Mountain Run PCB TMDL Study:

Second Technical Advisory Committee Meeting

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Virginia Department of Environmental Quality

July 26, 2022

Agenda

- **Welcome and Introductions**
  - Meeting Objectives
- **Refresher – TMDL Development**
- **Setting the TMDL Endpoint**
  - Bioaccumulation Factor/WQS
  - Endpoint Discussion
- **Watershed Modeling**
  - HSPF
  - Discuss TMDL Allocations
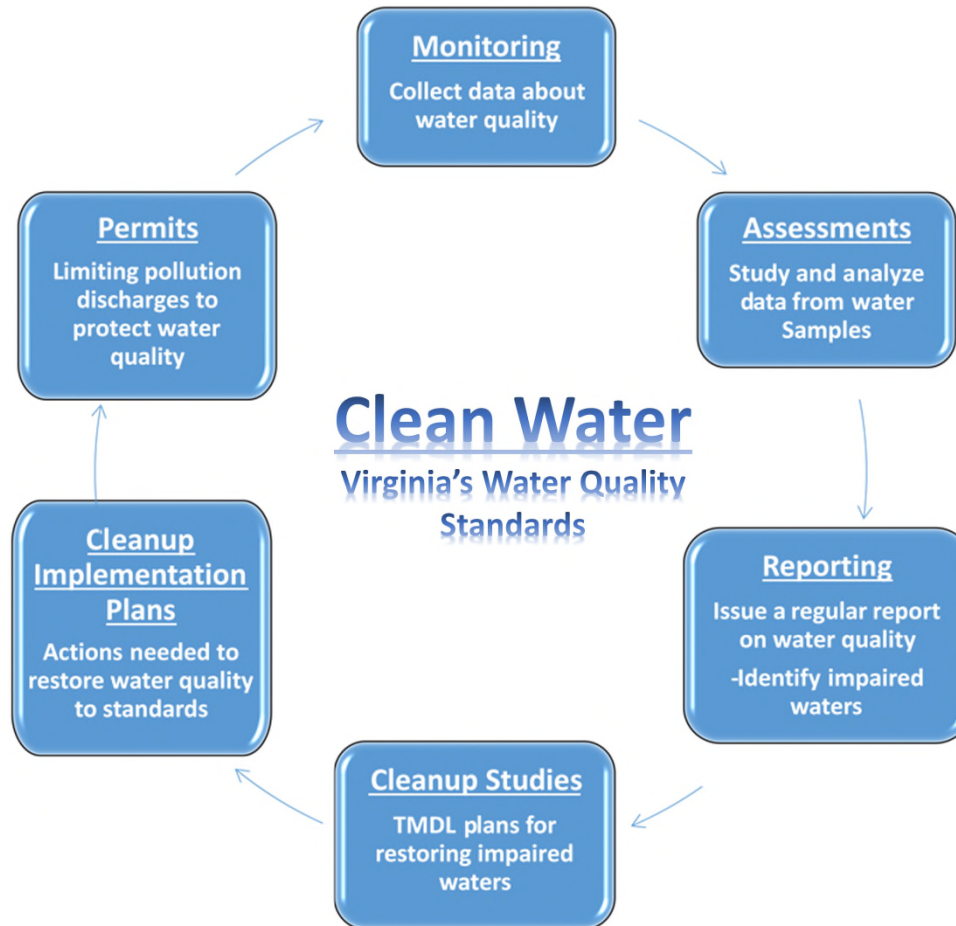- **Wrap-up & Next Steps**

Photo: Friends of the Rappahannock

DEQ

Our **goals** for today…

- Review with you
  - PCB background information and impacts to Mountain Run
  - DEQ's PCB source assessment study for Mountain Run
- You share your thoughts
  - Setting the TMDL endpoint
  - PCB Allocations

Photo: October Greenfield, Friends of the Rappahannock

Continuous Planning Process

VA Water Quality Criterion – Total PCBs

Agency	Fish Tissue Threshold (ppb)	WQC (pg/L)
VDH	100 (Fish Consumption Advisory)	- -
DEQ	18 (Screening Value)	640 Draft revision - 580

- DEQ's Water Quality Assessment (Integrated Report)
  - VDH: Consumption Advisory = impairment
  - DEQ: If two or more fish samples exceed screening value at a site or two water samples exceed criterion at a site = impairment

  From: DEQ's 2022 Water Quality Assessment Guidance Manual

DEQ

DEQ Fish Tissue Monitoring

- Monitor to assess the "Fishable" Goal of the Clean Water Act - 305(b)

- Target lipophilic or "fat loving" contaminants that accumulate in tissue

  - PCBs, Pesticides, etc.

- Compare to trigger values (protect human health)

  - Listed on "dirty waters" report if exceeds - 303(d)

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Total Maximum Daily Load (TMDL)

