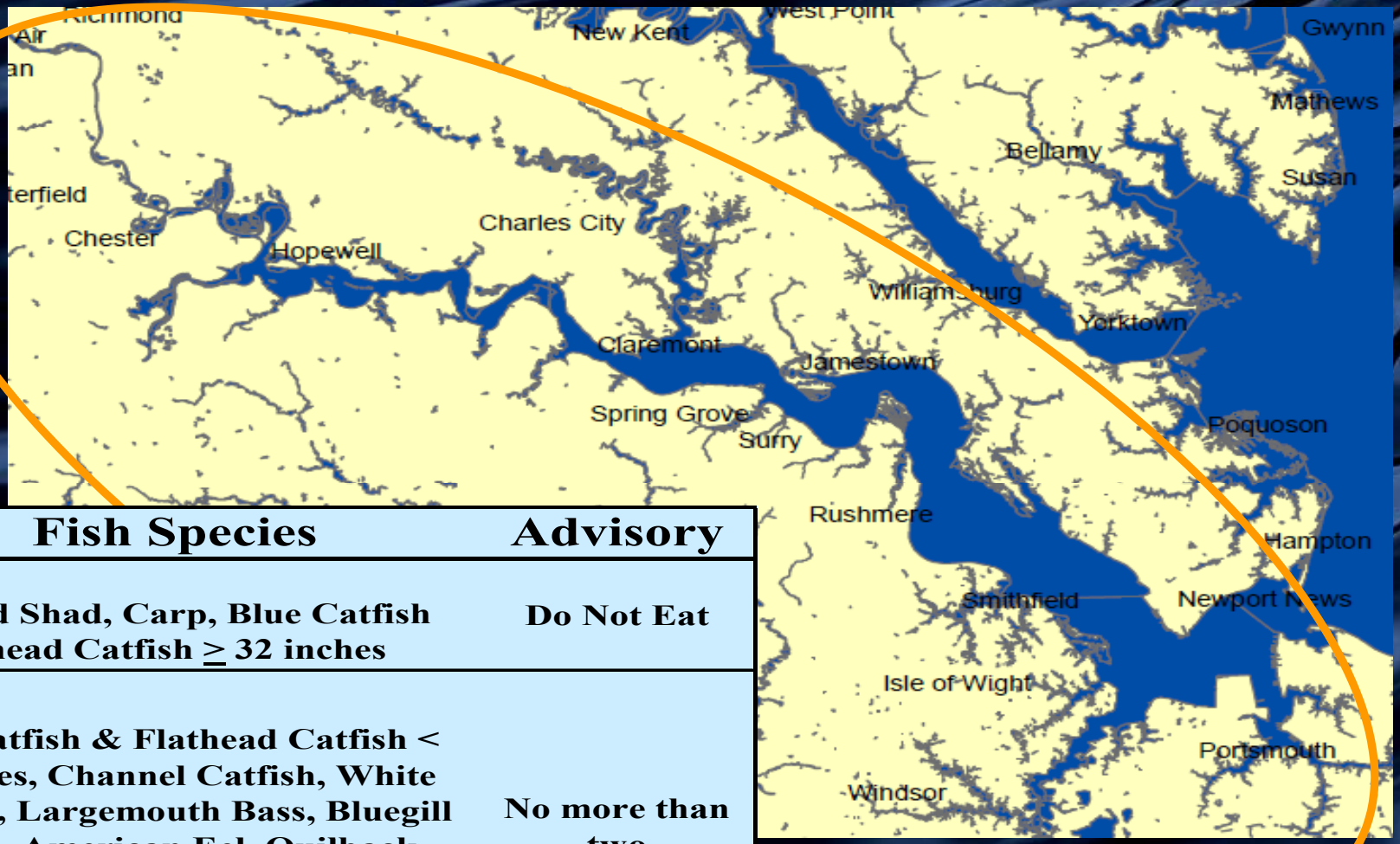
Technical Advisory Committee

Tidal James River PCB TMDL

April 27, 2011

Mark Richards (DEQ)

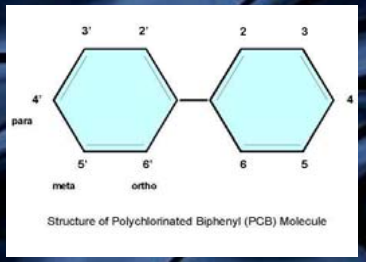
Tidal James River PCB Impairment



Fish Species	Advisory
Gizzard Shad, Carp, Blue Catfish & Flathead Catfish ≥ 32 inches	Do Not Eat
Blue Catfish & Flathead Catfish < 32 inches, Channel Catfish, White Catfish, Largemouth Bass, Bluegill Sunfish, American Eel, Quilback Carpsucker, Smallmouth Bass, Creek Chub, Yellow Bullhead Catfish, White Perch, Striped Bass, Hickory Shad	No more than two meals/month

Why PCBs Are Still an Issue

- On-going releases (TMDL address)
- Human Health concerns
  - Suspected carcinogen
  - Immunotoxicity, reproduction and developmental, hepatotoxicity (liver), neurotoxicity, and chloracne
- Bioaccumulate at low conc. (lipids)
- Major Sources of Exposure (humans)
  - Consumption of contaminated fish
  - Inhalation (dust from contaminated sites)



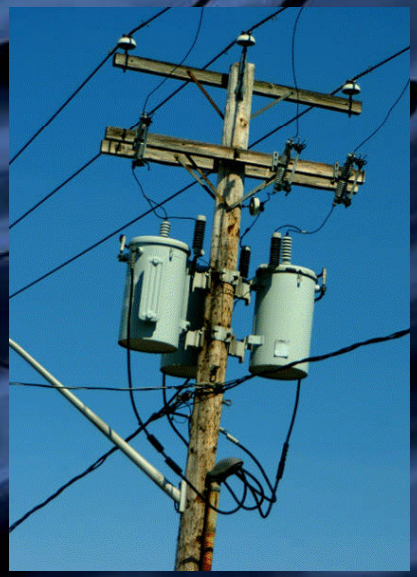
Structure of Polychlorinated Biphenyl (PCB) Molecule

