Total Maximum Daily Loads for PCBs in the Trinity River

Segments 0829, 0806, 0841, & 0805

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Texas Commission on Environmental Quality

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Problem Definition

- Texas Department of State Health Services (TDSHS) issued Aquatic Life Order 14 (AL-14) and Fish Consumption Advisory 25 (ADV-25) in 2002 due to "PCBs in fish tissue" for 150 miles of the Trinity River
- As a result the TCEQ placed four segments (nine Assessment Units (AUs)) of the Trinity River on the CWA 303 (d) list due to impairment of the "fish consumption" designated use
- Fish Consumption Advisory 43 (July 2010) expanded the area addressed to the TCEQ segment boundaries (covering 12 assessment units).

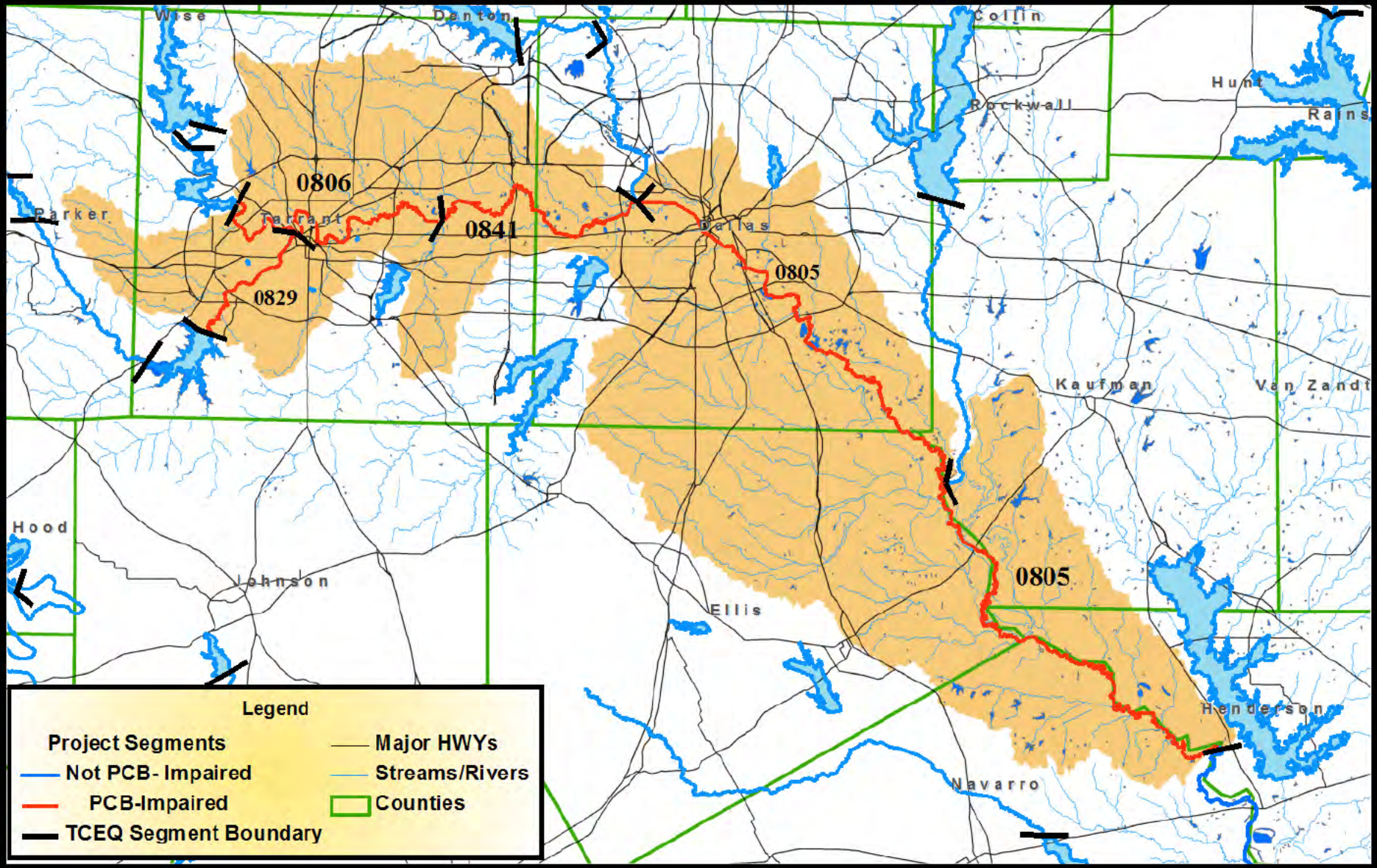
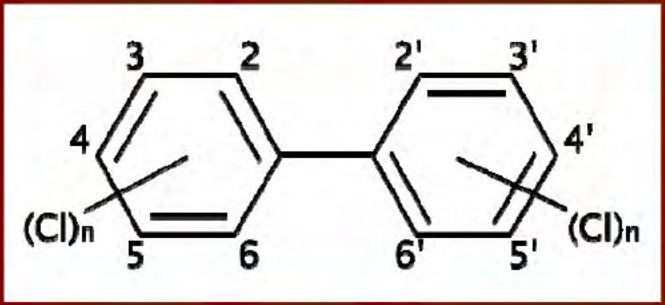


Figure 11. Location Map

Polychlorinated Biphenyls (PCBs)

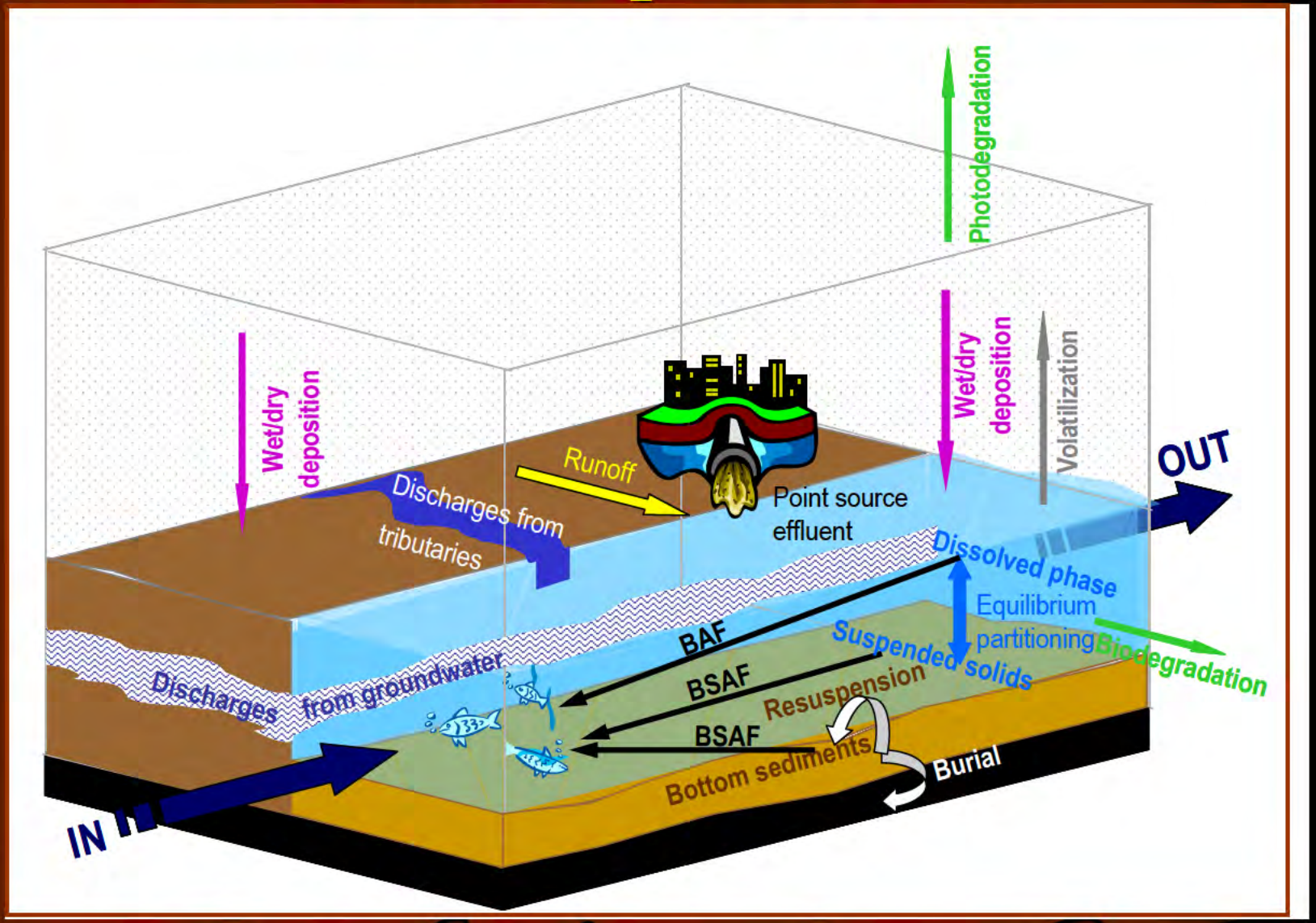


- A group of 209 compounds, known as PCB congeners
- From 1 to 10 chlorines on 2 connected benzene rings
- Properties and toxicity vary, but all poorly soluble in water
- Tend to be associated with sediments in aquatic systems
- Highly resistant to degradation
- Residence times in aquatic systems on the order of decades

Polychlorinated Biphenyls (PCBs)

- Sold in the USA under trade name Aroclor
- Used mainly as
  - Dielectric fluids in transformers
  - Heat transfer fluids
  - Heat-resistant hydraulic fluids
- Myriad other uses
- Production, distribution and new use banned in 1976 by Toxic Substances Control Act (TSCA)

PCB Conceptual Model



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PCB fate in water is largely controlled by their partitioning to sediments

- PCBs and water mix like oil and water
- Given the chance, PCBs dissolved in water will tend to "sorb" to suspended or bed sediment particles
- Organic particles can absorb a large amount of PCBs relative to most mineral particles.
- This is also why fish "bioaccumulate" PCBs to high levels
- Among minerals, clays can take up more PCB than silt or sand due to greater surface area.
- PCB uptake by sediments is controlled largely by their organic content.
- Given enough time, an equilibrium distribution of PCB concentrations between dissolved and sediment phases occurs

Data Collection

March – August 2008

In-stream PCB concentration measurements

- 18 measurements at 13 main stem sites

- Sediment PCB concentration measurements
  - 77 measurements at 32 main stem and 43 tributary sites
- PCB loads from wastewater discharges
  - 8 measurements at 4 facilities
- PCB loads from storm water
  - 9 measurements at 5 sites
- Individual PCB congeners measured by EPA Method 1668A