- Pollution Budget
- Addresses different pollution categories
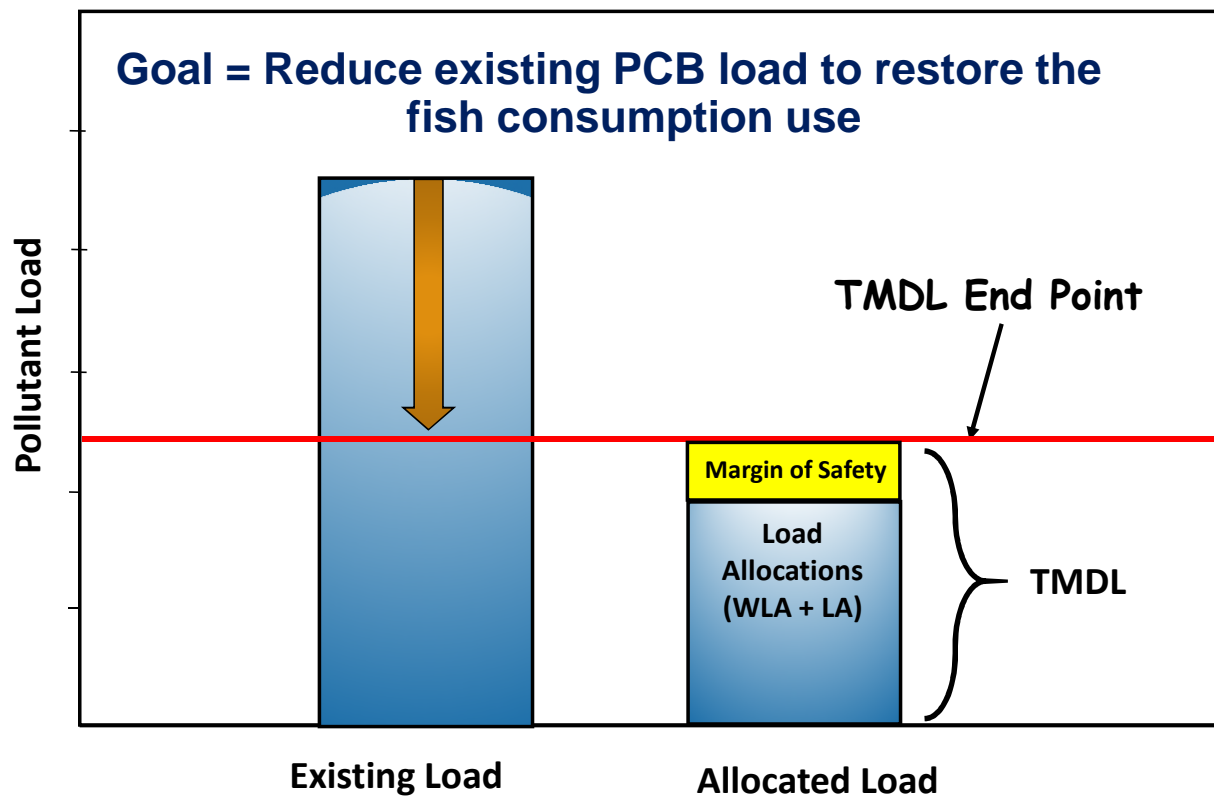- PCB TMDL - Multi-media approach
  - Air, Land, Water

TMDL = WLA + LA + MOS

Where:
  WLA = Waste Load Allocation
  LA = Load Allocation
  MOS = Margin of Safety

Goal = Reduce existing PCB load to restore the fish consumption use

Pollutant Load

TMDL End Point

Margin of Safety

Load Allocations (WLA + LA)

TMDL

Existing Load

Allocated Load

⭐ To be restored the waterbody must meet two thresholds: 1) Numeric WQC [*or site specific value*] and 2) fish tissue threshold