WQC =

0.00064 ug/L

PCB Description and Use

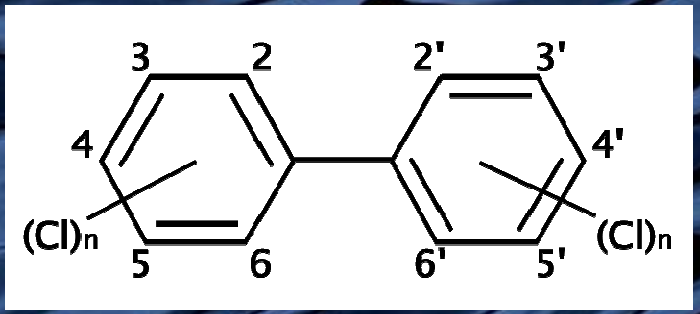
- Polychlorinated Biphenyls (PCBs)
  - Used as a coolant and insulating fluid in electrical transformers and capacitors
  - Other uses: plasticizers, lubricating oil, hydraulic fluid, carbonless copy paper
  - Highly valued properties – chemically inert, non-flammable, heat resistant
  - Lipophilic (fat loving)
  - Banned in US in late 1970's



DEQ

PCB Description and Use

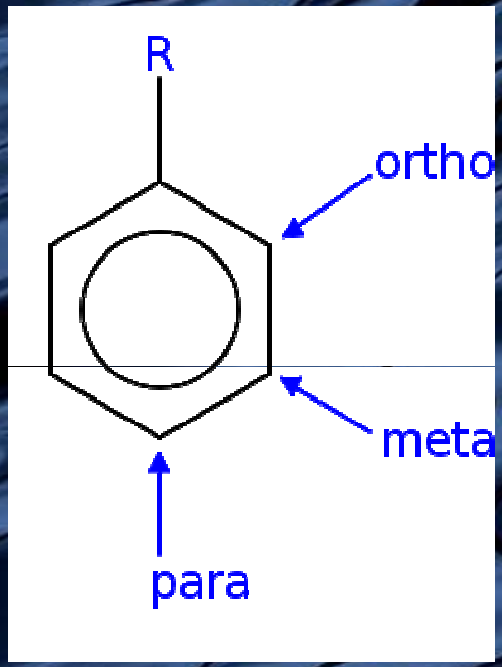
- Biphenyl ring structure with 1 to 10 chlorines
- 209 congeners
- Always present as a mixture
- Mixtures produced under trade name Aroclor (Monsanto)
  - Aroclor 1260
  - 12 – number of carbons
  - 60 – percent chlorine by weight
- Estimated that > 1.5 Billion lbs. manufactured in the U.S.

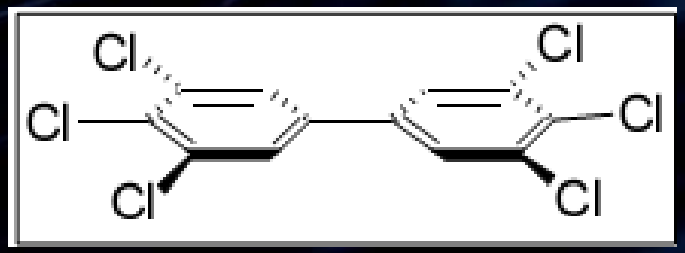


PCB Homolog	Cl's	Number of Congeners
Biphenyl	0	1
Monochlorobiphenyl	1	3
Dichlorobiphenyl	2	12
Trichlorobiphenyl	3	24
Tetrachlorobiphenyl	4	42
Pentachlorobiphenyl	5	46
Hexachlorobiphenyl	6	42
Heptachlorobiphenyl	7	24
Octachlorobiphenyl	8	12
Nonachlorobiphenyl	9	3
Decachlorobiphenyl	10	1

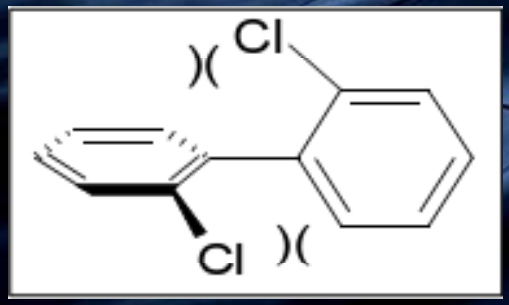
PCB Description and Use

- Shape of the molecule depends on the location of the chlorine atom
- PCBs without Cl in the ortho position are “coplanar PCBs”
- Coplanar PCBs
  - Resemble dioxin
  - Often more toxic than non-coplanar PCBs





Coplanar PCB



Non-coplanar PCB

PCB Description and Use

- World Health Organization (WHO)
  - Identified the 12 most toxic or "dioxin-like" PCB Congeners
    - PCB 126 & 169 ~ 100X less toxic than dioxin (TEF 0.01)
- Regulated by VADEQ as Total PCB (tPCB) = Sum 209 Congeners
  - Adhere to EPA guidelines

PCB	Most Toxic
77	
81	
105	
114	
118	
123	
126	X
156	
157	
167	
169	X
189	

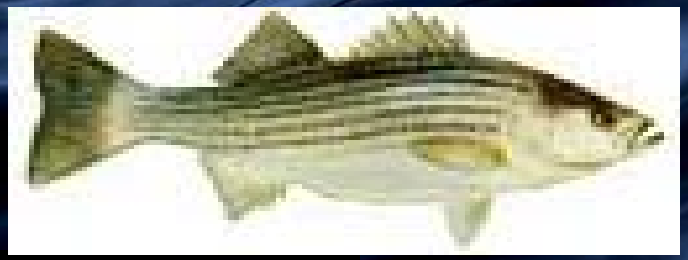
PCBs – A Legacy or On-going Issue?

