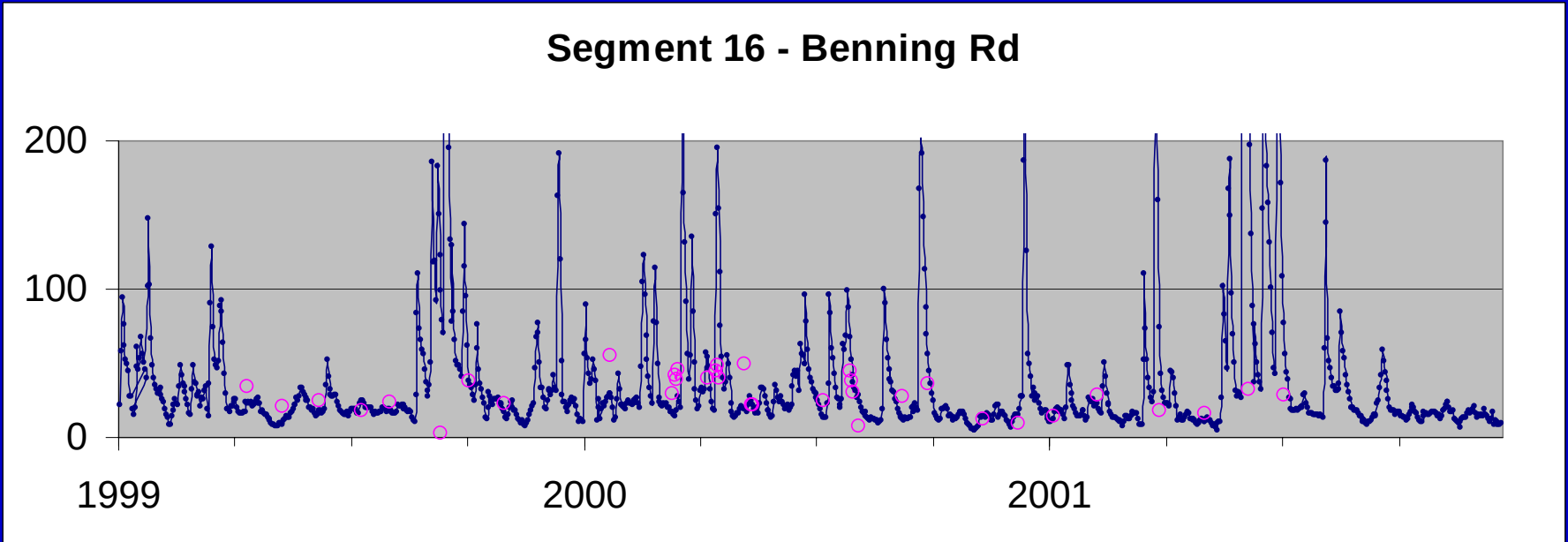

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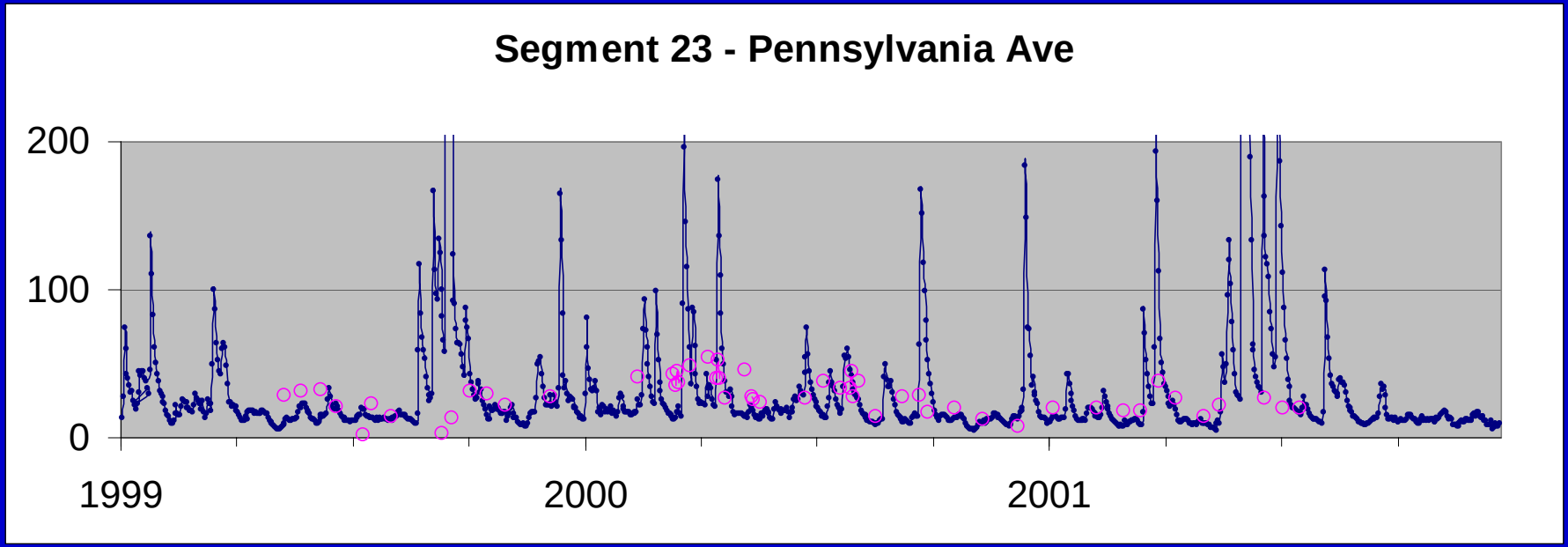