DEQ

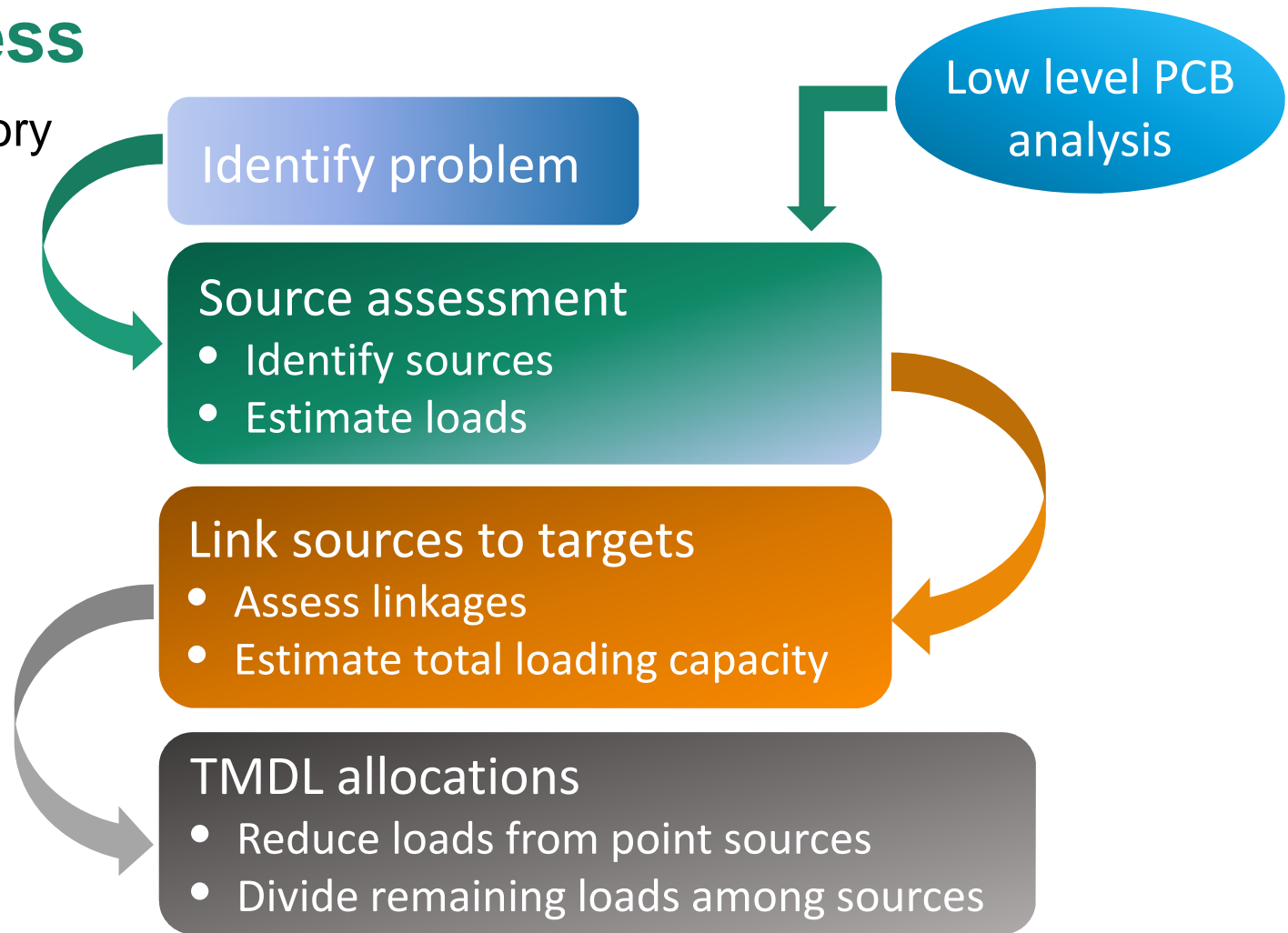# The TMDL Process

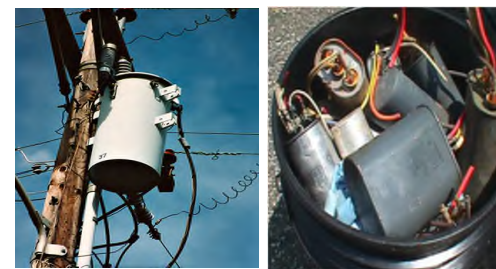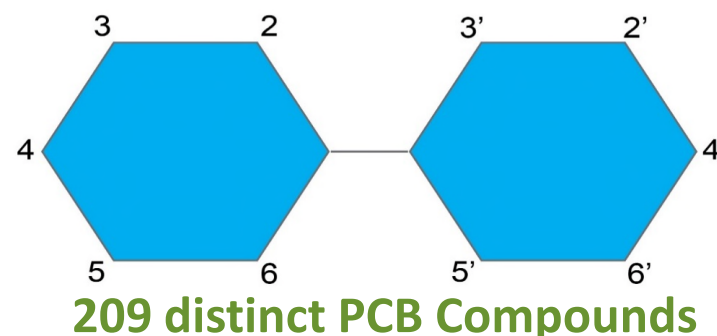Fish Consumption Advisory

Completed

Completed

In Process

Identify problem

Low level PCB analysis

Source assessment
- Identify sources
- Estimate loads

Link sources to targets
- Assess linkages
- Estimate total loading capacity

TMDL allocations
- Reduce loads from point sources
- Divide remaining loads among sources

TMDL = Sum of WLA + Sum of LA + MOS

DEQ

# PCB Background and Mountain Run Water Quality Impairment

Polychlorinated Biphenyls: PCBs

- Biphenyl molecule (1-10 chlorine atoms)
- Aroclors (Monsanto tradename) = mixture of PCB compounds
  - Examples 1248, 1254, 1260
- Legacy Contaminant (banned 1977)
- Stable & persists in the environment
- Common uses:
  - Transformers, capacitors, hydraulic fluids, circuit breakers, PVC Products, carbonless copy paper, caulking material, paints, and more!

209 distinct PCB Compounds

PCBs Continue to be an Issue – Why?

- Human health concern
    - Fish consumption significant exposure pathway
    - Carcinogen (suspected)
    - Immunotoxicity, hepatotoxicity (liver)
    - Affects reproduction and development

- Persistent, bioaccumulates at a low conc. (pg/L) & biomagnifies

- Confirmed on-going releases

DEQ
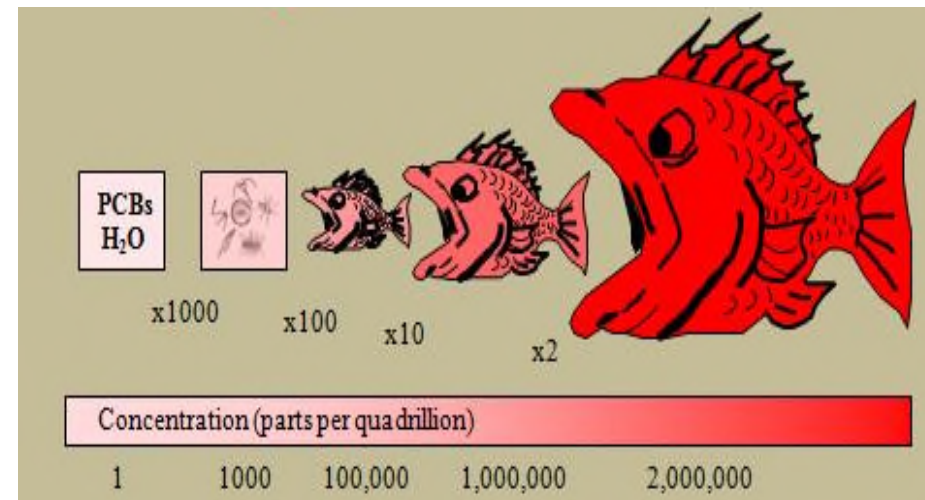
Mountain Run PCB Impairment Timeline

- *1999 & 2001*: DEQ monitors fish tissue

- *2004*: VA Department of Health issues fish consumption advisory for the American Eel (≤ 2 meals/month)

- *2006*: 19.9-mile segment placed on VA's impaired waters list

- *2006 & 2013*: DEQ completes additional fish tissue monitoring

- *2013-2018*: DEQ completes water and sediment monitoring to prepare for PCB study