- PCBs used many years after banned (1990's)
- Dielectric oils considered non PCB < 50 ppm
  - Fish advisories at 0.05 ppm
- Inadvertent production
  - Carbon + heat + chlorine
  - Up to 50 ppm allowed (TSCA)
- Contaminated sites with active transport (non-point - e.g., CERCLA, RCRA, VRP, unknown)
- Atmosphere (off-gas from contaminated sites)
- Point Sources

PCB Exposure Pathways (fish)

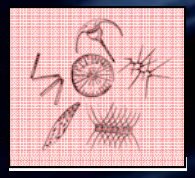
- Intake through gills from water column
  - Basis of existing WQC (1980 EPA guidelines)
- Ingestion of contaminated sediment
  - Indirect uptake from foraging

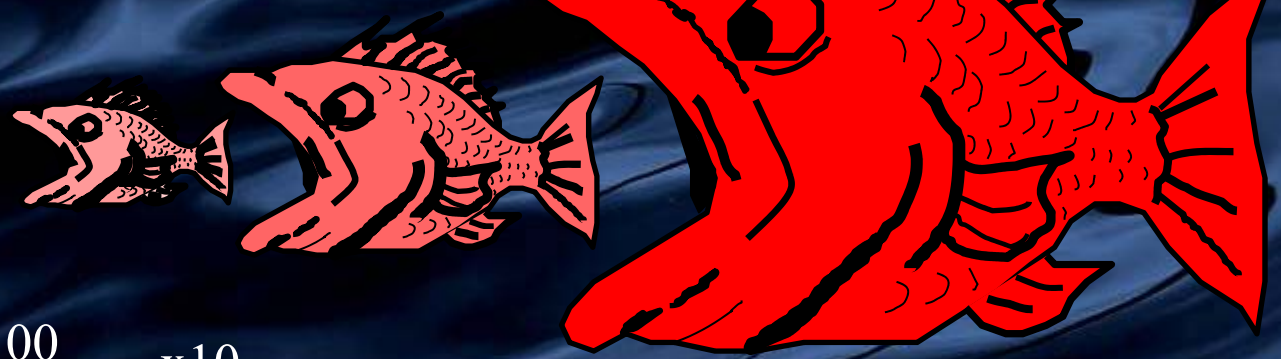
- Exposure through skin from contaminated sediment (e.g. catfish)
- Ingestion of prey
  - Biomagnification



Biomagnification

PCBs
H_2O





x1000

x100

x10

x2

Concentration (parts per trillion)

0.001 1 1,000 10,000 20,000

DEQ

VA Regulatory Criteria

Consumption Advisories Fish Tissue (ppb)		Water Quality Criterion (WQC) Total PCBs (ppb)
VDH 50		
DEQ (screening) 20	⟷	0.00064

Criterion represents target concentration in the water column that minimizes the bioaccumulation of tPCBs in fish to protect human consumption

PCB Analysis

Investigative PCB Studies

- Historic Focus
  - Fish tissue and sediment sample collection/analysis
  - PCBs detected in water column during 1970's (ug/L)
    - From 1980's on difficult to detect in water matrix (conc. declined)
- Recent Focus
  - PCB data from water matrix (TMDL need)
  - Semi-permeable membrane devices (SPMD lipid bags)
    - Mimic fish (concentrates lipophilic toxins)
  - Improved PCB analytical methods
    - EPA Method 1668 – Detects PCBs in water (ultra-low concentration)
      - Important PCB TMDL development tool

PCB Analytical Methodology

- EPA Method 1668 (Version A 1999)
  - Current Version 1668C
- High Resolution Gas Chromatography / High Resolution Mass Spectrophotometer (HRGS/HRMS)
- Targets 209 PCB Congeners
  - Summed = tPCB (WQC)
- MDLs < 3 pg/L & QLs 5-20 pg/L on a congener basis
- 2 – 4 L water samples

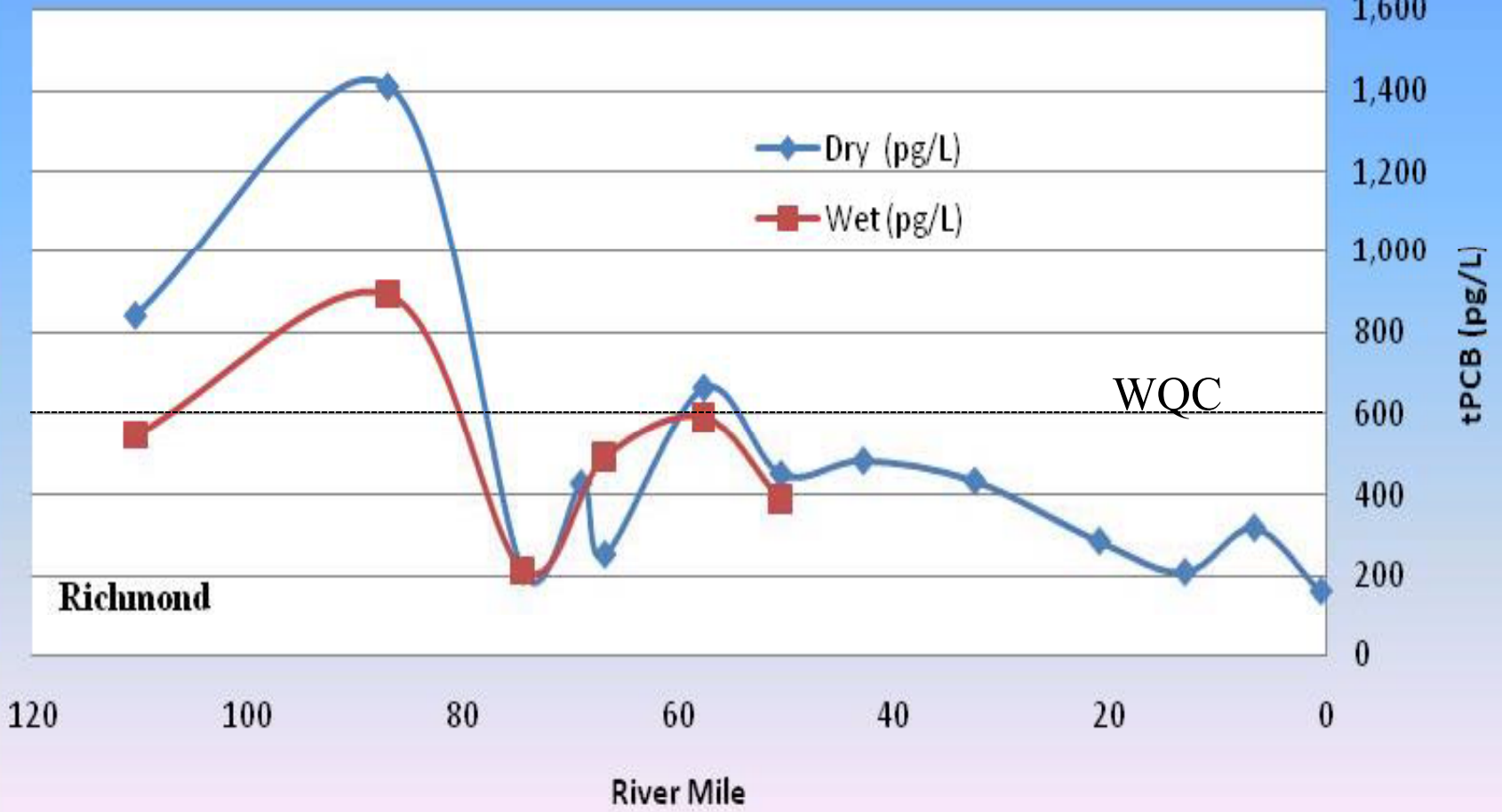
PCB congener detection = 0.000003 µg/L

DEQ

TMDL Source Identification Studies

- Ambient water PCB results necessary to develop TMDLs
  - Source identification
  - Assist in the development of site specific PCB endpoints if necessary
  - Fate & Transport model calibration/validation

tPCB Concentrations in Ambient River Water Collected from the Tidal James River Mainstem