  - results reflect Sum PCBs as the sum of "detected" congeners

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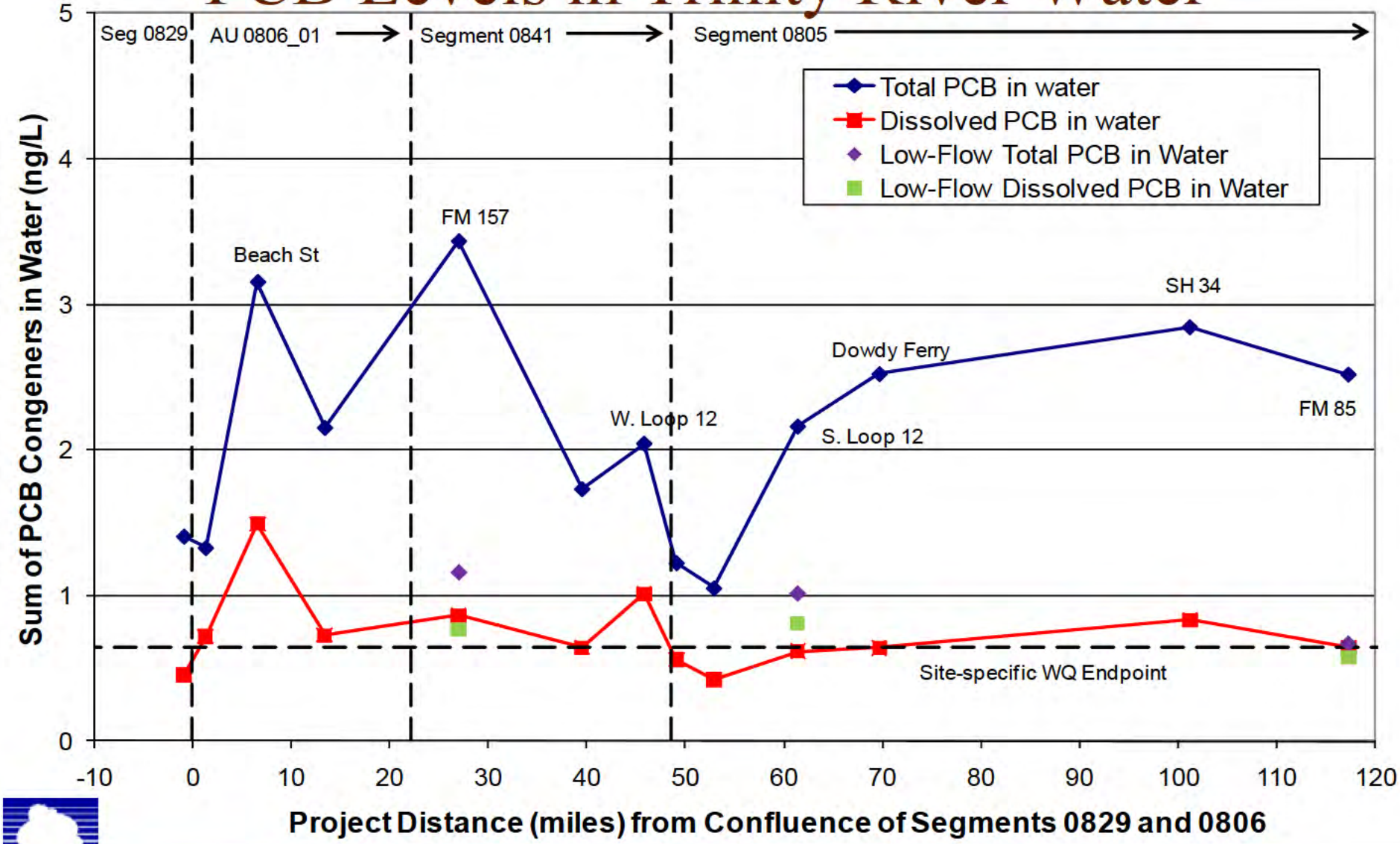
PCB Levels in Trinity River Water



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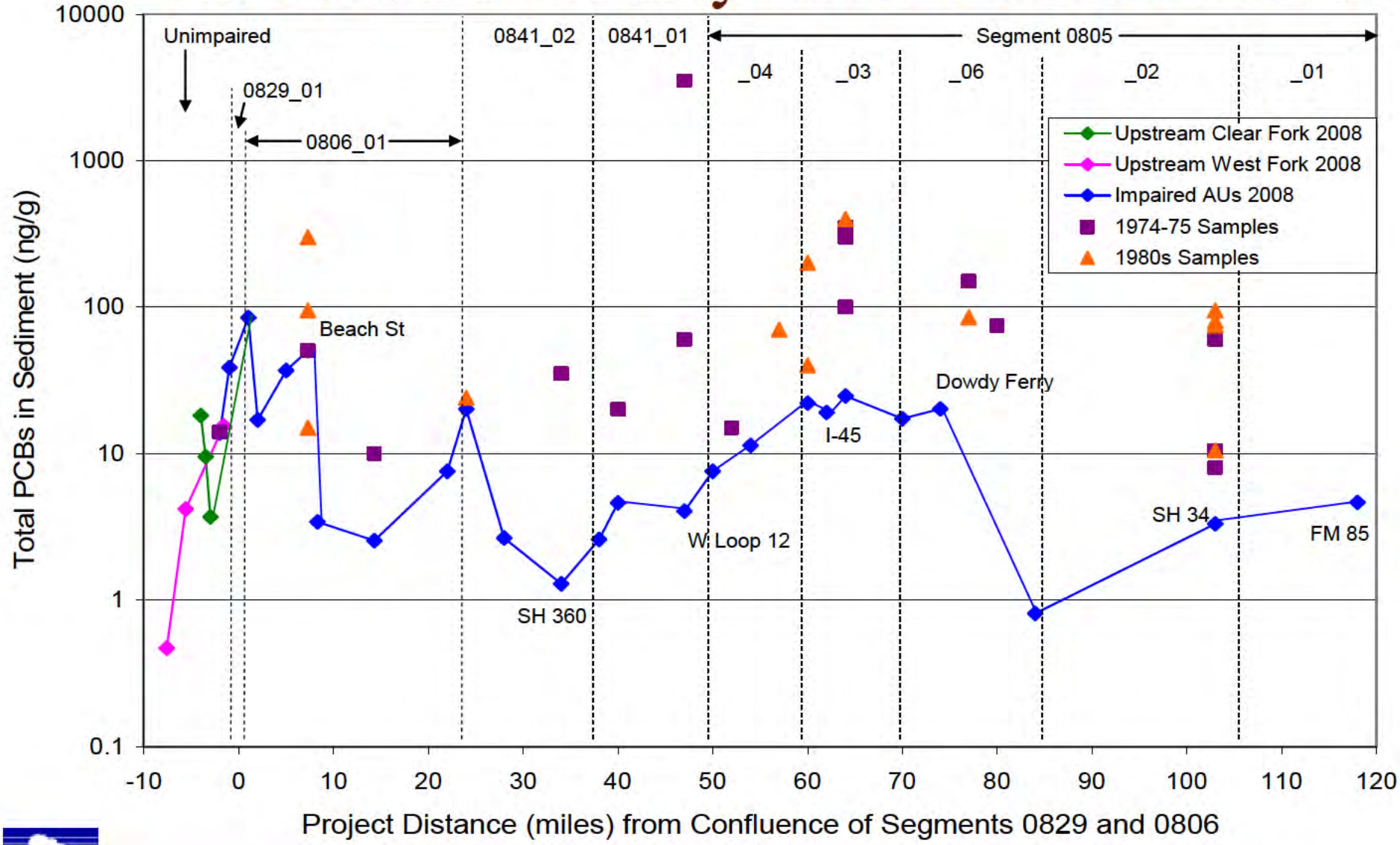
PCB Levels in Trinity River Bed Sediments



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Endpoint Identification

- Current Texas Water Quality Criterion for Protection of Human Health (Fish Consumption):

  19.96 micrograms of PCB per kilogram of fish tissue

  (19.96 parts per billion)

- TMDL Water Quality Target in Water:

  = Tissue Criterion / Bioaccumulation Factor (BAF†)

  = 64 nanograms of PCB per liter of water

  (64 parts per trillion)

† BAF = 31,200 L/kg

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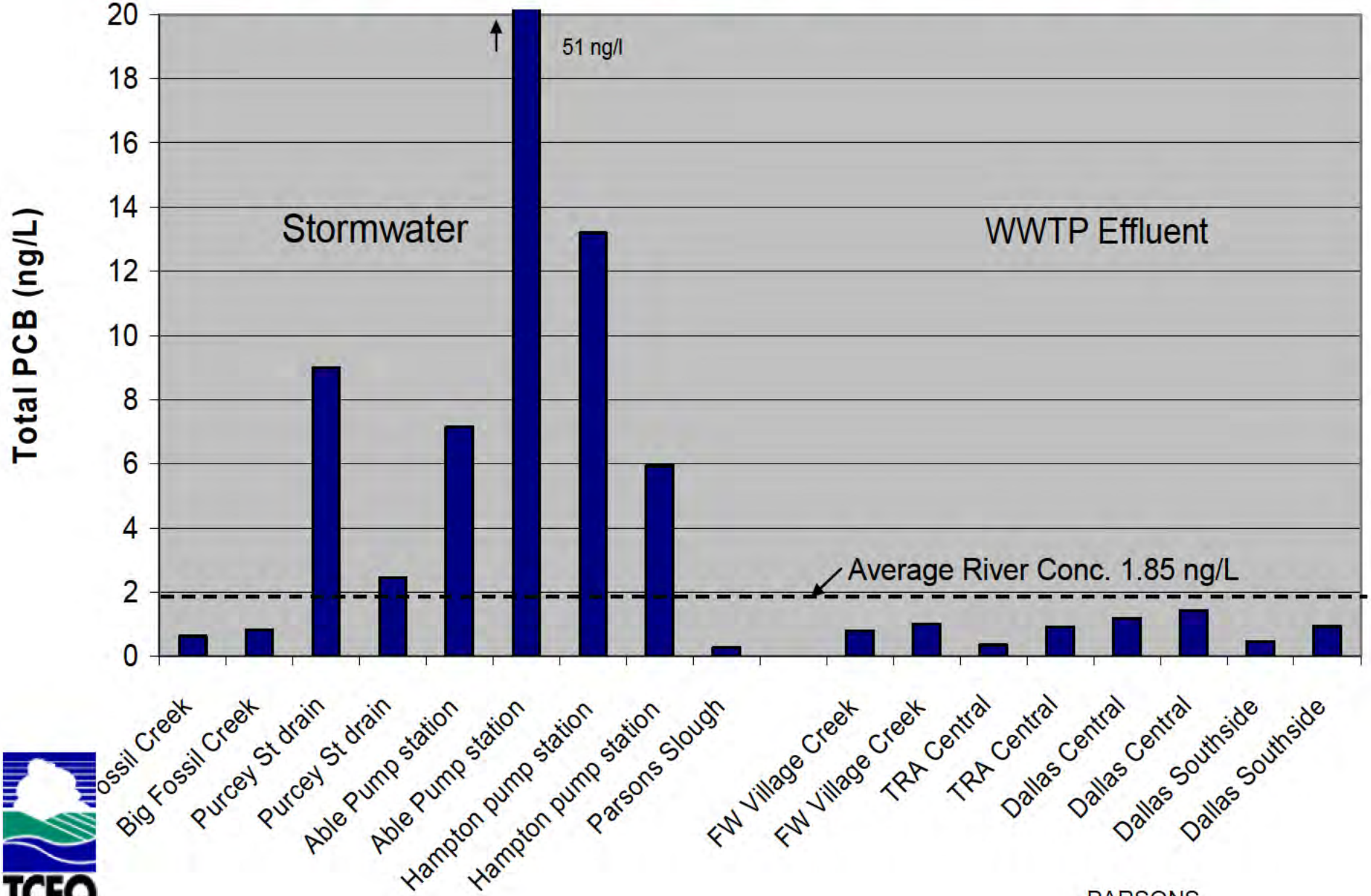
Pollutant Source Assessment

- Inflows from Upstream Segments
- TPDES Permitted Point Sources
  - Individually Permitted Sources (e.g., municipal WWTFs, industrial storm water, treated groundwater)
  - TPDES Regulated Storm Water
    - Municipal Separate Storm Sewerage Systems (MS4s)
    - TPDES general permits (e.g., construction, multi-sector)
- Non-Regulated Sources
  - Nonpoint Source Runoff
  - Dry and Wet Air Deposition
  - Fluxes from Contaminated Sediments