- 2020: Impaired segment increased to 24.53-miles due to water concentrations
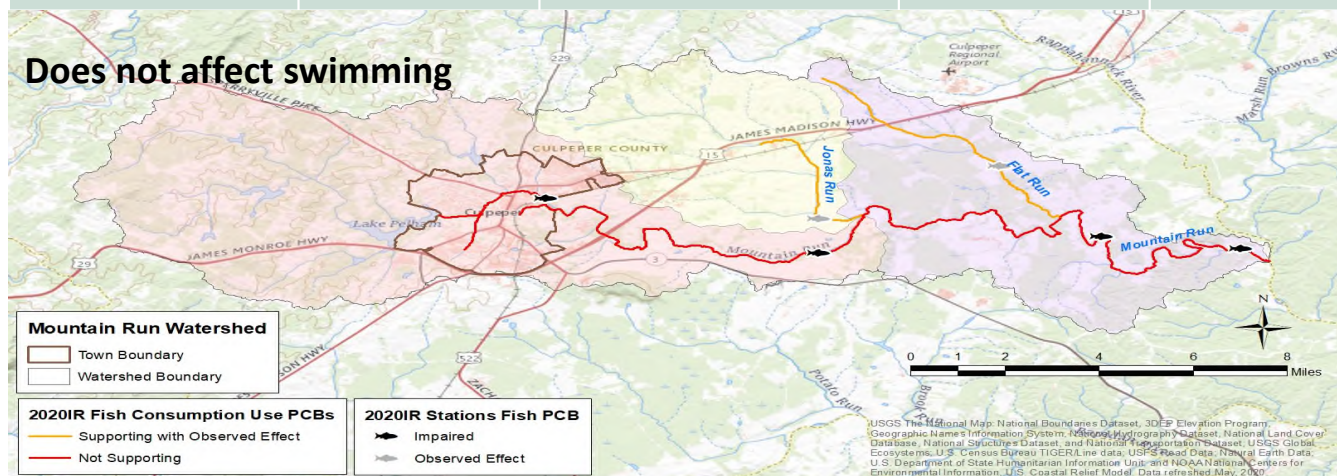
- 2021: DEQ Initiated TMDL

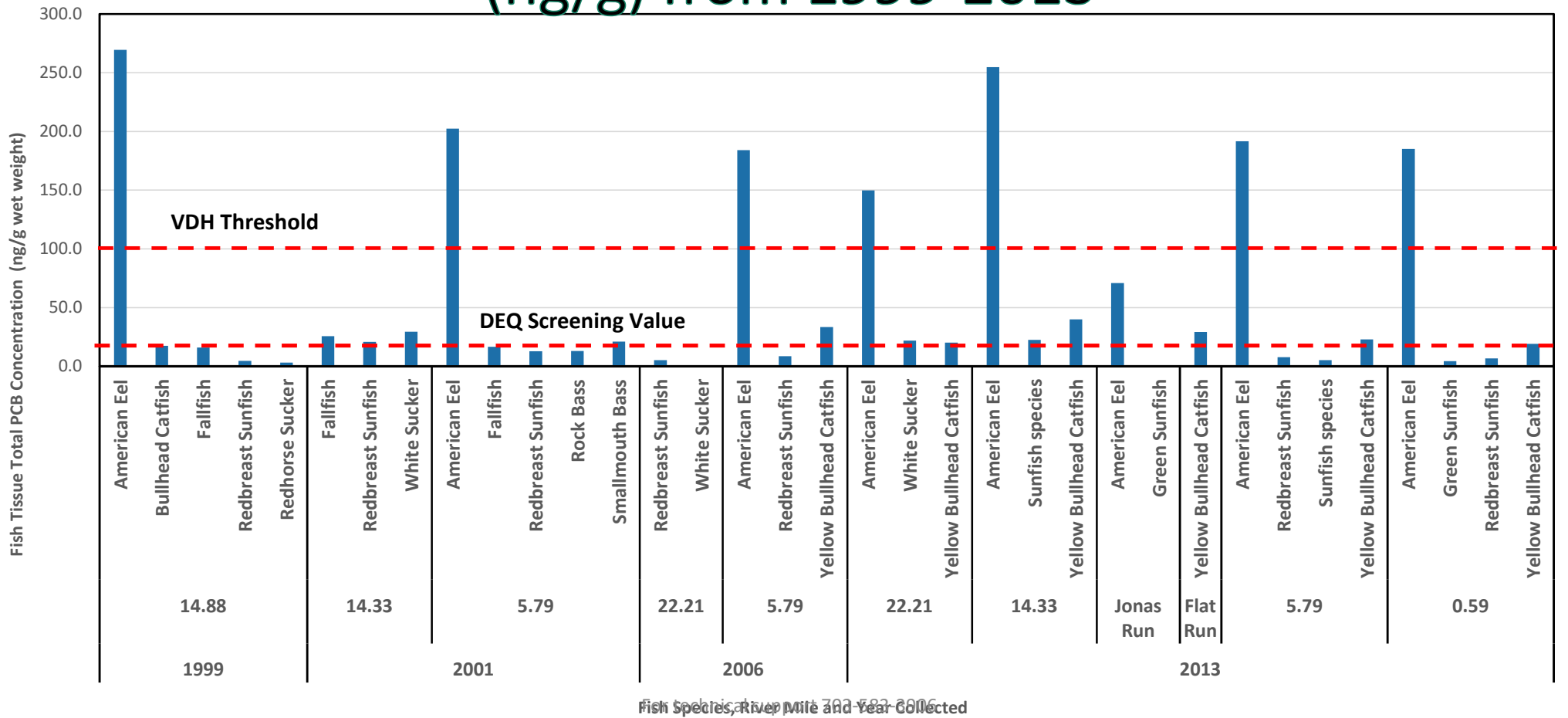Photo: https://www.cfr.msstate.edu/wildlife/fisheries/pdf/AmericanEel.pdf

Photo: https://www.google.com/maps/place/Yowell+Meadow+Park/@33.4756743,-77.9990059

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VDH Fish Consumption Advisory