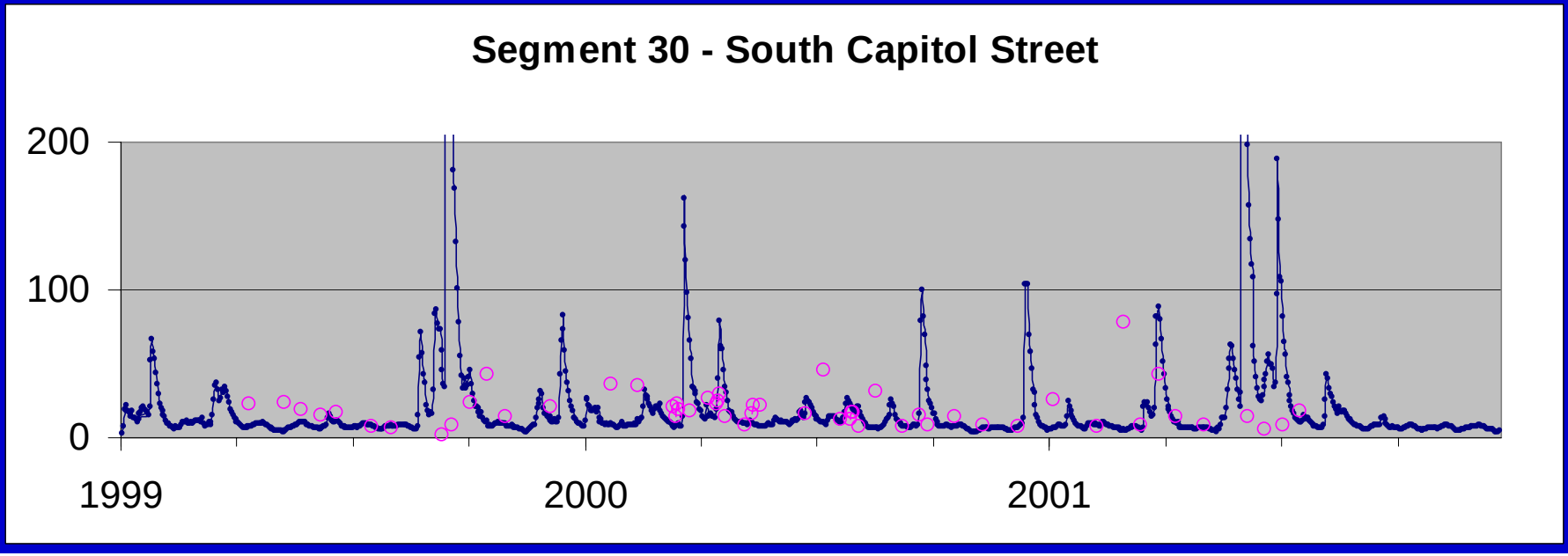
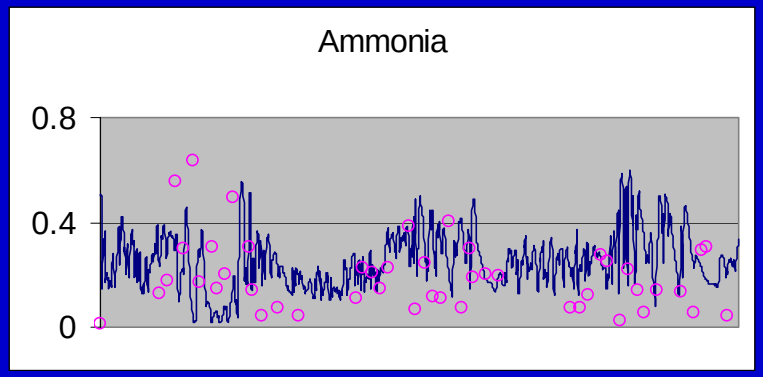
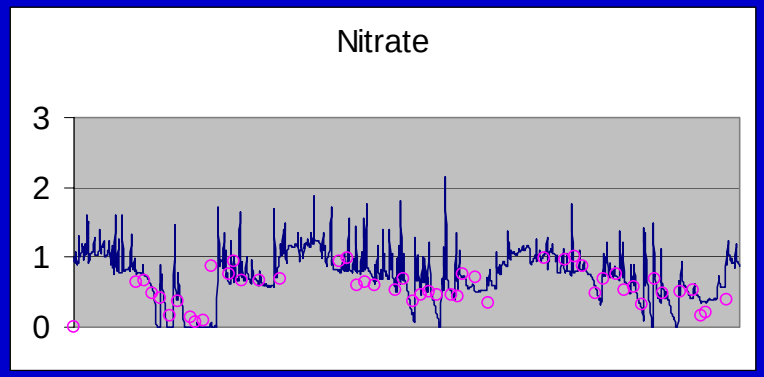
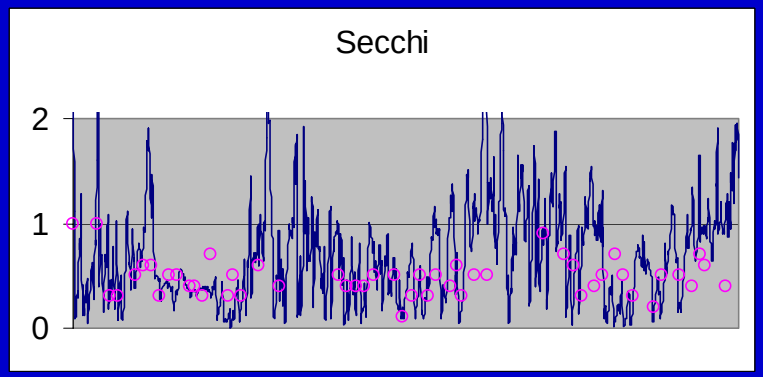