PCB Sources: Stormwater and WWTP Effluent



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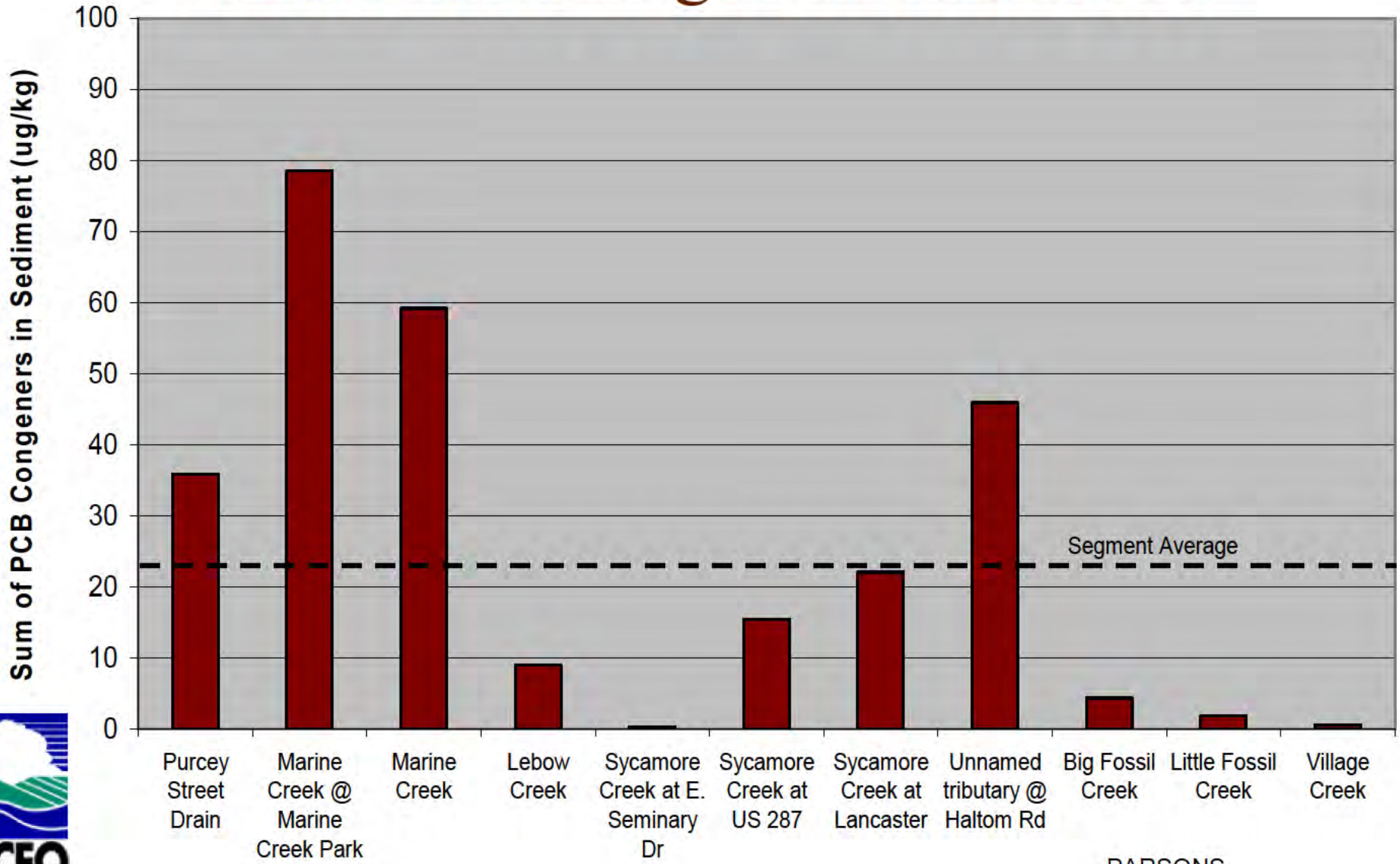
PCB Levels in Bed Sediments of Tributaries to Segment 0806/0829



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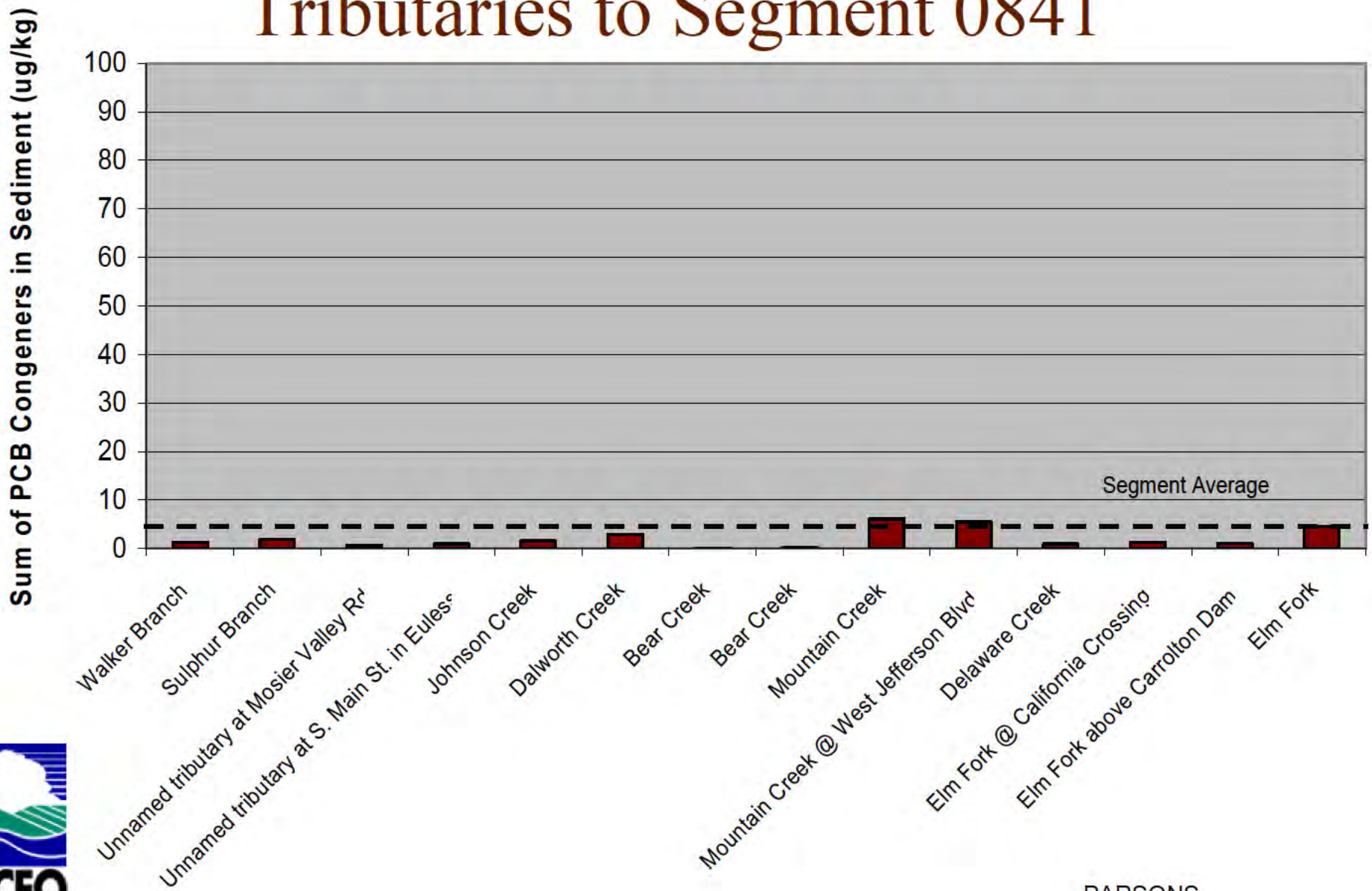
PCB Levels in Bed Sediments of Tributaries to Segment 0841



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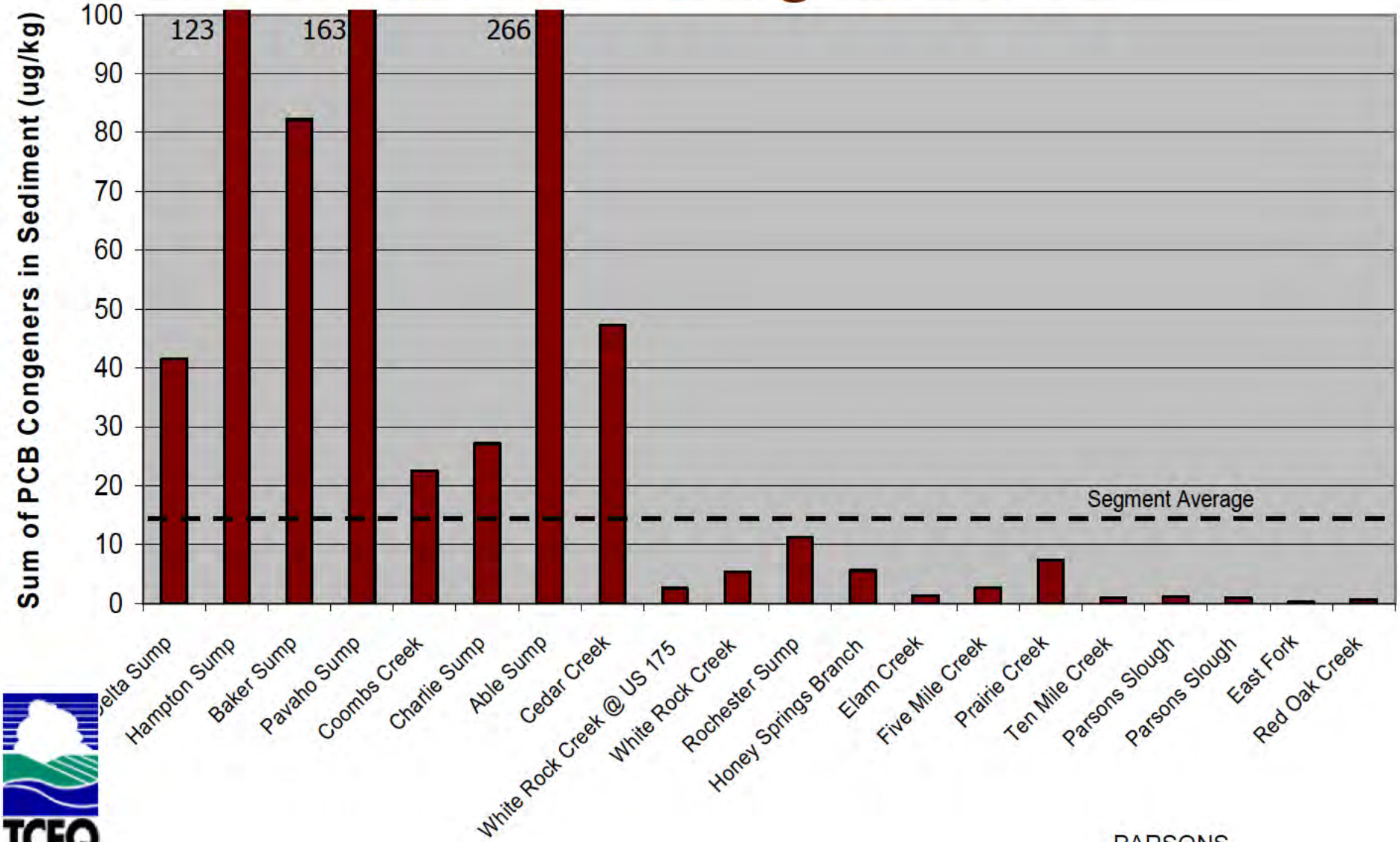
PCB Levels in Bed Sediments of Tributaries to Segment 0805