River basin	Waterbody	Section	Locality	Contaminants	Fish species	Advisory description
Rappahannock	Mountain Run	From rt. 15/29 bridge 19 miles to confluence with Rappahannock River	Culpeper	PCBs	American Eel	≤ 2 meals/month

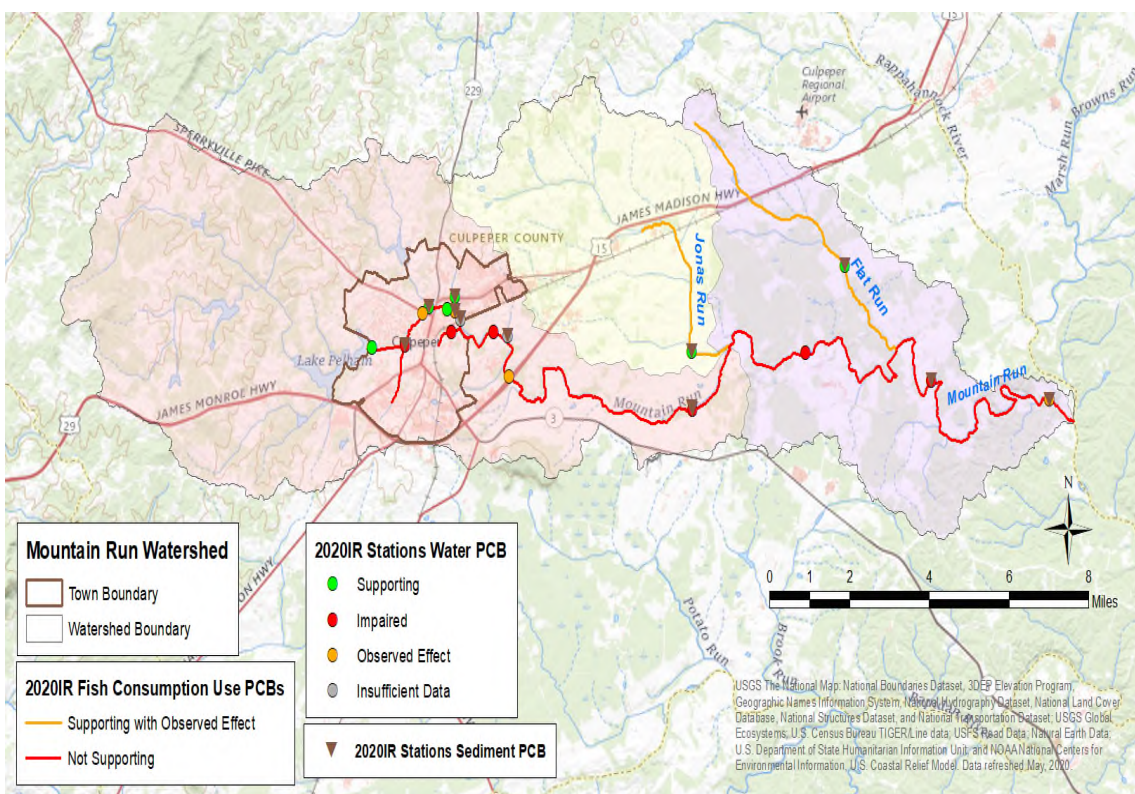Does not affect swimming

Photo: Rick Browder, VADEQ

http://www.vdh.virginia.gov/environmental-health/public-health-toxicology/fish-consumption-advisory/

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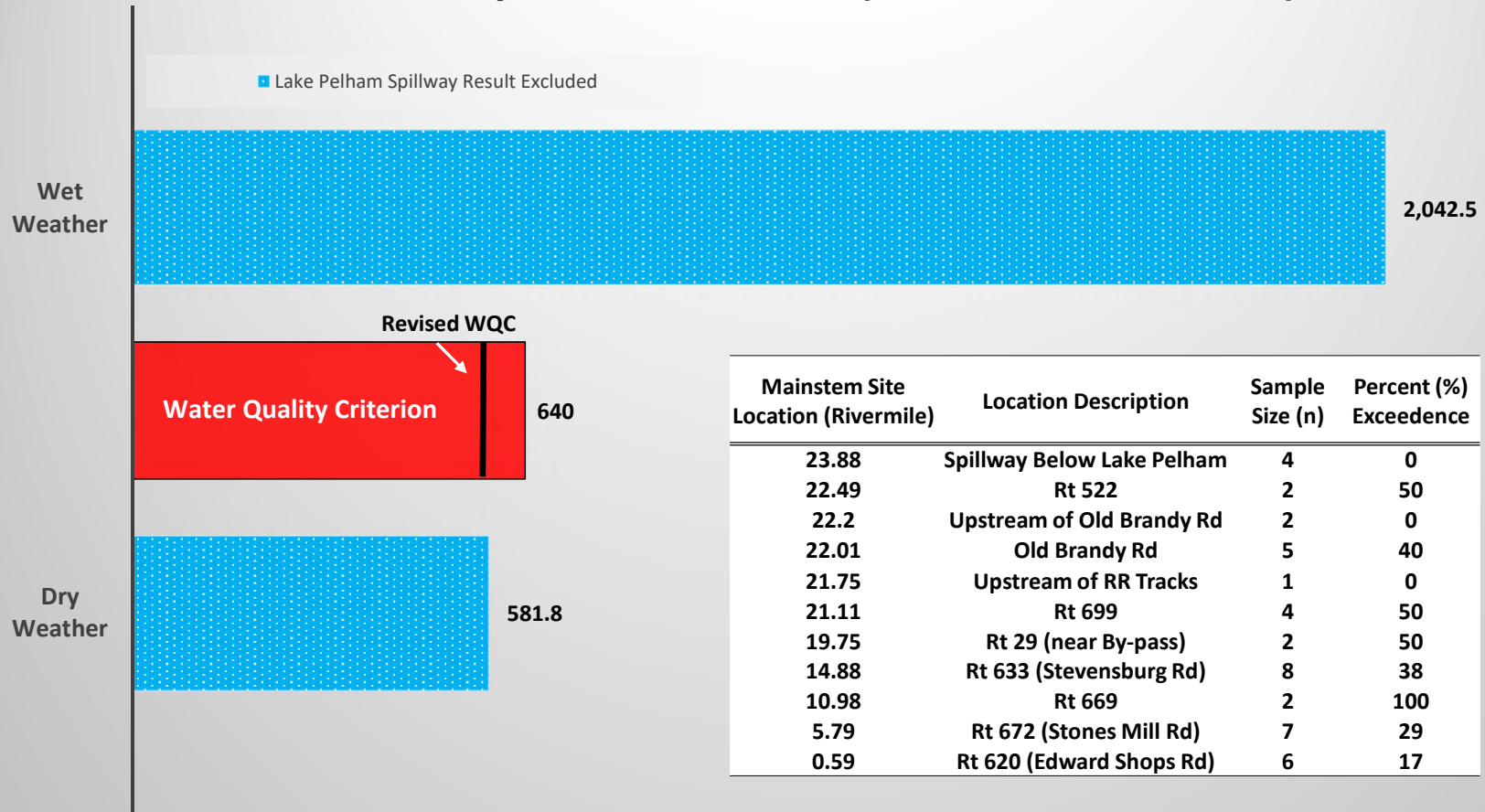Mountain Run Fish Tissue PCB Concentrations (ng/g) from 1999-2013