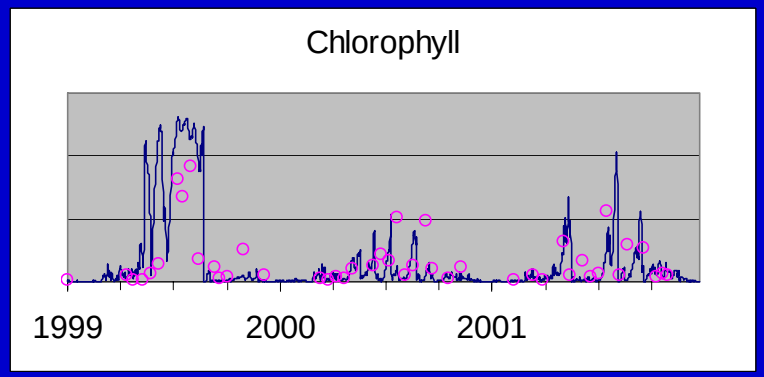


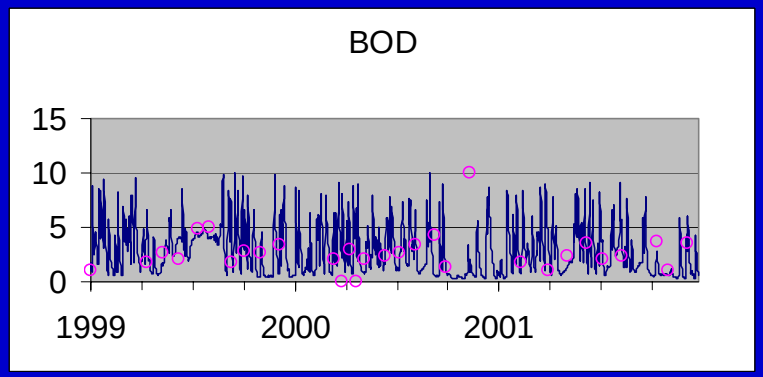
WQ Predictions at Bladensburg Marina

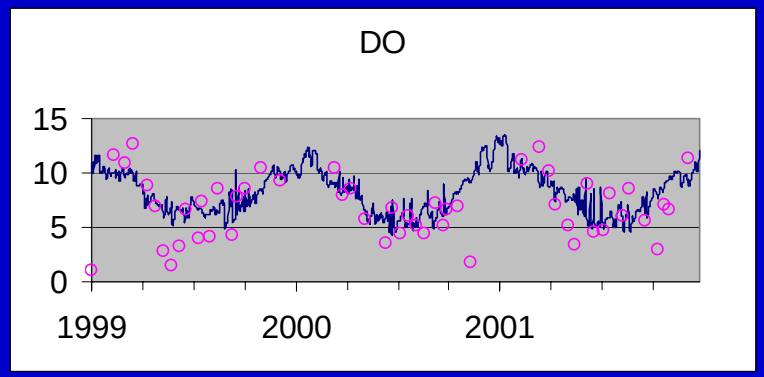












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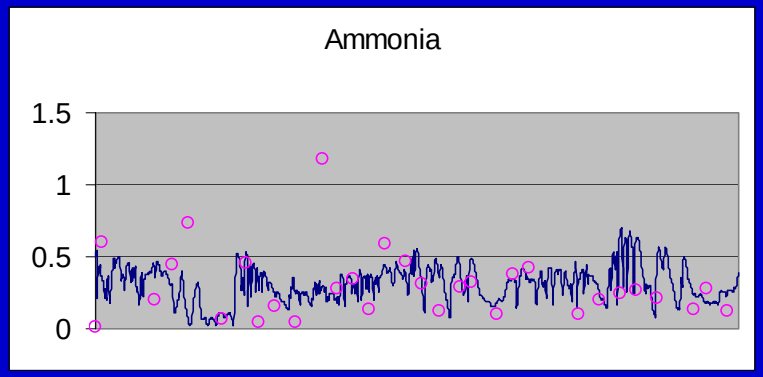
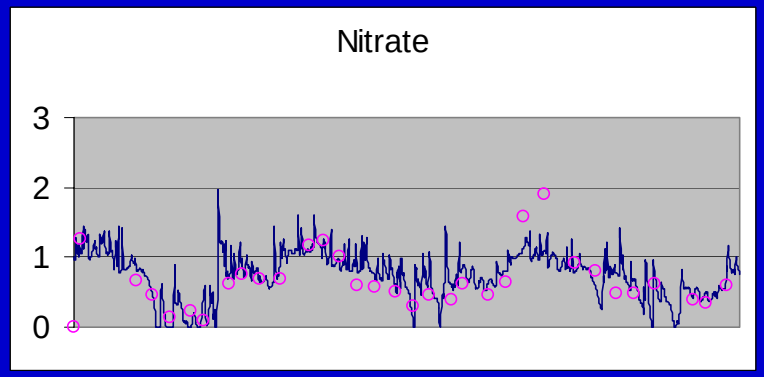
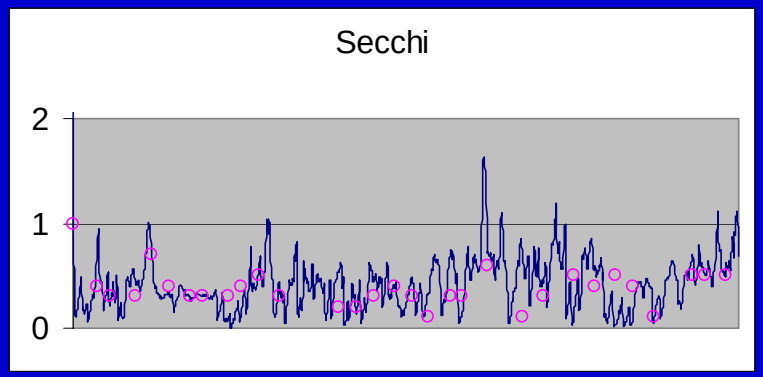
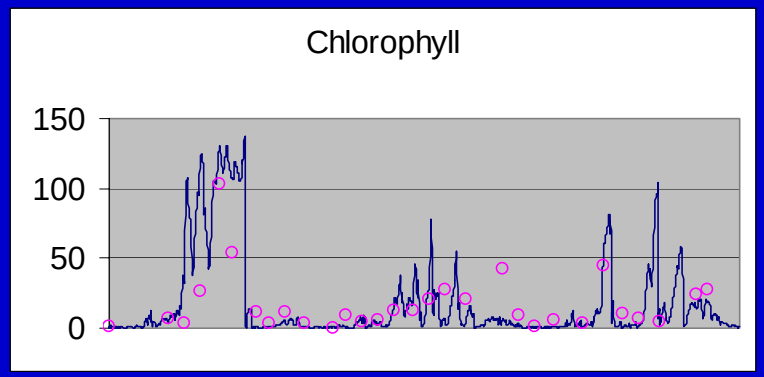
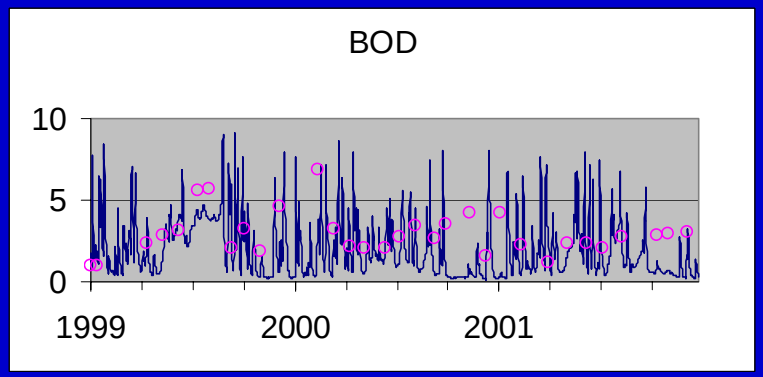
WQ Predictions at Benning Rd