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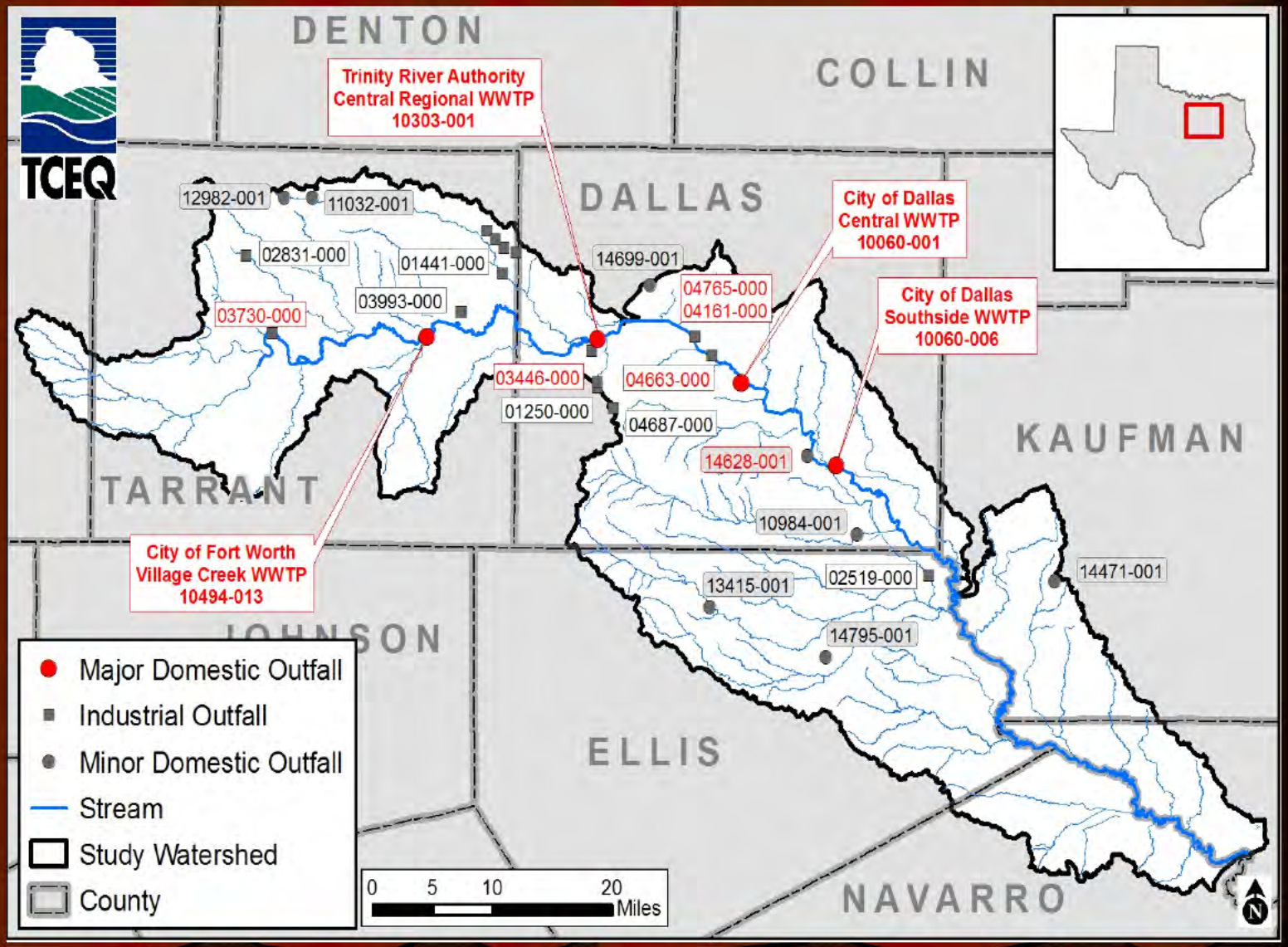
Individually Permitted TPDES Facilities



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Existing Loads from Individually-Permitted TPDES Facilities

- See handout
- PCB loads calculated as average self-reported flow (2004 – 2008) multiplied by average measured total PCB concentration in effluent
- For facilities where we did not measure PCB concentrations, used average concentrations from four facilities with sampled discharge
- For facilities without self-reported flow, assumed half of the permitted flow

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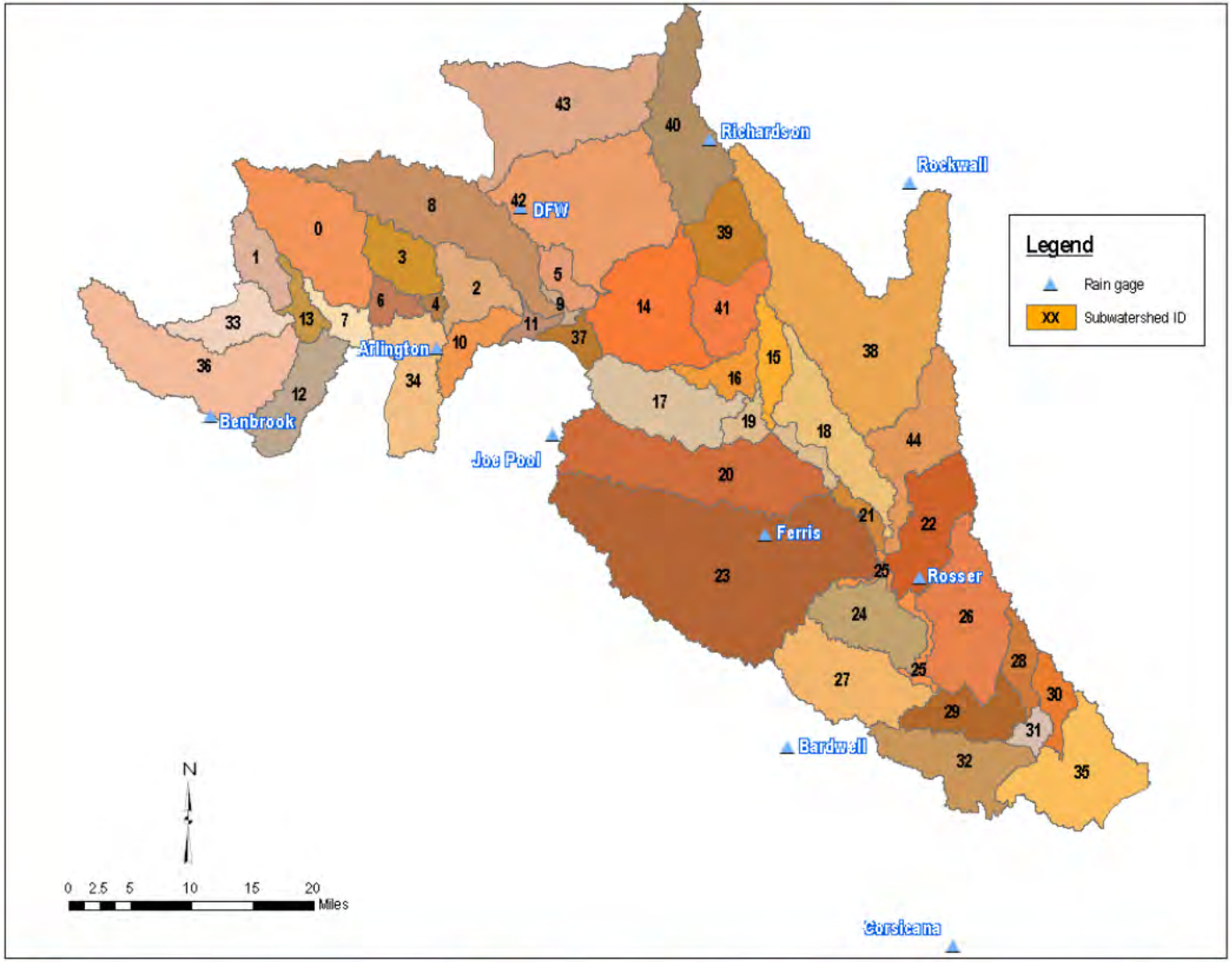
Watershed Runoff

- Monthly average flows and suspended solids loads predicted based on Generalized Watershed Loading Function
- Computes runoff volume based on the NRCS Curve Number equation
- Computes sediment yield based on the Universal Soil Loss Equation and sediment delivery ratios
- Flow output calibrated at five gaged tributaries based on evapotranspiration cover coefficient
- Sediment yield also calibrated at another five tributaries based on ground cover factors

45 Sub-Watersheds Simulated



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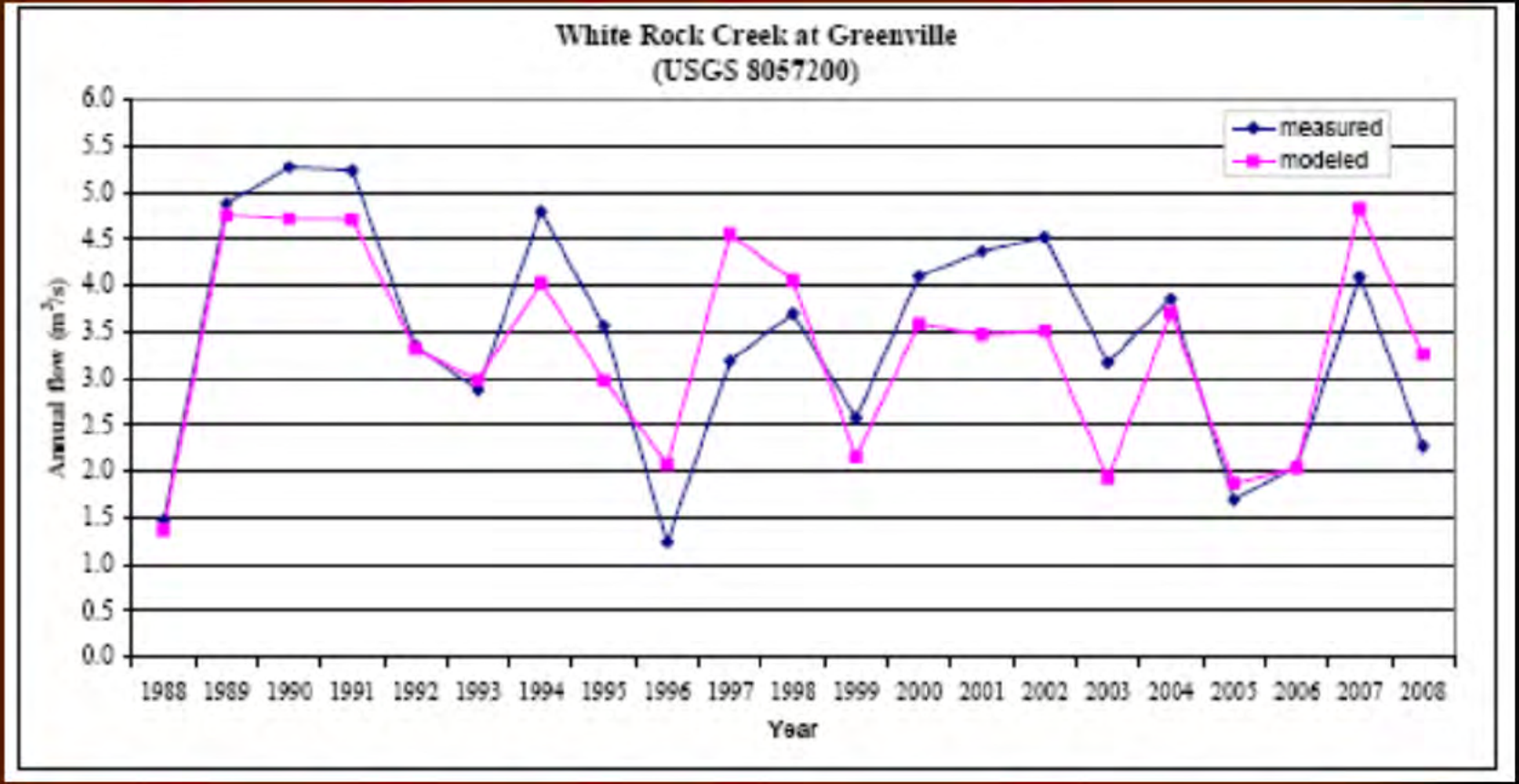
Example GWLF Flow Calibration