DEQ TMDL Sampling Approach
2013 – 2015, 2018 & 2021

- Source identification
- TMDL model support
  - Calibration/validation
- 2013 – 2018, 2021 water column, sediment
  - Water column grab samples: High and Base Flow (n = 68)
  - Sediment samples as needed

Mountain Run Watershed
- Town Boundary
- Watershed Boundary

2020IR Fish Consumption Use PCBs
- Supporting with Observed Effect
- Not Supporting

2020IR Stations Water PCB
- ● Supporting
- ● Impaired
- ● Observed Effect
- ● Insufficient Data

▼ 2020IR Stations Sediment PCB

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Total PCB (pg/L) Water Concentrations in Mountain Run During Wet and Dry Flow Conditions (Mean Concentration)

■ Lake Pelham Spillway Result Excluded

Wet Weather — 2,042.5

Revised WQC

Water Quality Criterion — 640

Dry Weather — 581.8

Mainstem Site Location (Rivermile)	Location Description	Sample Size (n)	Percent (%) Exceedence
23.88	Spillway Below Lake Pelham	4	0
22.49	Rt 522	2	50
22.2	Upstream of Old Brandy Rd	2	0
22.01	Old Brandy Rd	5	40
21.75	Upstream of RR Tracks	1	0
21.11	Rt 699	4	50
19.75	Rt 29 (near By-pass)	2	50
14.88	Rt 633 (Stevensburg Rd)	8	38
10.98	Rt 669	2	100
5.79	Rt 672 (Stones Mill Rd)	7	29
0.59	Rt 620 (Edward Shops Rd)	6	17

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Sediment tPCB (pg/g) Concentrations Detected in Mountain Run and Tributaries

Sediment Site Location (Rivermile)	Location Description
Lake Pelham (24.05)	Lake Pelham above Spillway
UT to Mtn Run (0.06)	End of Spring Street
Balds Run (0.08)	Colonel Jamerson Rd
Hidens Branch (0.22)	Rt 29 (Business)
Mountain Run (22.01)	Old Brandy Rd
UT to Mtn Run (0.10)	Rt. 667 (Nalles Mill Rd)
Mountain Run (14.88)	Rt 633 (Stevensburg Rd)
UT to Mtn Run (0.05)	UT to Mtn Run (near Power Lines) - downhill from Jim's liquid waste
Mountain Run (12.04)	Downstream from Coles Hill Rd (below Jim's liquid waste)
Mountain Run (0.59)	Rt 620 (Edward Shops Rd)

Y-axis: tPCB Concentraton (pg/g) — 0; 20,000; 40,000; 60,000; 80,000; 100,000; 120,000