TMDL Source Identification Studies

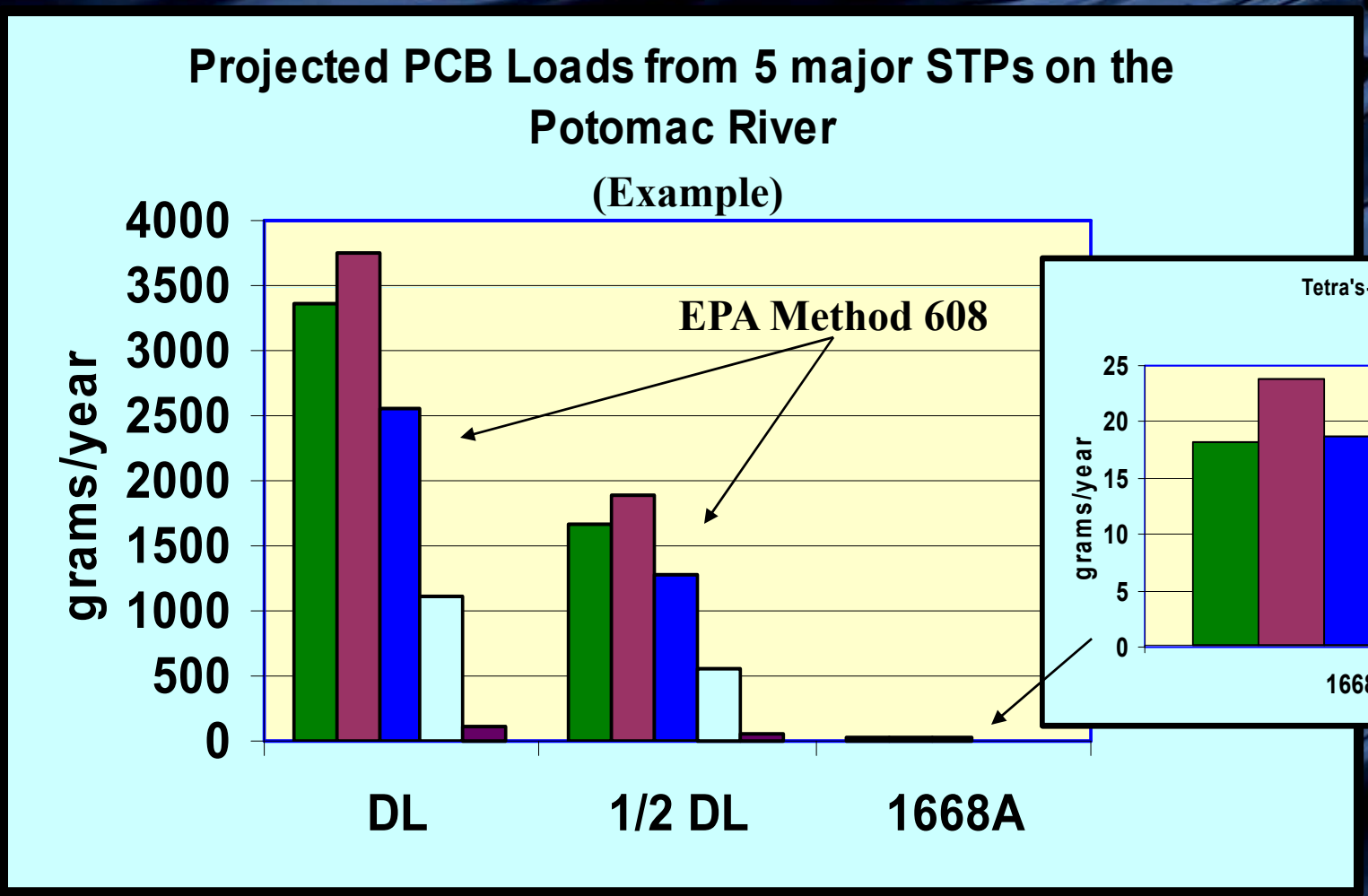
- Point Source PCB results necessary for TMDL development
  - Municipal, Industrial, MS4
    - Baseline load development
- EPA Method 608 (Permit method)
  - PCBs rarely detected (MDL = 0.065 µg/L; QL = 0.5 µg/L)
  - Reported as Aroclors
    - Assumes original congener formulation retained

tPCB WQC = 0.00064 µg/L

Point Sources

- TMDL Baseline Development
  - No data ≠ no load
  - Use assumptions (Method DL, QL, or ½ of DL, QL as default)
  - Generate low level PCB data
    - Relevant to fish impairments

Assumptions vs. Real Data



Point Sources

- DEQ requested voluntary monitoring of point source outfalls
  - Informational meetings held:
    - Upper Tidal James - September 2009
    - Elizabeth River – November 2009
    - Middle & Lower Tidal James – October 2010
  - PCB Data requested by Sept. – Oct. 2011
  - Facilities selected in accordance with DEQ's PCB Guidance Document

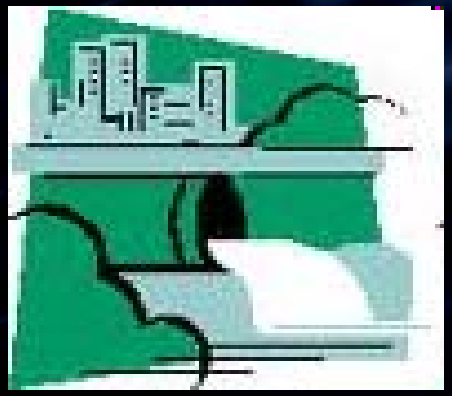
http://www.deq.virginia.gov/tmdl/pcb.html