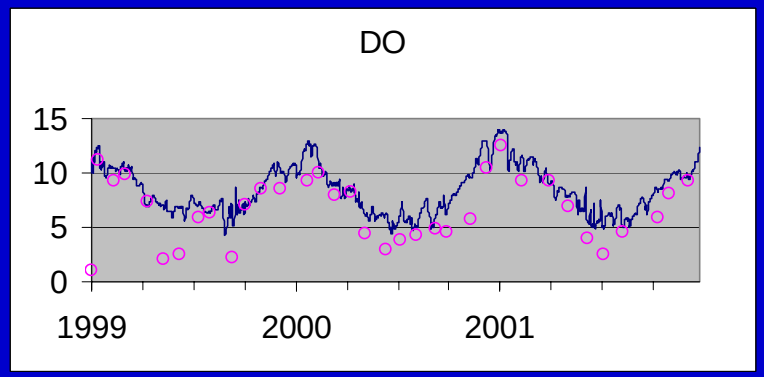












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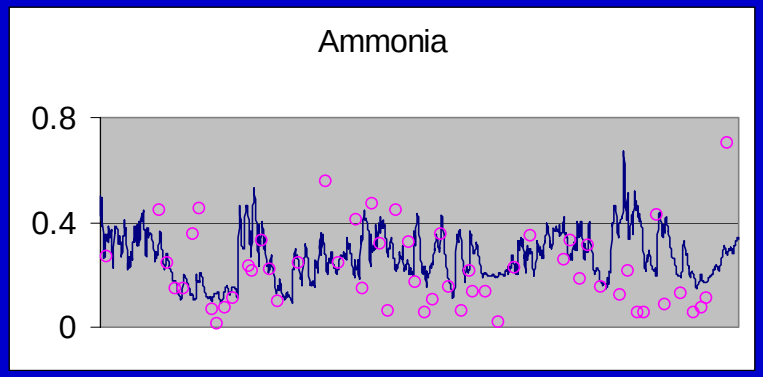
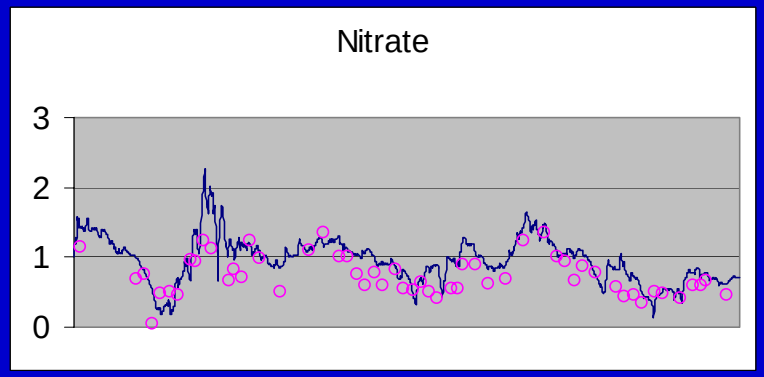
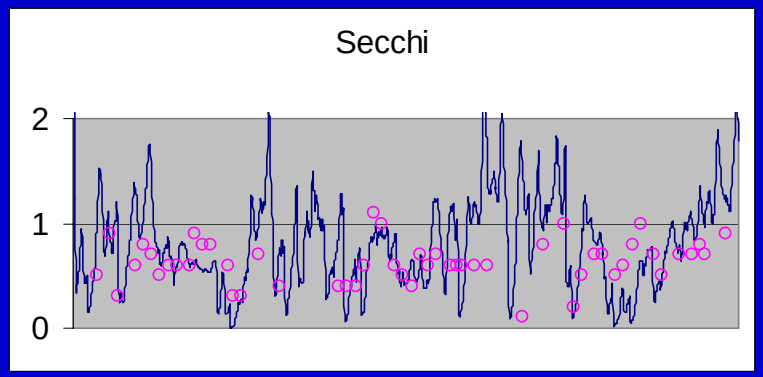
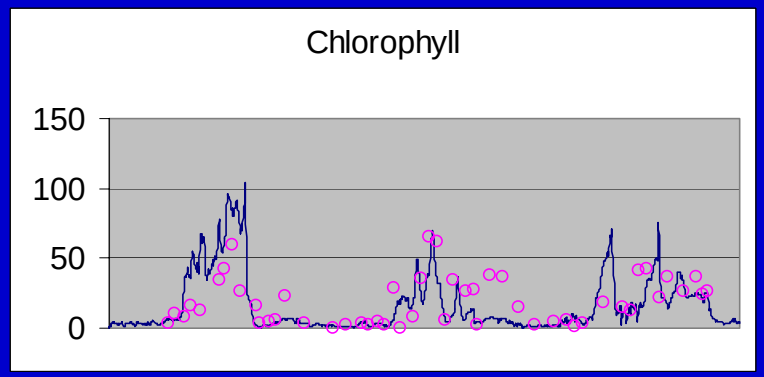
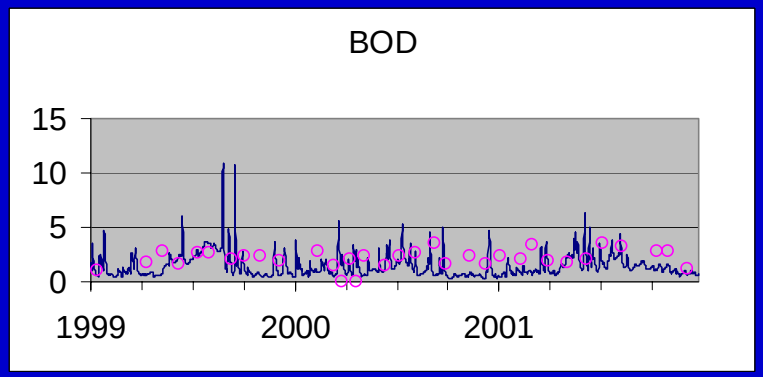
WQ Predictions at South Capitol St