X-axis (Location): 3-MTN024.05, 3-XIH000.06, 3-BLS000.08, 3-HID000.22, 3-MTN022.01, 3-XEH000.10, 3-XEH000.10, 3-MTN014.88, 3-XMS000.05, 3-MTN012.04, 3-MTN000.59
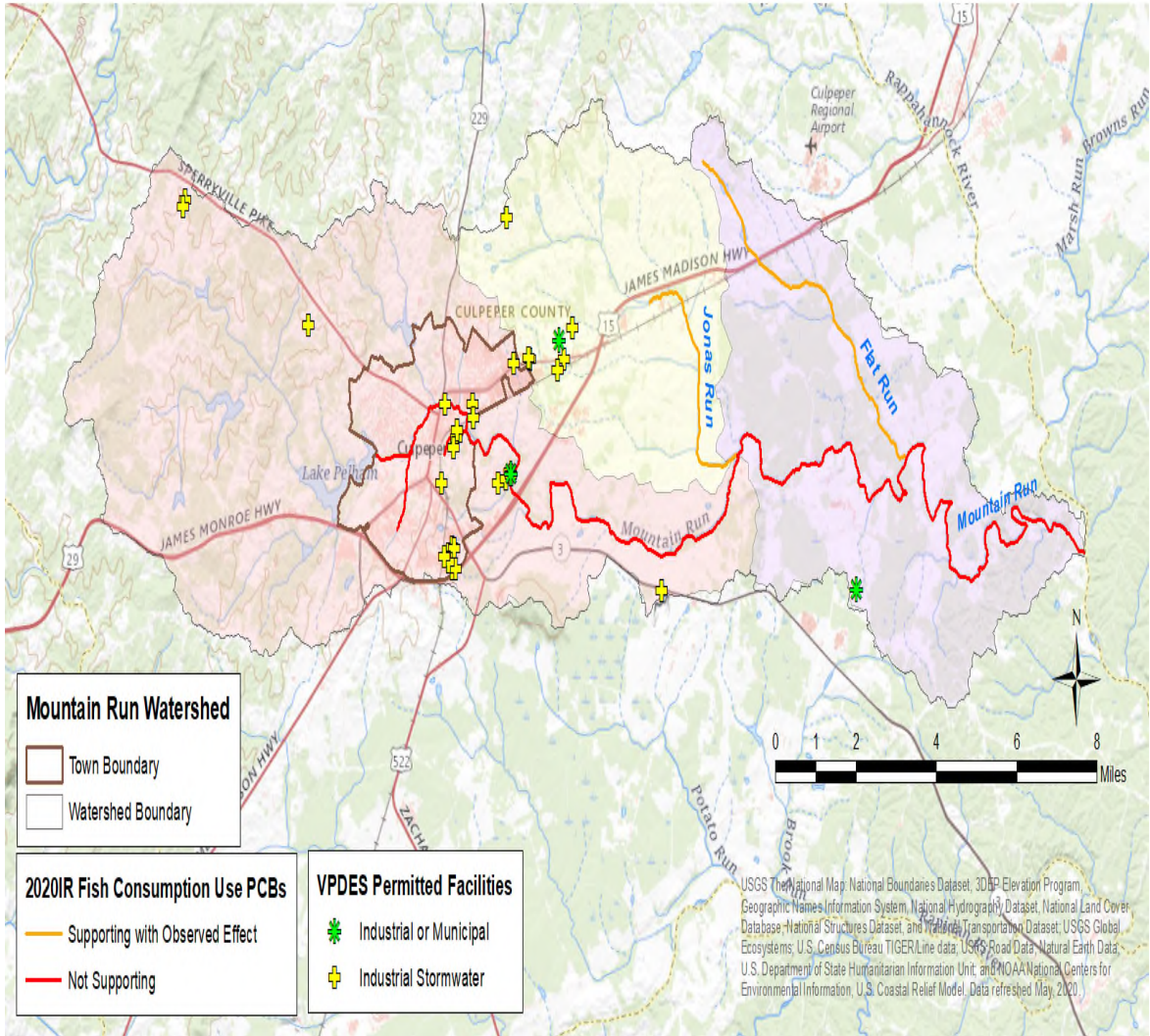
TMDL Source Category Point Sources

Permitted facilities

(1) Municipal WWTP

(7) Industrial Storm Water (General Permits)

No Regulated Storm Water (MS4)

MS4 – Municipal Separate Storm Sewer System

TMDL Source Category

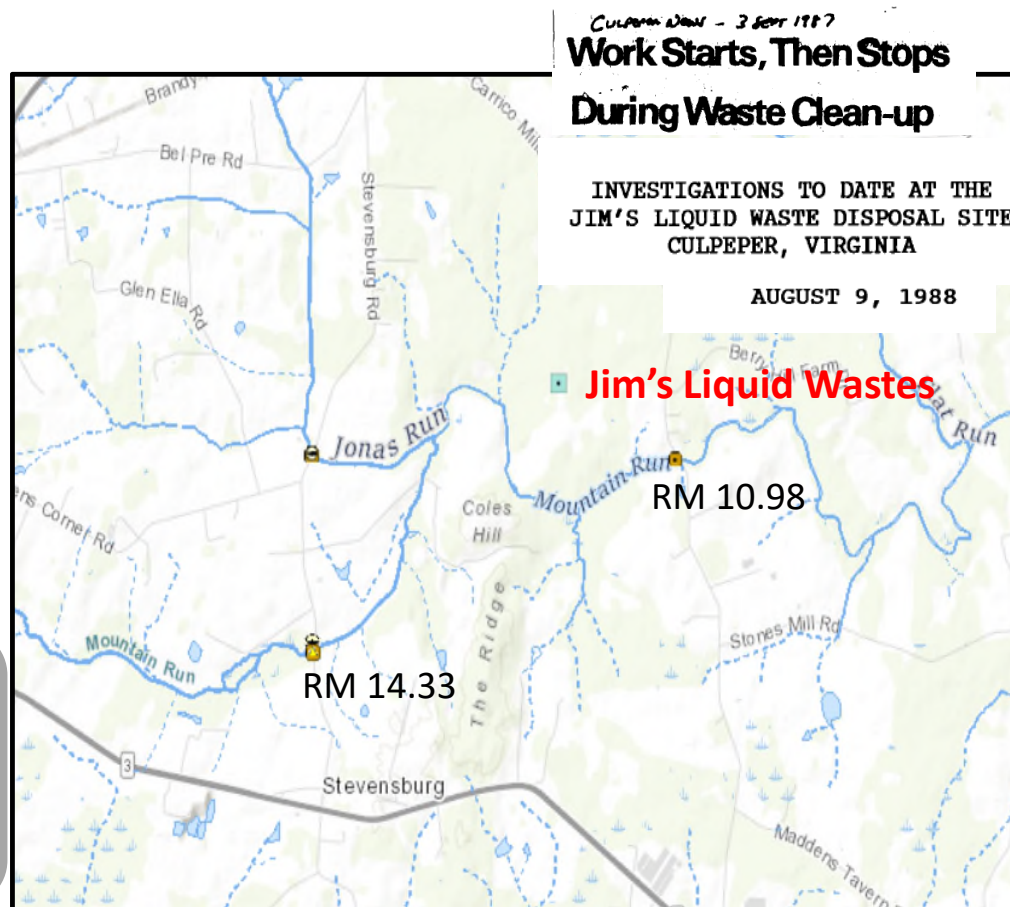## Contaminated Sites

Voluntary remediation program (DEQ)