PCB Interlaboratory Study

- Virginia Association of Municipal Wastewater Agencies (VAMWA) and Virginia Manufacturing Association (VMA)
  - Evaluated Method 1668
- DEQ has reviewed study and provided comments
- Responses provided by VAMWA & VMA
  - Currently under review by DEQ

EPA PCB Method (1668)

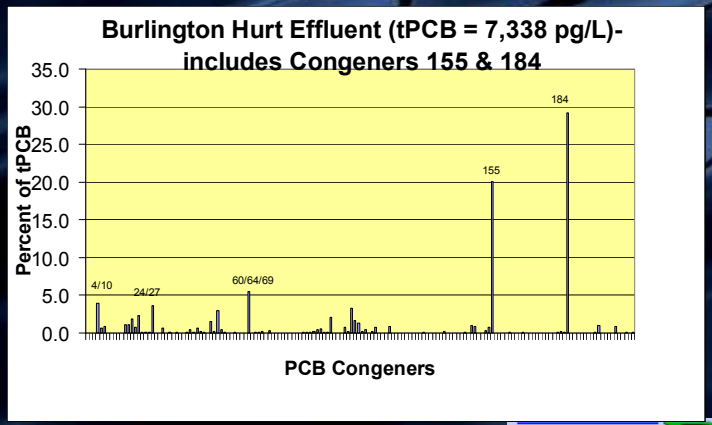
- Analyzes 209 PCB congeners
  - PCB congener profiles deviate from original commercial mixtures (ERASC-003, 2003)
    - Accounts for weathering and biotransformation
  - Can facilitate source identification through "fingerprinting"



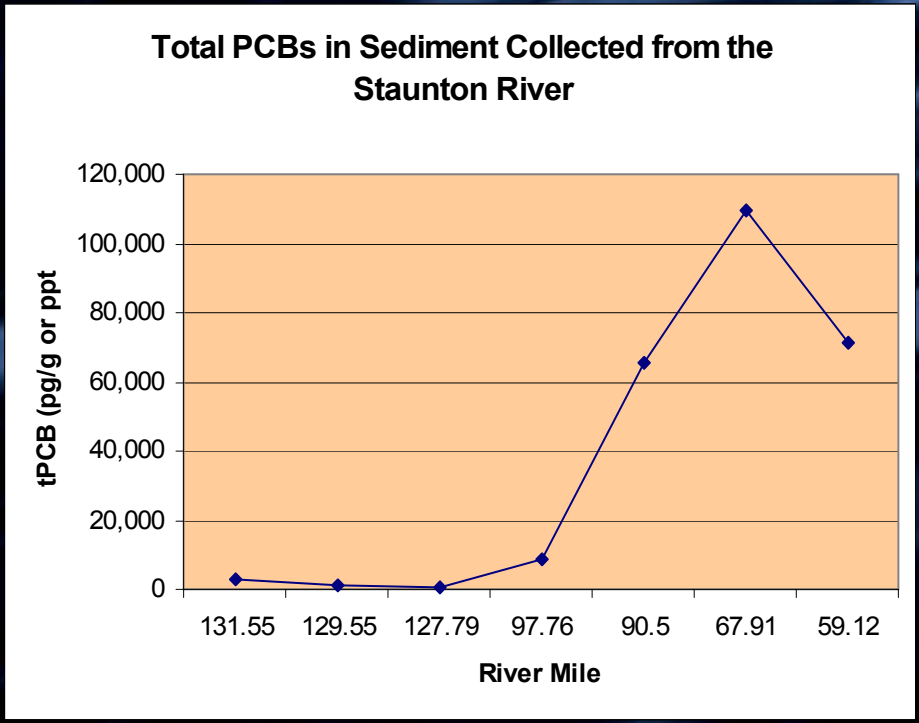
PCB "Fingerprint" Example

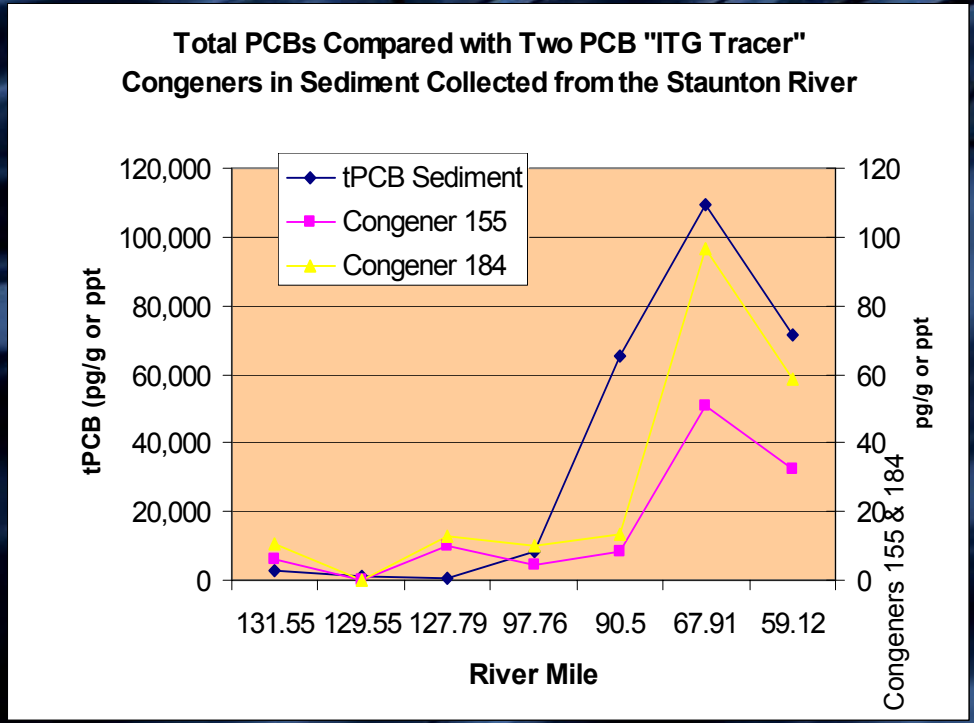
Roanoke/Staunton River

- Mean tPCB conc. = 19.2 ng/L (ppt)
  - Contributes ~9% of PCB load (Staunton R.)
- PCB congener profile
- Congeners 155 & 184 are not part of known Aroclor mixture
  - > 45% of tPCB concentration
- Track down study
  - Lubrication oil (1996)