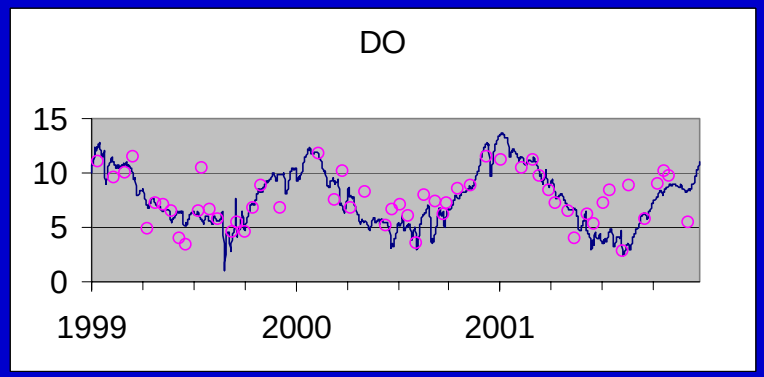












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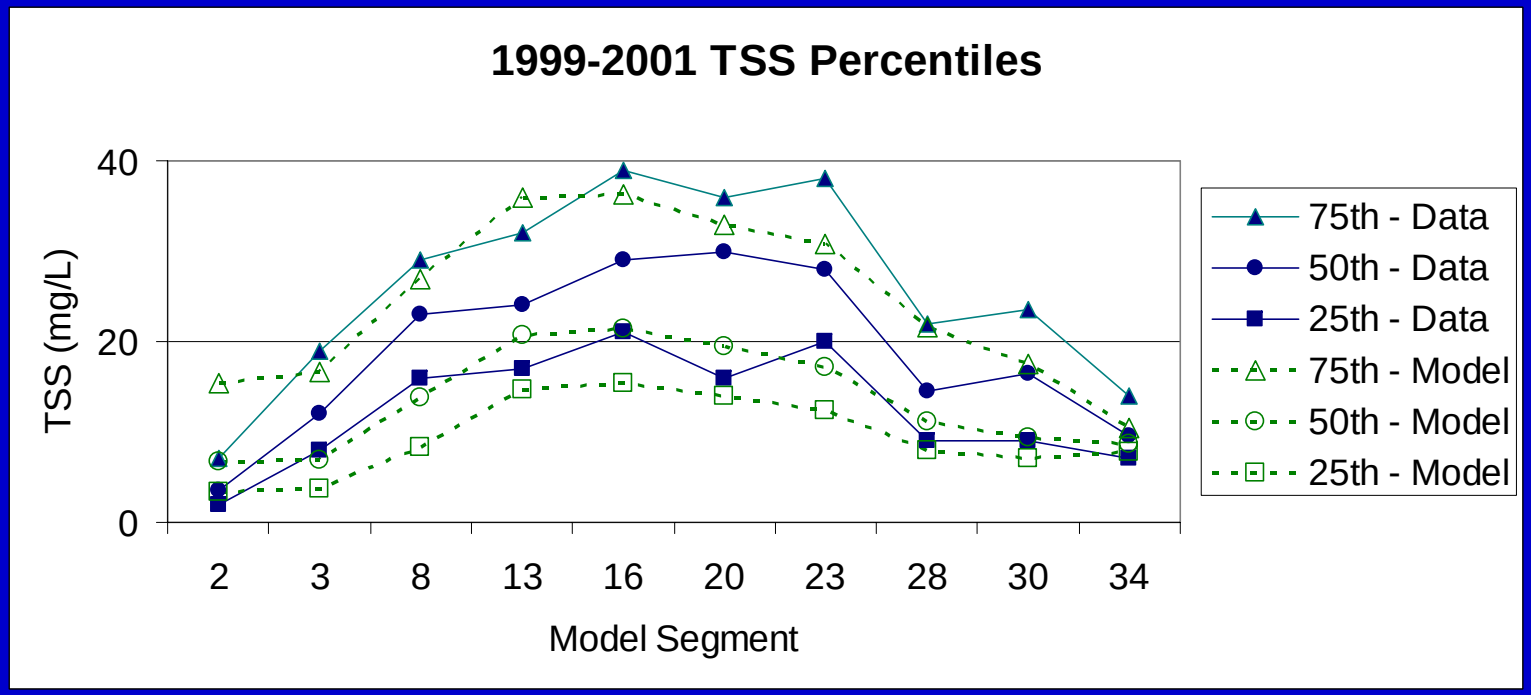
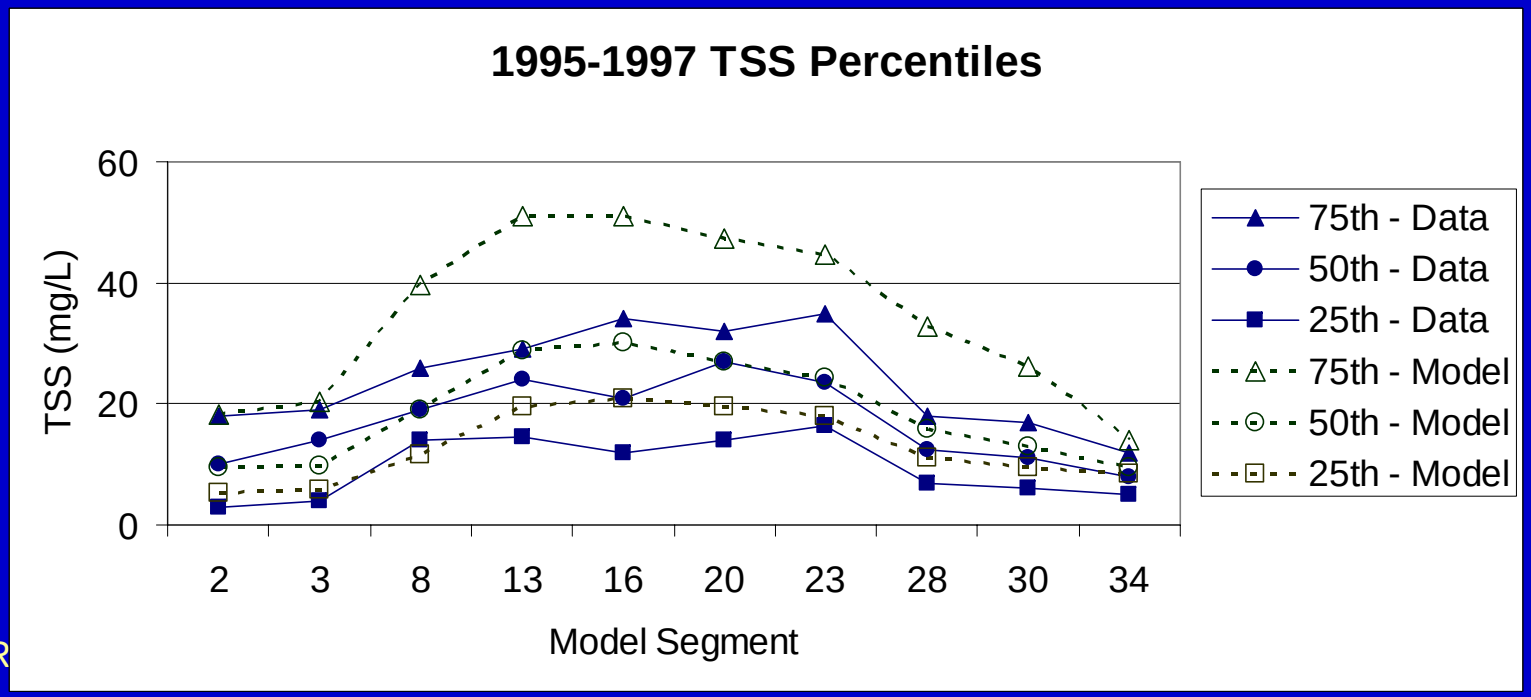