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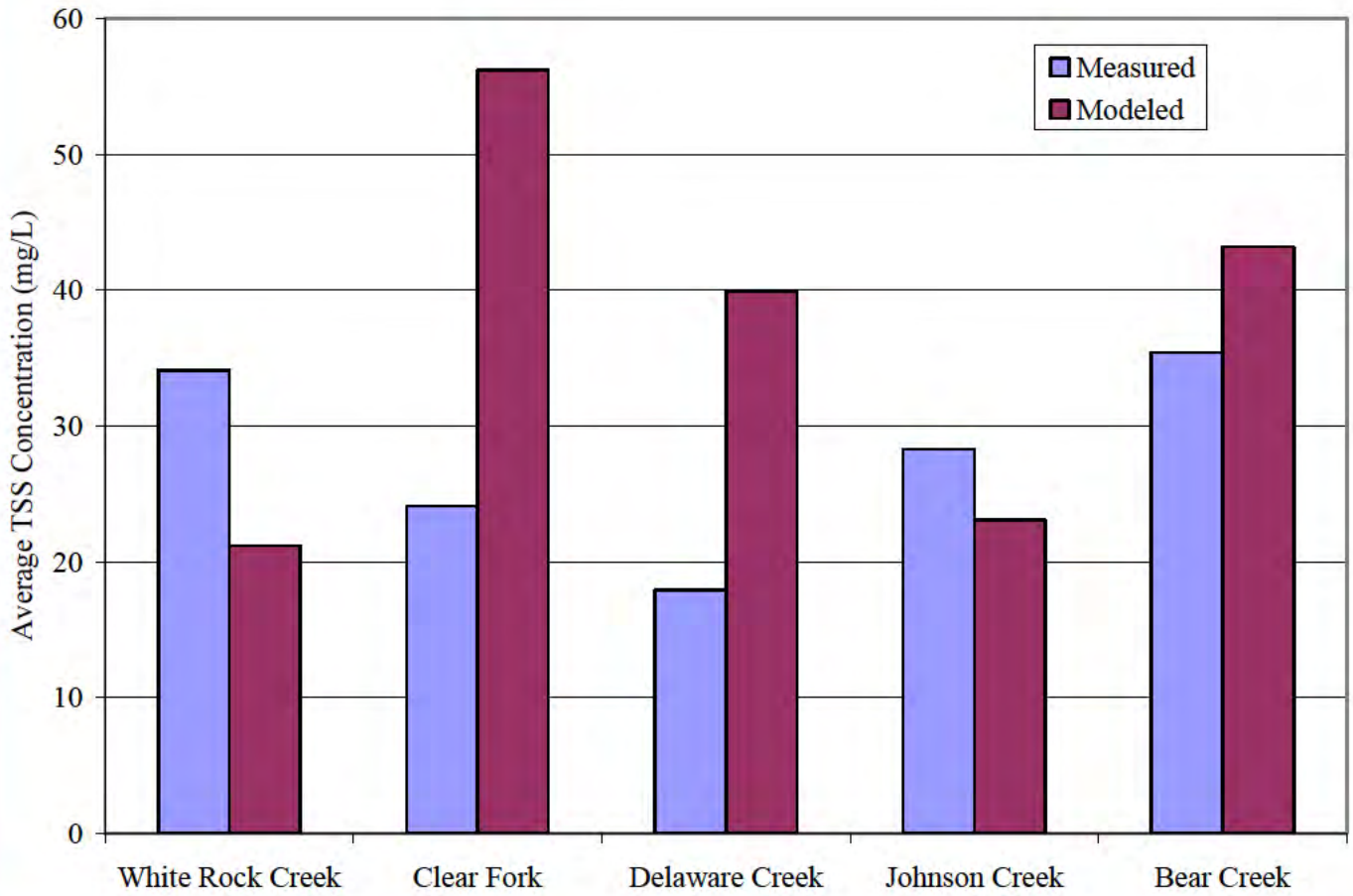
Runoff Solids Calibration



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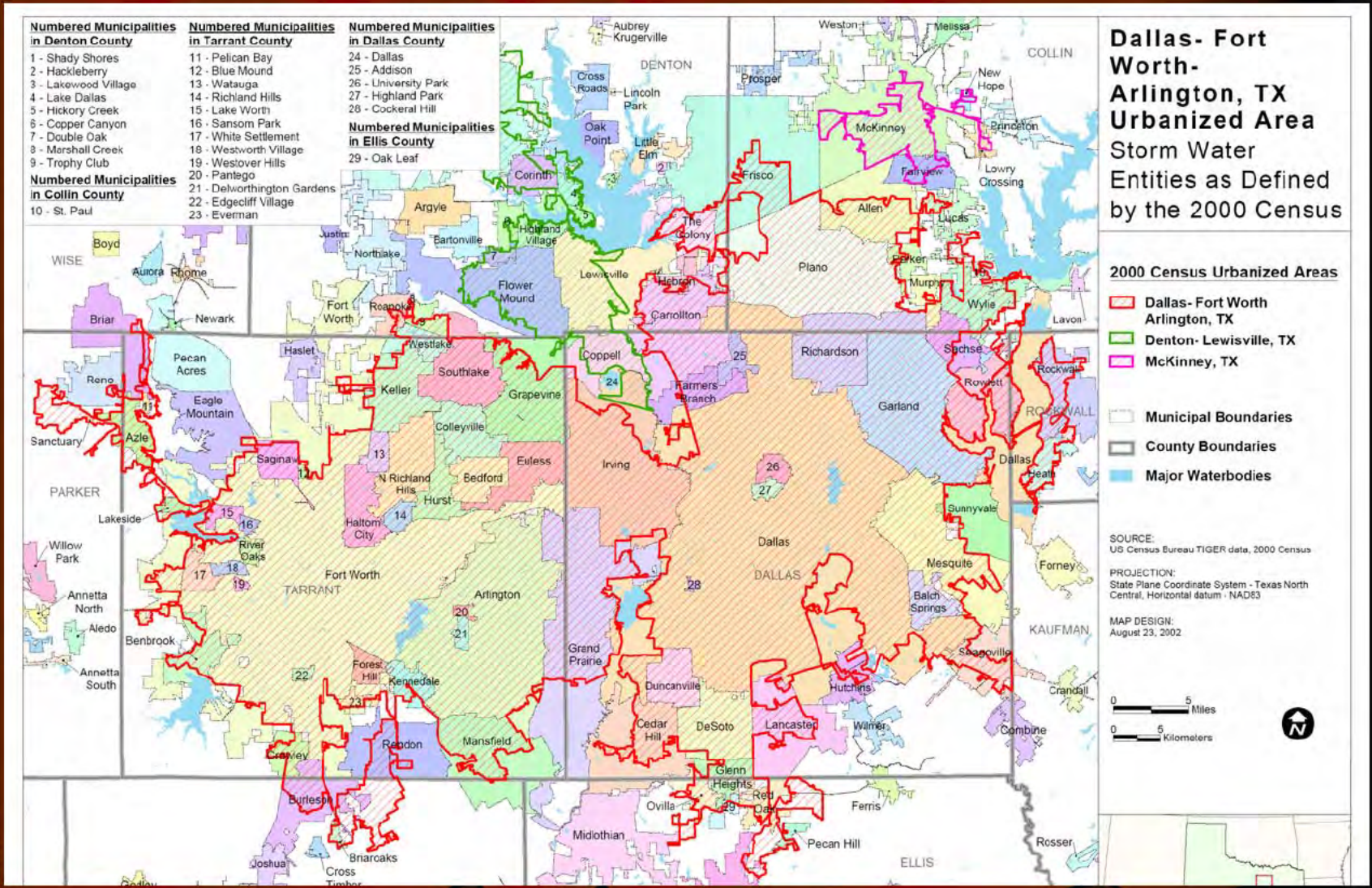
Municipal Separate Storm Sewer Systems (MS4s)



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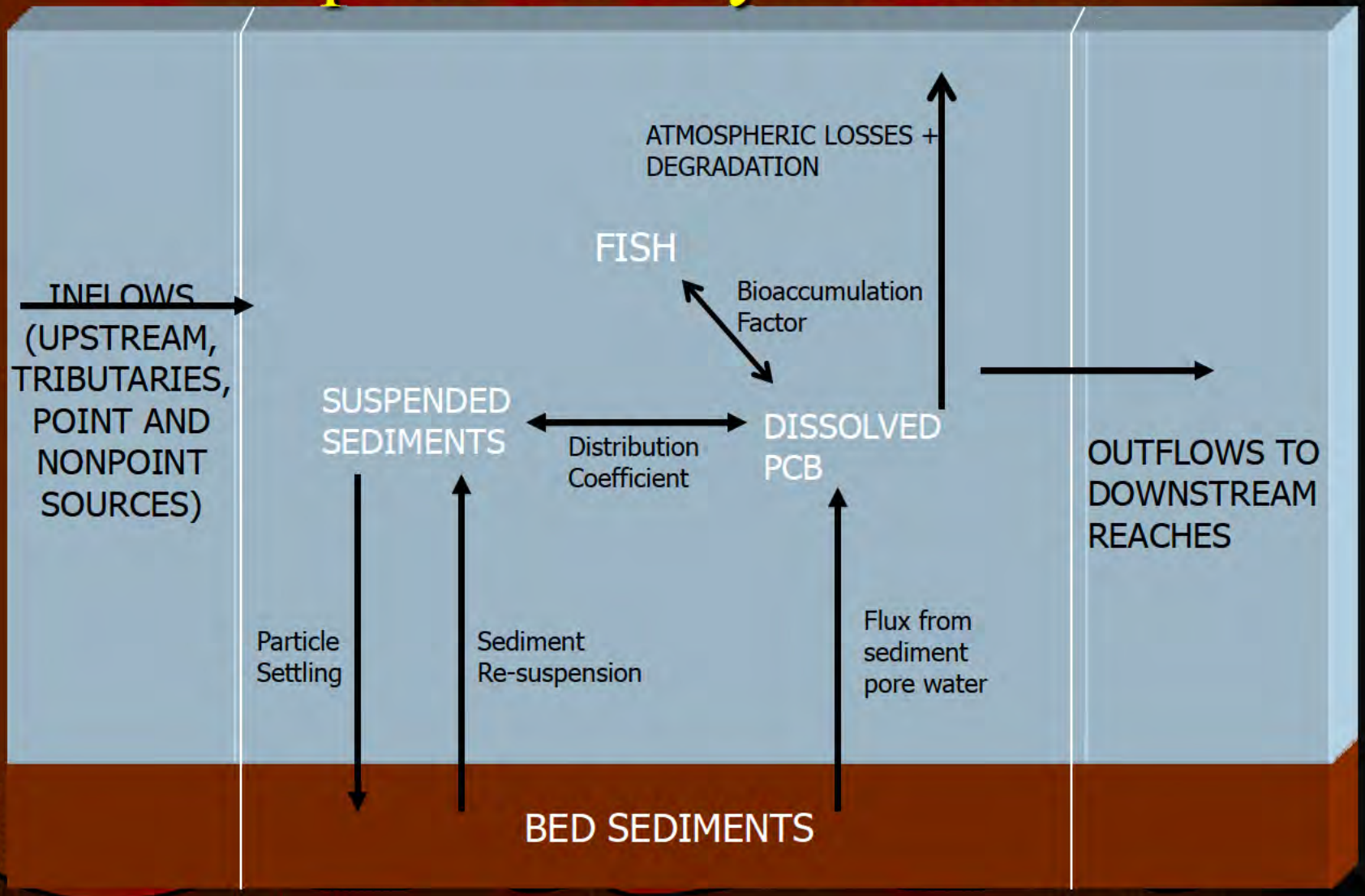
Runoff Loads to TMDL Assessment Units