Staunton River Sediment
PCB 155 & 184 Signature



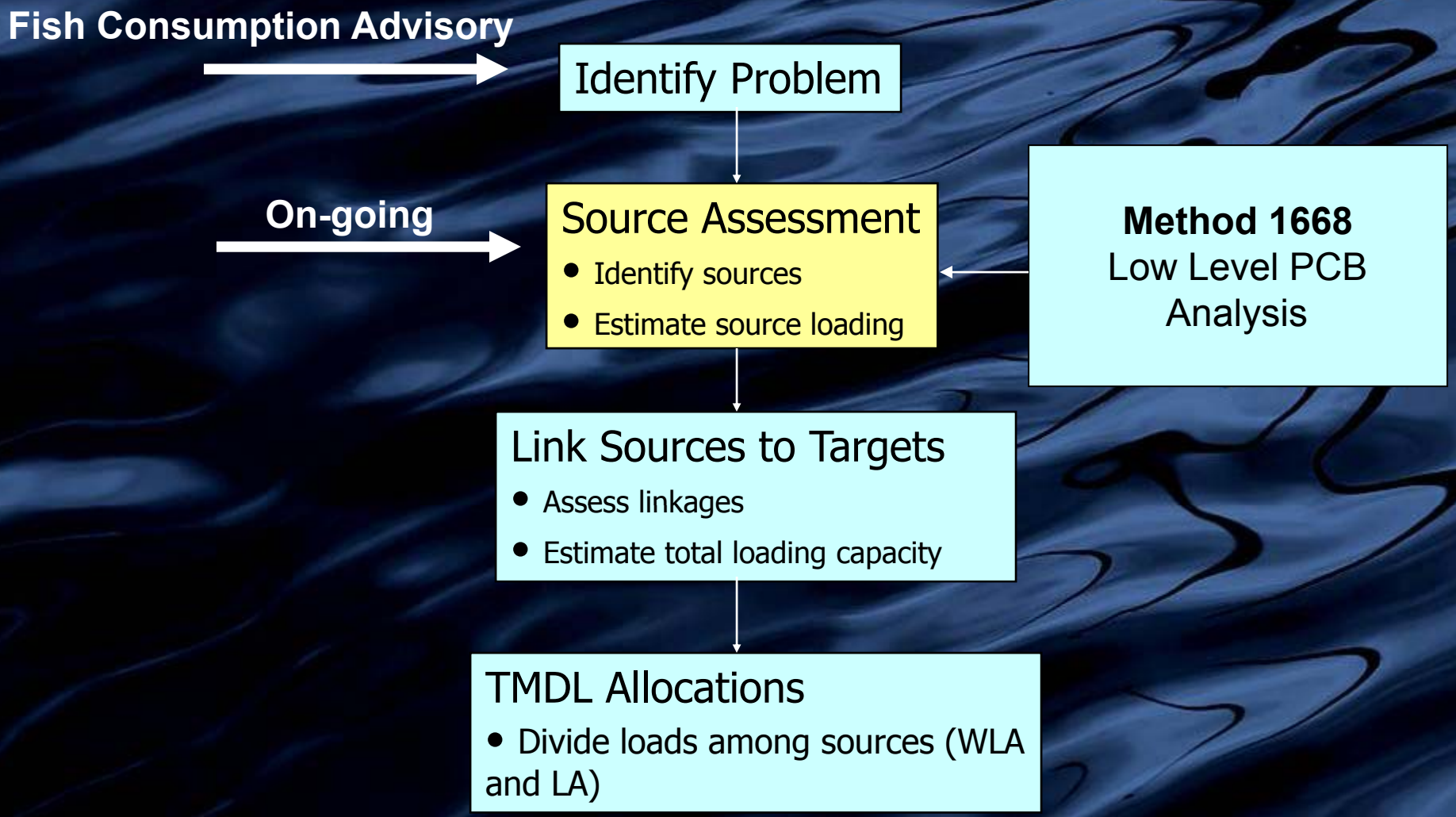


Inadvertent PCB Production
Detected with Method 1668

- PCB 11 (3,3’ – dichlorophenol)
- Produced inadvertently from manufacturing of diarylide yellow dye
  - Used in printing applications
  - Found in consumer goods (i.e., color newspaper, glossy magazine, yellow plastic bags, etc., *Rodenburg et al., 2009)*
- Common lab contaminant
- Detected in environmental air samples