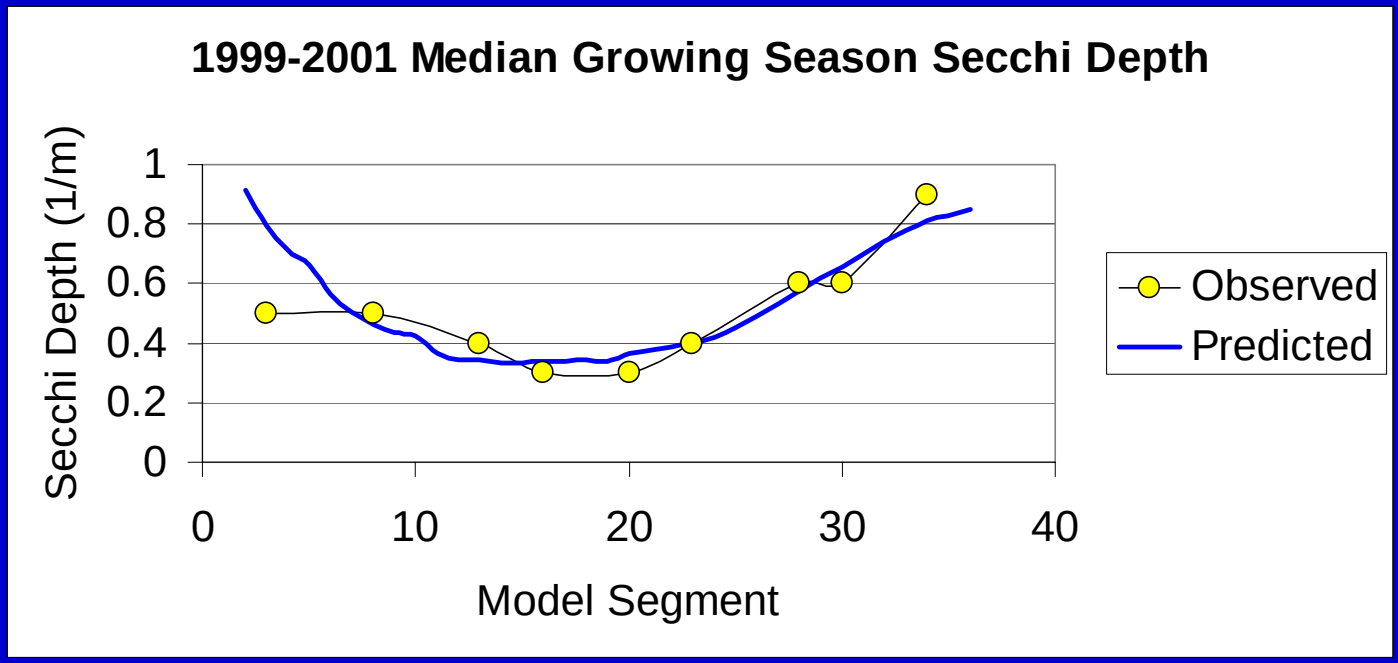
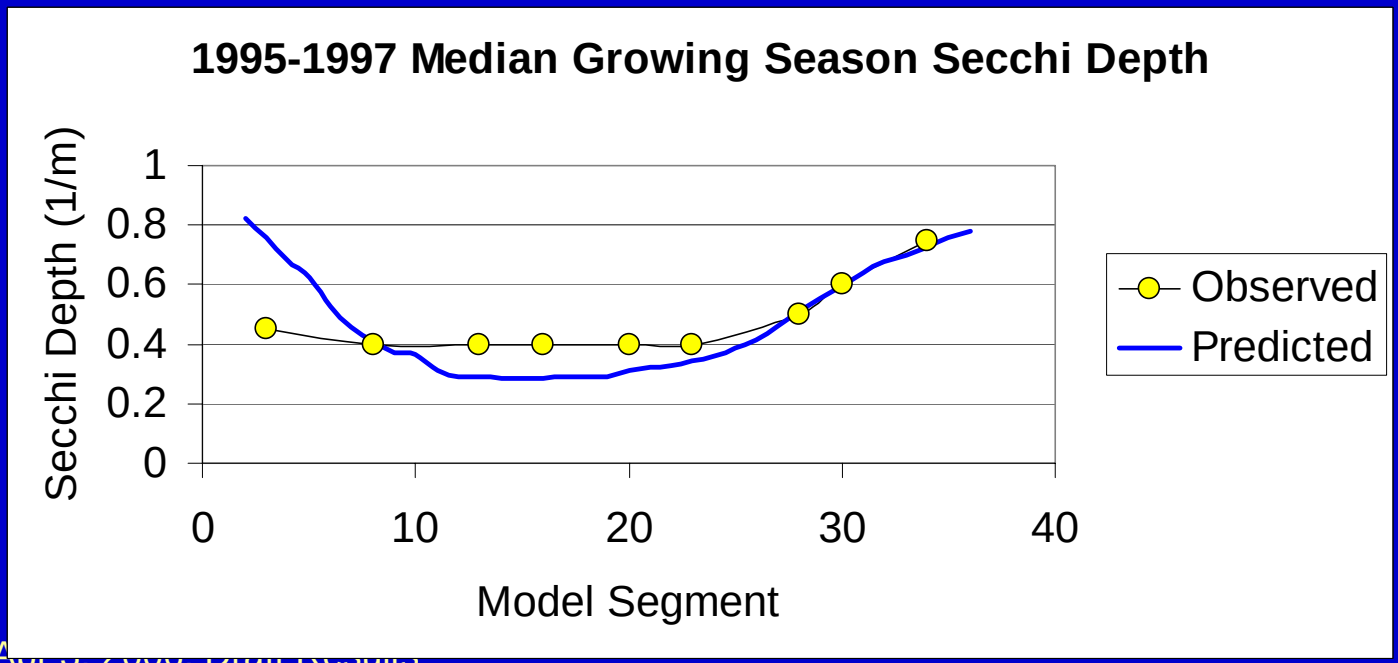