- Calculated for individual subwatersheds from GWLF output (flows and solids) together with measured PCB levels in tributary sediment
- Divided into point source (MS4) and nonpoint source based on area of watershed in MS4
- See handout

Instream Mass Balance Model Written to Capture the Key Processes



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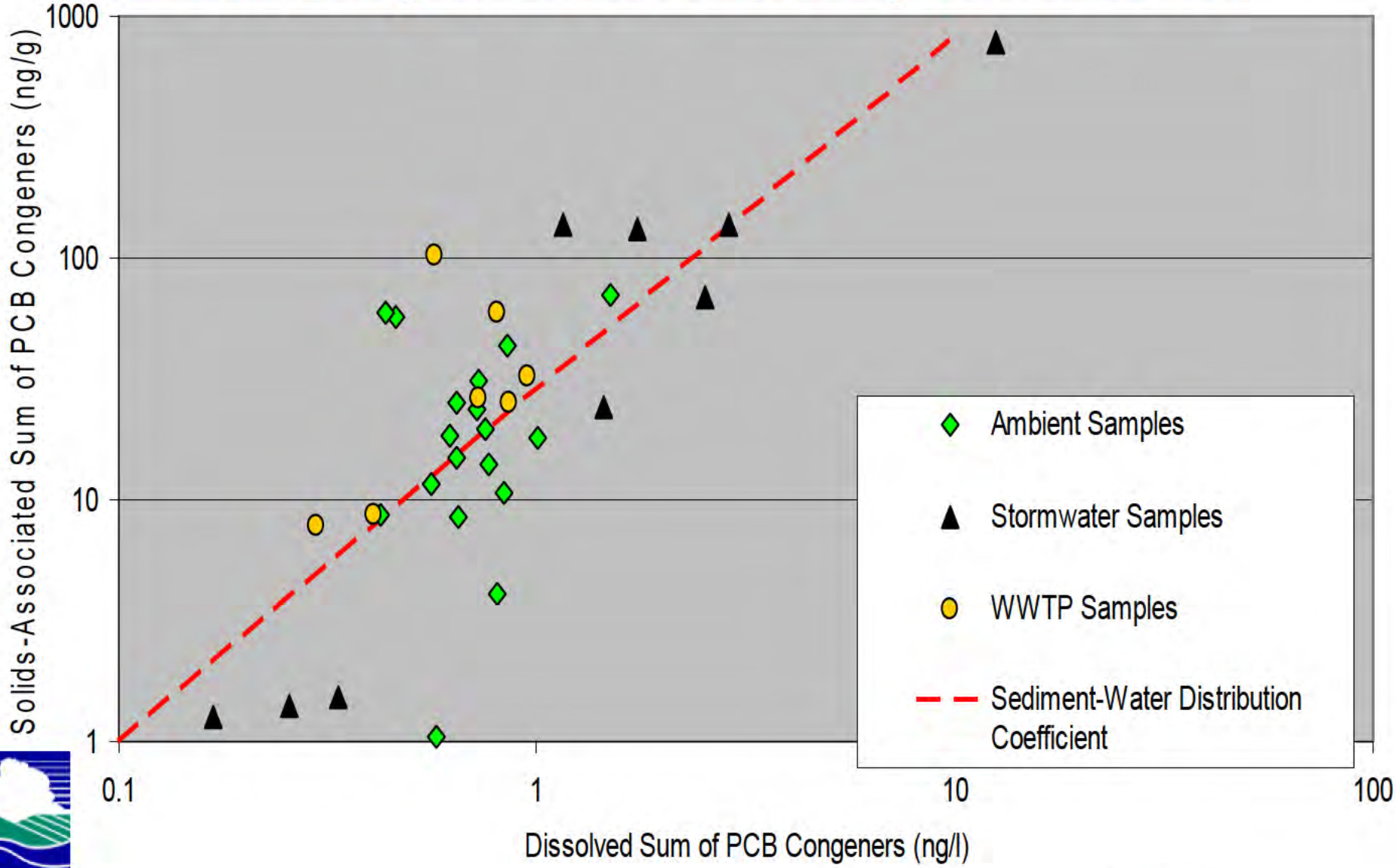
Suspended Sediment : Dissolved Phase Partitioning of PCBs in Trinity River Water



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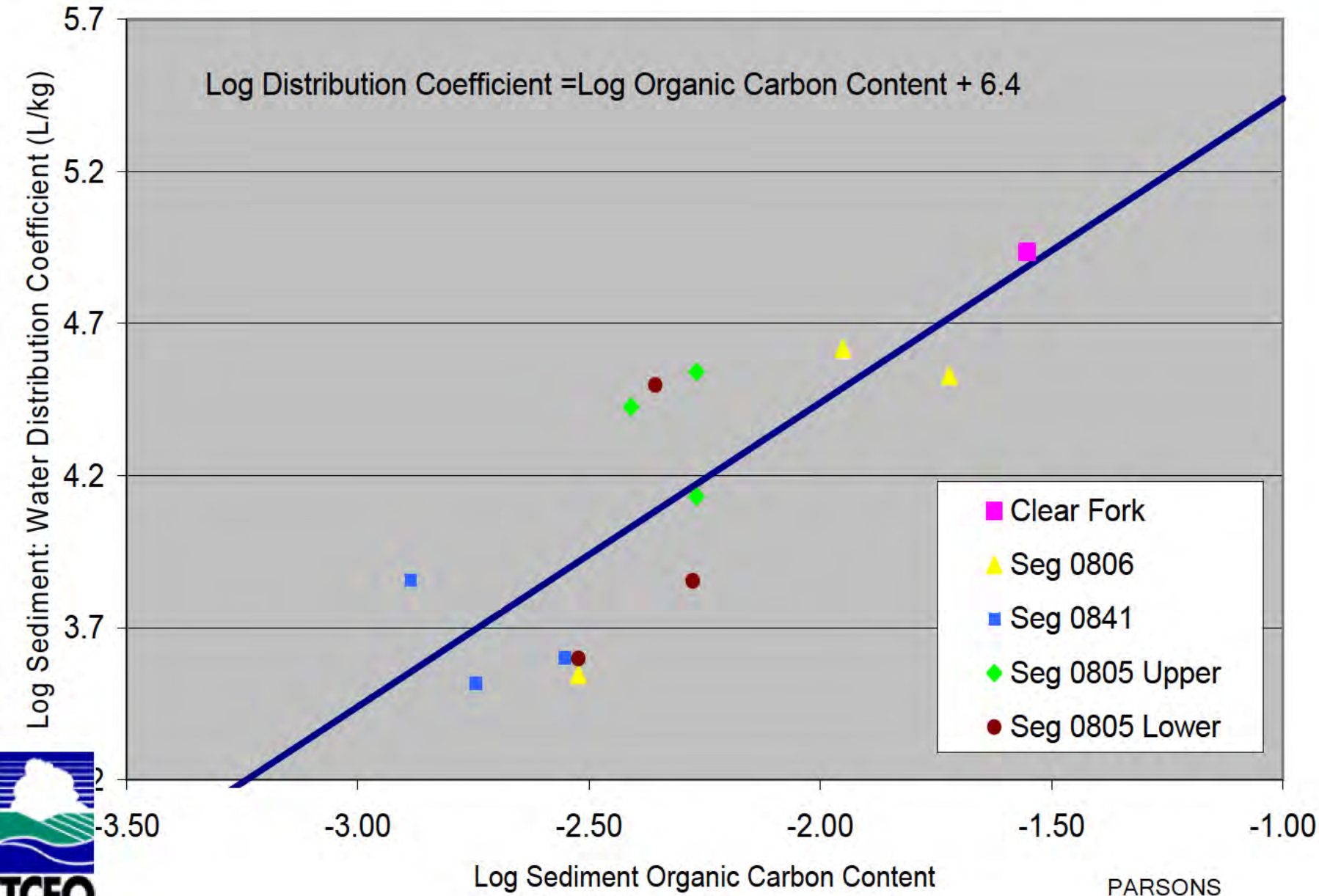
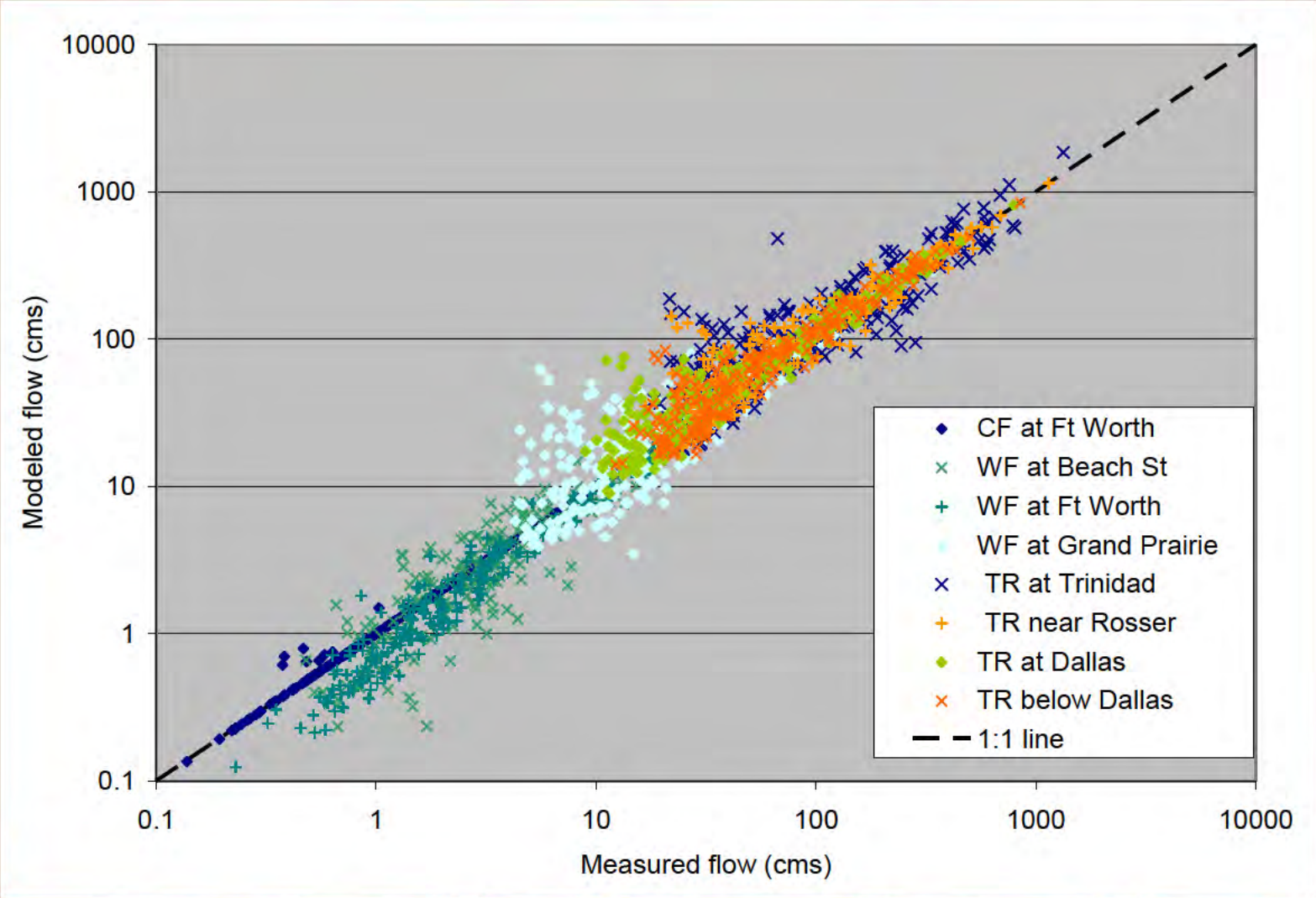
Bed Sediment-Dissolved Phase Partitioning