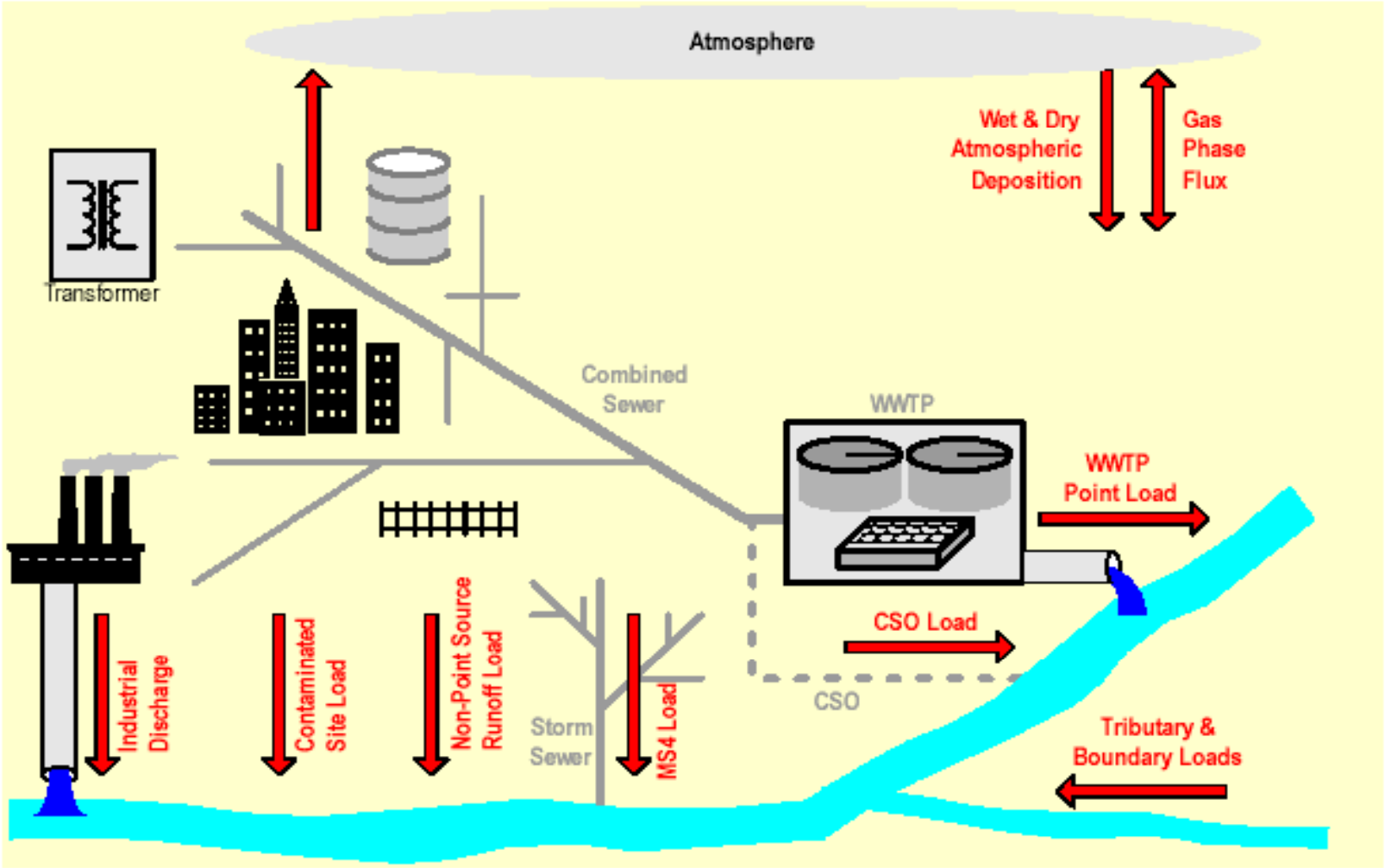
TMDL Development

Components of TMDL Study



WLA + LA + MOS = TMDL

External Sources of PCBs (TMDL)

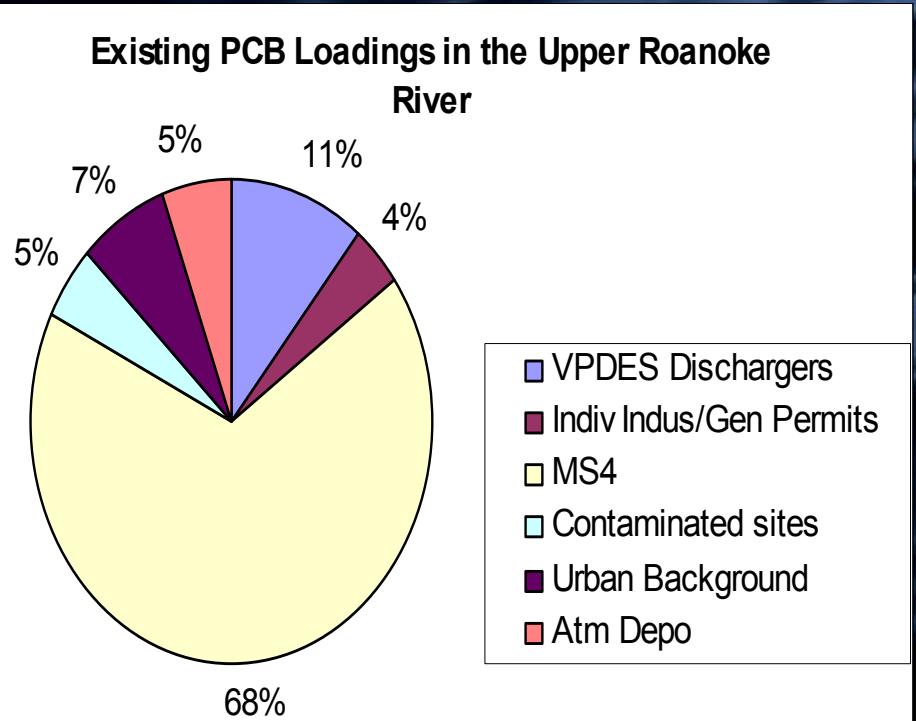


Potomac River PCB TMDL
Completed 2007

Total PCB loads to the tidal Potomac and Anacostia rivers, in g/year

Source category	Baseline (g/year)	TMDL (g/year)	Reduction
Potomac @ Chain Bridge[1]	16,433	329	98%
Lower Basin Tributaries[2]	2,857	407	86%
Direct drainage[3]	10,996	413	96%
WWTP[4]	762	68.2	91%
CSO[5]	3,020	61.2	98%
Atmospheric deposition[6]	3,070	217	93%
Contaminated sites[7]	15.1	10.8	28%
TOTAL[8]	37,156	1,505	96%