1999-2001 TSS Percentiles
TSS (mg/L)
40
20
0
2
3
8
13
16
20
23
28
30
34
Model Segment
75th - Data
50th - Data
25th - Data
75th - Model
50th - Model
25th - Model


1995-1997 TSS Percentiles
TSS (mg/L)
60
40
20
0
2
3
8
13
16
20
23
28
30
34
Model Segment
75th - Data
50th - Data
25th - Data
75th - Model
50th - Model
25th - Model


1999-2001 Median Growing Season Secchi Depth
Secchi Depth (1/m)
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
Model Segment
Observed
Predicted


1995-1997 Median Growing Season Secchi Depth
Secchi Depth (1/m)
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
Model Segment
Observed
Predicted

Draft TMDL Scenario Results (1995-1997 time period)

- **To meet WQSs for protection of aquatic life in non-tidal tribs:**
  - ~30-40% reduction in sediment loads
- **To meet DC's standard for water clarity in tidal river:**
  - ~85-95% reduction in sediment loads
  - ~30-40% reduction in nutrient loads

Remaining Issues/Tasks

- **Finalize non-tidal HSPF model**
  - Review Watts Br results
- **Finalize tidal water clarity model**
  - Use total suspended solids or non-algal solids in light extinction equation?
- **Allocate load reductions – mostly to stream bank erosion (from altered hydrology)**