Flow Simulation 1988 - 2008



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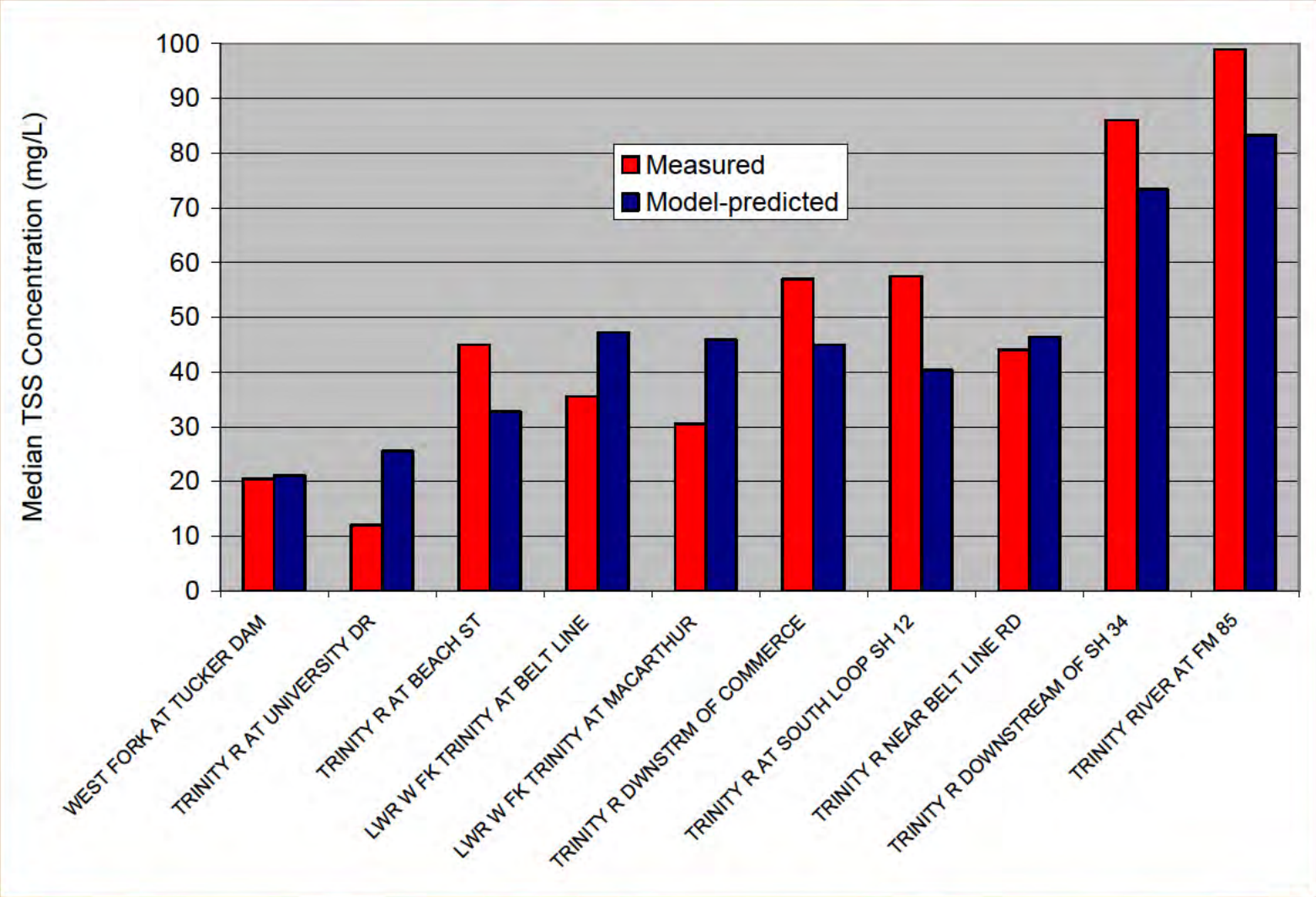
TSS Simulation



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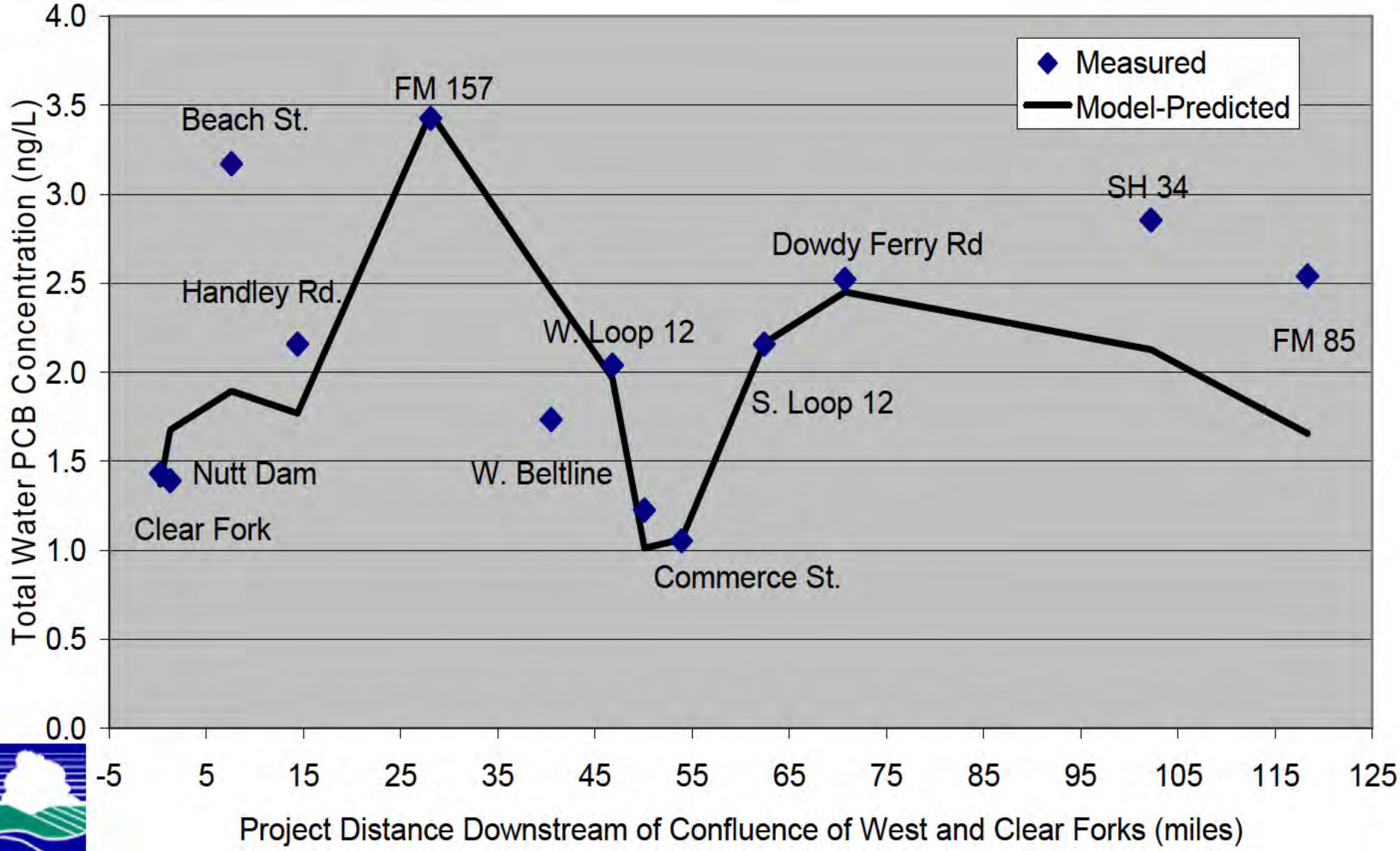
Total PCB Simulation – Spring 2008



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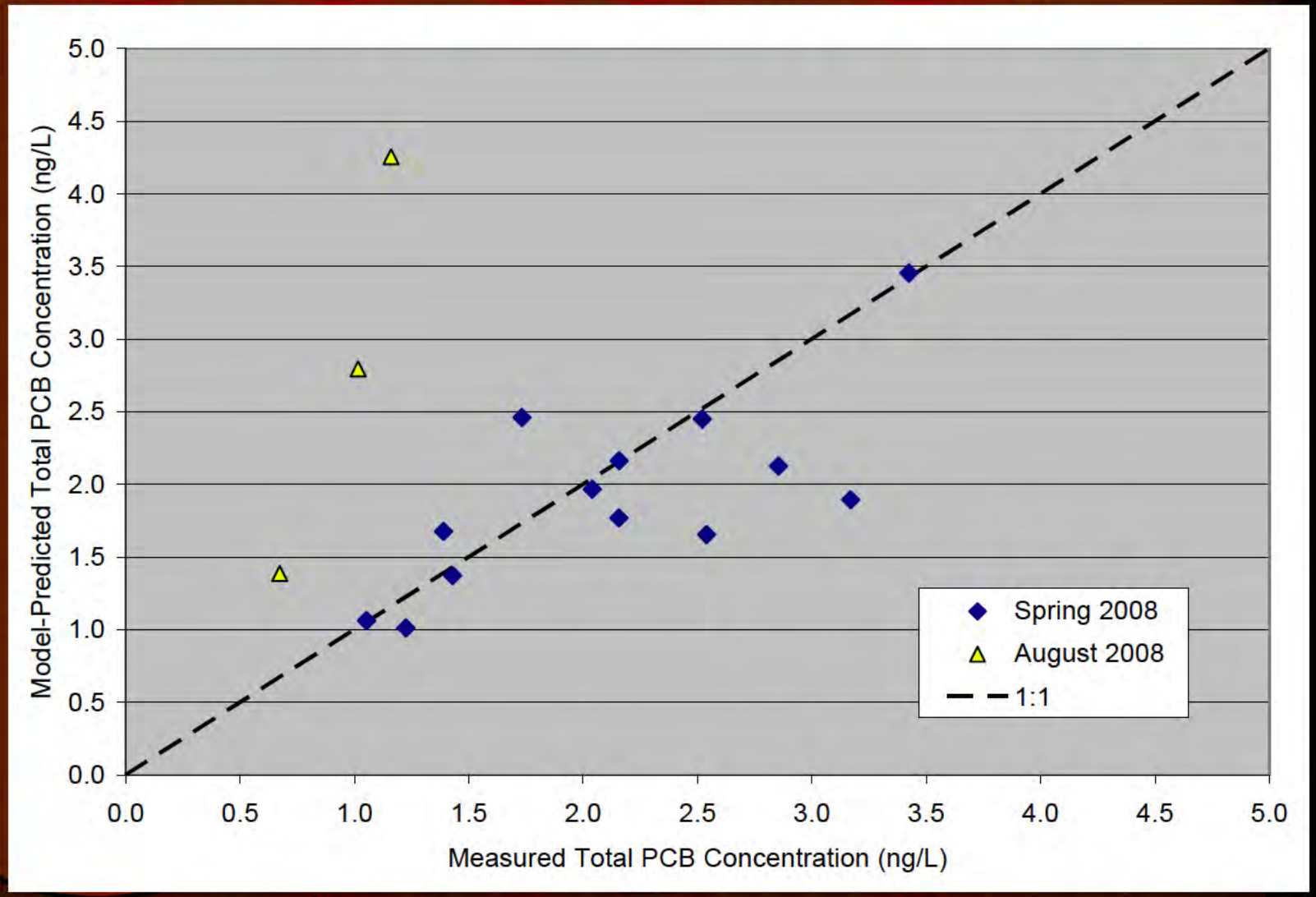
Model does not perform as well under very low flow conditions of August 2008



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Summary of Existing Average Conditions Predicted by Model