Upper Roanoke PCB TMDL
Completed 2009

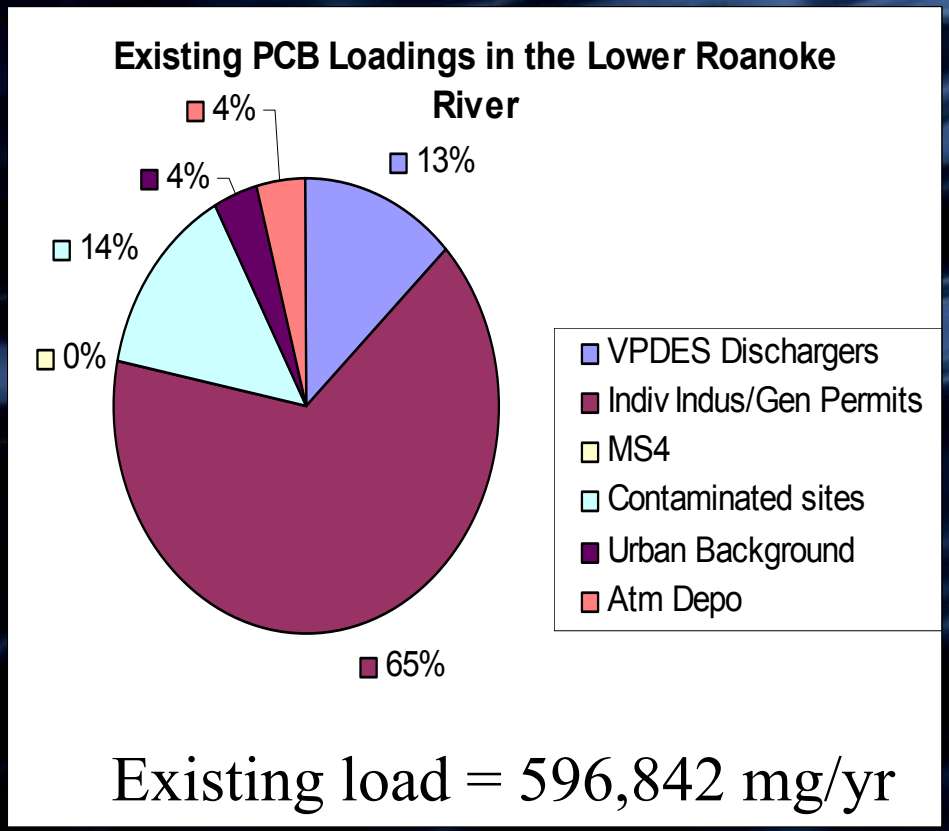


Existing load = 162,914 mg/yr

Source Category	% Reduction
VPDES Dischargers	-60
Indiv Indus/Gen Permits	100
MS4	100
Contaminated sites	100
Urban Background	99.4
Atm Depo	5
total	77

TMDL = 39,094 mg/yr

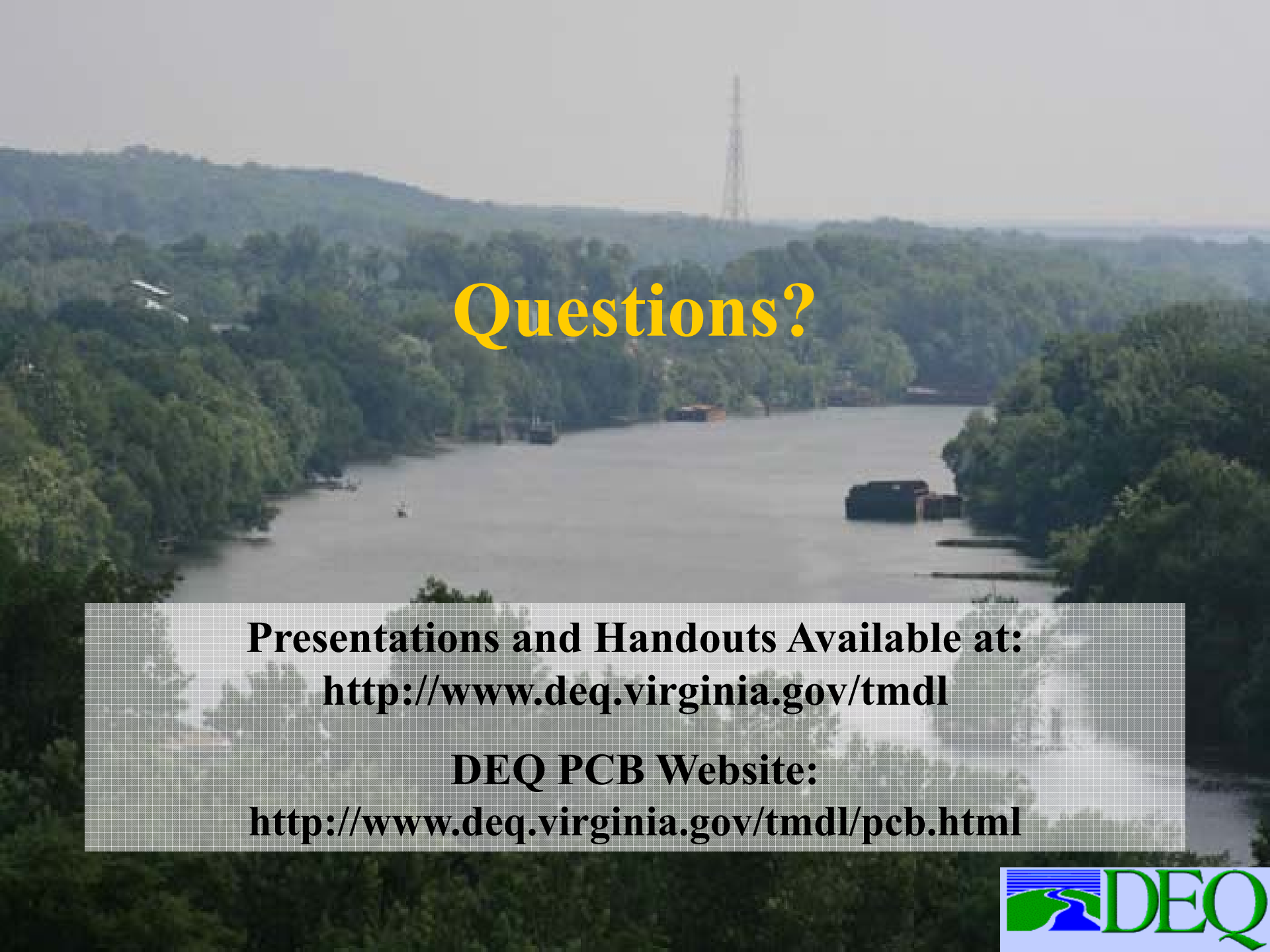
Lower Roanoke PCB TMDL
Completed 2009



Existing load = 596,842 mg/yr

Source Category	% Reduction
VPDES Dischargers	97.5
Indiv Indus/Gen Permits	100
MS4	99.3
Contaminated sites	100
Urban Background	99.4
Atm Depo	5
total	95.8

TMDL = 26,549 mg/yr



Questions?

Presentations and Handouts Available at:
http://www.deq.virginia.gov/tmdl

DEQ PCB Website:
http://www.deq.virginia.gov/tmdl/pcb.html

Extra Slides

Point Sources

- TMDL requirements:
  - Baseline or existing load condition
  - Waste Load Allocations (WLAs)

$$\text{Baseline PCB Condition (g/yr)} = \left[\text{PCB conc. ng/L}\right] * \left[\text{Ave Flow (mgd)}\right] * \text{Conv. Factor}$$

$$\text{TMDL WLA (g/yr)} = \left[\text{PCB Endpoint conc. conc. ng/L}\right] * \left[\text{Design Flow (mgd)}\right] * \text{Conv. Factor}$$

MS4s

- Prefer to generate PCB data using Method 1668
  - Without data will estimate loadings
  - Utilize Simple Method for loading calculation
- Internal dialogue (DEQ) on how to address PCB contamination
  - TMDL group with Waste Division
  - Exploring options to expedite PCB remediation