Assessment Unit	Predicted Average Total PCBs (ng/L)
0829_03	0.3
0829_02	0.7
0829_01	1.8
0806_02	0.9
0806_01	1.5 – 2.5 (3 sites)
0841_02	4.6
0841_01	2.1 – 3.4 (2 sites)
0805_04	1.6 – 1.8 (2 sites)
0805_03	2.4
0805_06	3.2
0805_02	2.2
0805_01	1.8

TMDL Water Quality Target = 0.64 ng/L Total PCB

Summary of Existing PCB Loads

AU	Average Daily Loads (mg/day)							
	External Loads					Sum of External Loads to AU[b]	Internal Load	Load at Downstream Boundary of AU
				Upstream Sources[a]				
	WW Discharges	Permitted SW Runoff	NPS Runoff	Non-impaired	Impaired		Sediment Exchange[c]	
0829_03	0	10	1	30[d]	0	41	0	41
0829_02	0	61	80	0	41	182	173	355
0829_01	0	40	0	0	355	395	453	848
0806_02	0	180	6	33[e]	0	219	310	529
0806_01	0.008	520	147	0	1203	1,870	-24	1,846
0841_02	371	113	0		1,846	2,340	6,960	9,300
0841_01	332	213	4	607[g]	9,300	10,456	-2,186	8,270
0805_04	0.71	1,673	0	694[h]	8,270	10,638	2,371	13,009
0805_03	602	162	0	130[i]	13,008	13,902	10,064	23,966
0805_06	169	84	32	0	23,966	24,251	1,437	25,688
0805_02	0	20	90	183[j]	25,688	25,981	-2,161	23,820
0805_01	0	0	78	0	23,820	23,898	-5,097	18,801
Total Daily Load (mg/day)	1,475	3,076	438	1,687			12,300	
Total Annual Load (g/year)	538	1,123	160	616			4,490	
Percent of Total Load	**8%**	**16%**	**2%**	**9%**			**65%**	

See handout table with footnotes

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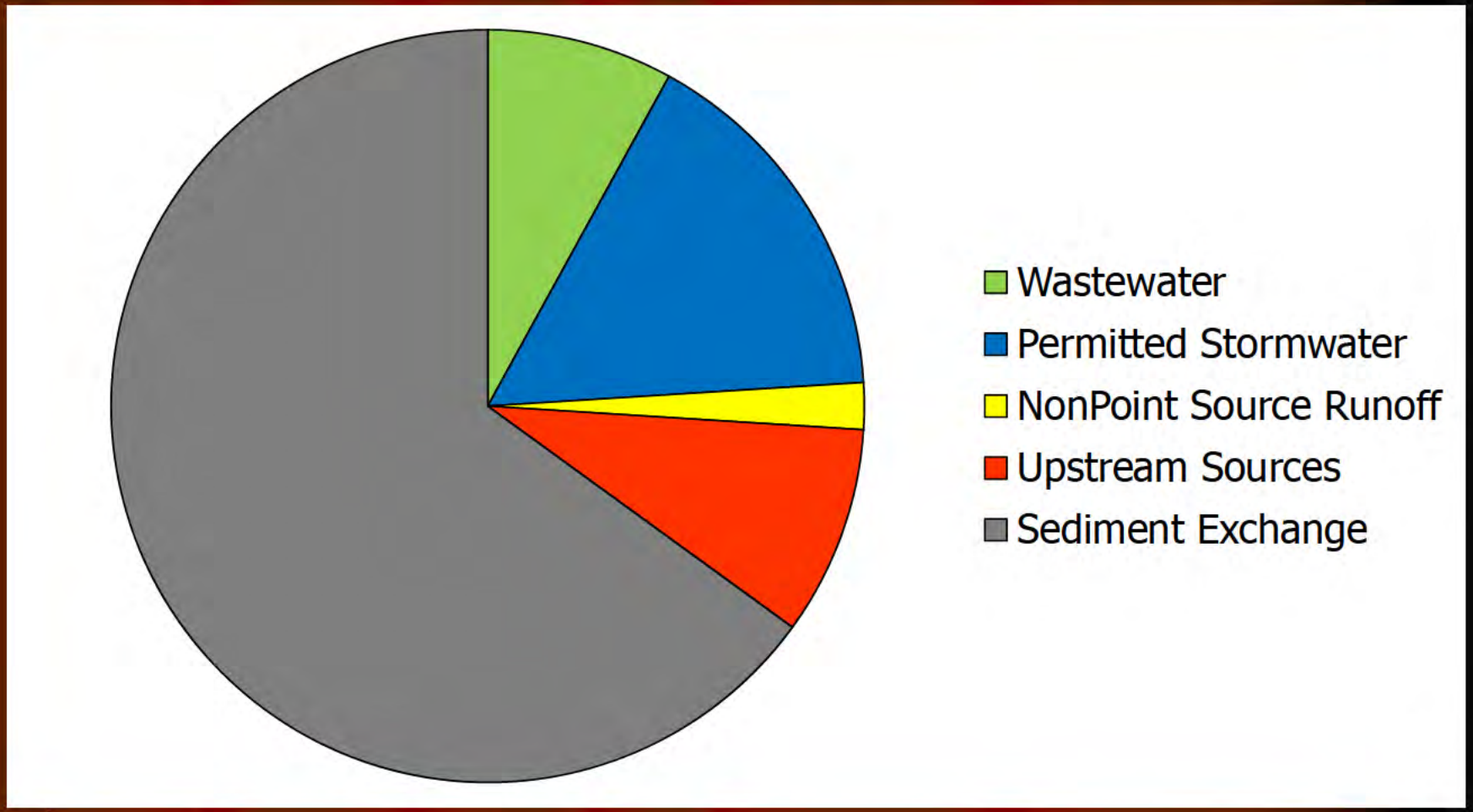
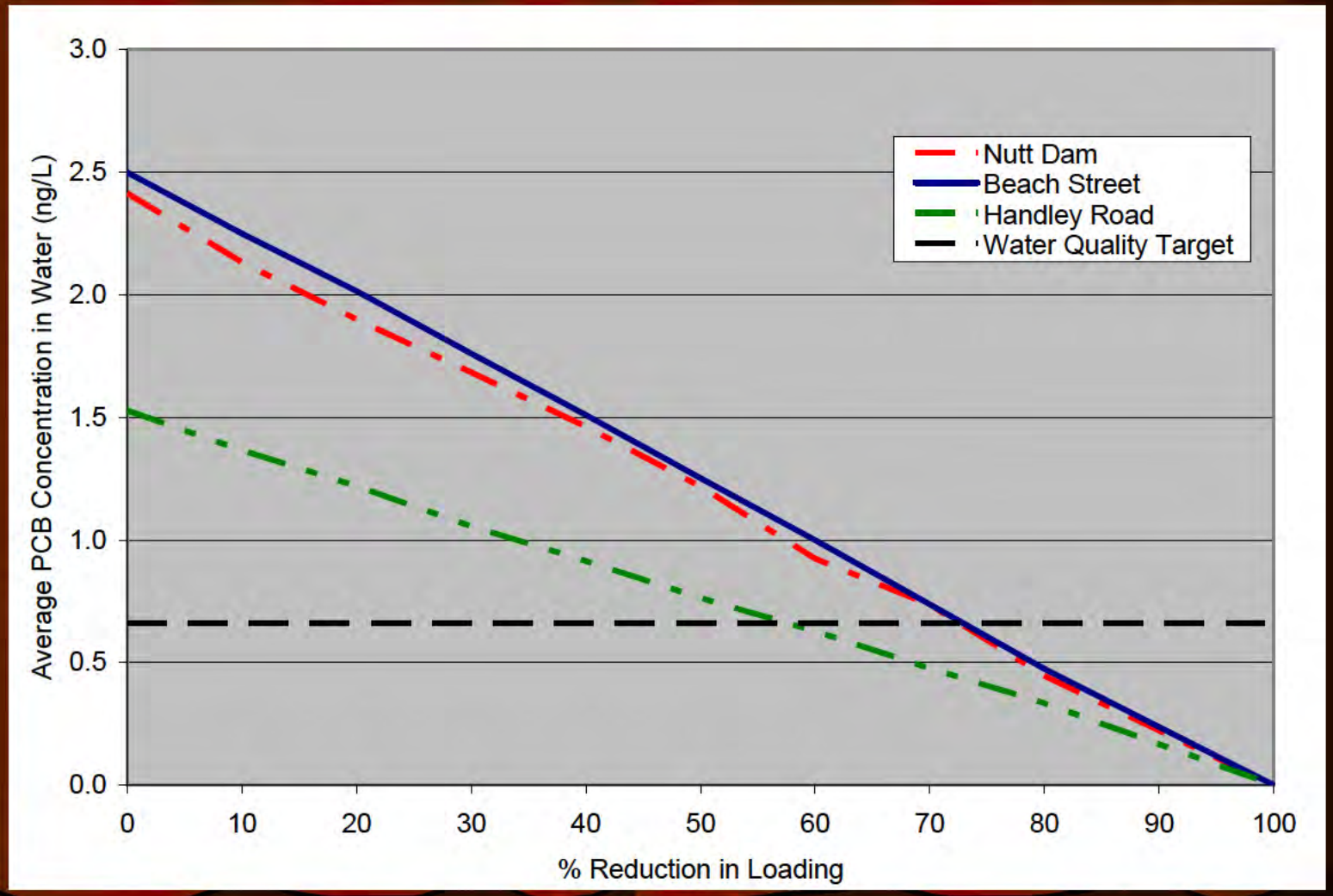
Overall Loading by Source Category



Percent Reductions Required to Meet Water Quality Target in Segment 0806



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TMDLs for Total PCBs

Assessment Unit	Existing Load (mg/day)	Overall Required Reduction	TMDL (mg/day)
0829_03	41	0%	87
0829_02	355	8%	325
0829_01	848	61%	332
0806_02	529	29%	376
0806_01	1,846	74%	486
0841_02	9,300	86%	1,265
0841_01	8,270	81%	1,541
0805_04	13,009	66%	4,467
0805_03	23,966	75%	6,045
0805_06	25,688	81%	4,950
0805_02	23,820	72%	6,640
0805_01	18,801	66%	6,411

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Load Allocation Methodology

- Upstream non-impaired designated segments left at current loads
- Wasteload allocations for individually permitted facilities:
  - Permitted flow rate x the water quality target of 0.64 ng/L
- Other sources and internal loading from sediments:
  - reduced by required percentage

TMDL Load Allocations

AU	TMDL (mg/day)	Waste Load Allocations (mg/day)		Load Allocations (mg/day)			
		WLA_{WW}	WLA_{SW}	LA_{SW}	LA_{US}	LA_{TRANS}	LA_{SED}[a]
0829_03	41	0	10	1	30	0	0
0829_02	325	0	52	69	0	41	163
0829_01	332	0	6	0	0	325	1
0806_02	376	0	116	4	33	0	224
0806_01	486	.0046	76	18	0	708	-316
0841_02	1265	402	16	0	10	486	351
0841_01	1541	460	29	2	607	1265	-821
0805_04	4467	0.44	234	0	694	1541	1998
0805_03	6045	484	23	0	130	4467	941
0805_06	4950	266	12	5	0	6045	-1378
0805_02	6640	0	3	13	183	4950	1491
0805_01	6411	0	0	11	0	6640	-240

See handout for footnotes and explanations

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Implicit Margin of Safety

- Load reductions were calculated based on the most contaminated site in an assessment unit, while fish are mobile and also exposed to less contaminated sites.
- The model over-predicts PCB concentrations at some sites, thereby requiring greater reductions than necessarily required.
- The TDSHS incorporates conservative assumptions in their risk assessments to ensure that public health will be protected.

Next Steps

- TCEQ will review final technical report
- TCEQ will prepare and issue a draft TMDL document for public comment
- TCEQ will request adoption of a final TMDL and submit the adopted TMDL to the USEPA for approval
- Work will begin on an Implementation Plan

Questions?

- For further questions:

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