Spill sites

Electric Utility Transformer Pads

Rail Yards/Spurs

*RCRA Corrective Action

*CERCLA

* Screened but non identified as a source

Work Starts, Then Stops
During Waste Clean-up

INVESTIGATIONS TO DATE AT THE
JIM'S LIQUID WASTE DISPOSAL SITE
CULPEPER, VIRGINIA

AUGUST 9, 1988

Jim's Liquid Wastes

RM 10.98

RM 14.33

DEQ

TMDL Source Categories

Non-regulated Surface Load

Unregulated stormwater

Loads from small tributaries

Unspecified Point Sources

Unidentified Contaminated Sites

Atmospheric Deposition

Streambed Sediment

Photo: Bryan Hofmann

TMDL Endpoint

Determining a PCB Endpoint: Two Options

Use water quality criterion

*640 pg/L

Default if < site specific value

*Impending Revision = 580 (pg/L)

Calculate site-specific value

Based on fish tissue samples from impaired stream

Calculate bioaccumulation factor for each species

PCB levels in the stream ⟷ **PCB levels in fish tissue**

Bioaccumulation Factor Approach (BAF)

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Factors to Consider for a Site-Specific Endpoint

Fish accumulate PCBs

Dissolved PCBs = basis for WQC

Different forms of PCBs in the stream

PCB uptake in the food chain

Average instream concentration often < WQC

Site specific value accounts for all **exposure pathways** **e.g., sediment ingestion**

DEQ
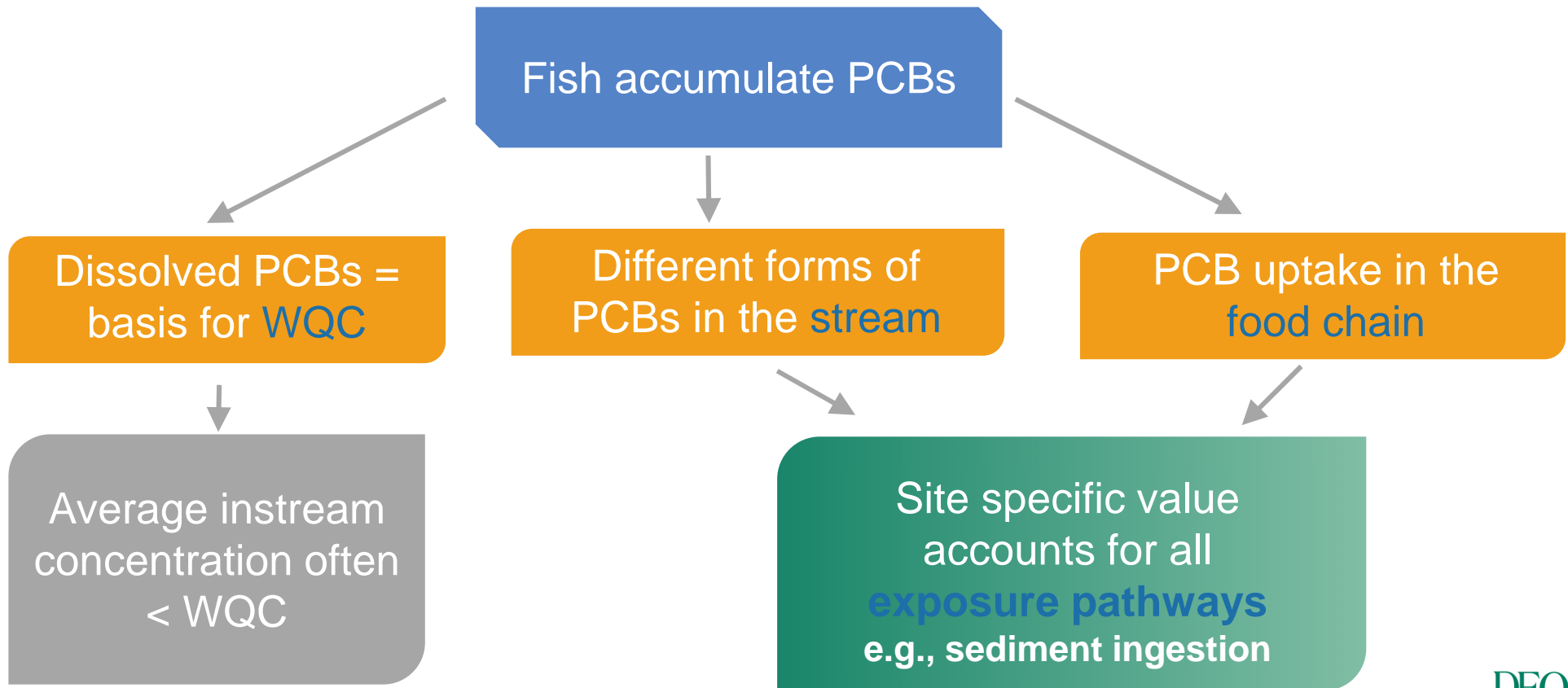
Calculating a bioaccumulation factor (BAF)

Within the <u>home range</u> of a fish species	Within a <u>TMDL watershed</u>

Ratio of Water PCBs and Fish Tissue PCBs → **Normalized for freely dissolved PCBs and fish tissue lipid content** → **Median of home range values** → **Normalized by median fish lipid content & freely dissolved PCBs**

↓

Normalized values divided by fish tissue threshold value (18 ppb)

- BAF values are calculated for each fish species in a TMDL watershed
- The TMDL endpoint is based on some average of selected fish species BAF values

Determining a PCB Endpoint in Mountain Run

Feeding Strategy	Fish Species	Endpoint (pg/L)	Sample Size (n)	Individuals
Predator	American Eel	25.00	11	76
Predator	Fallfish	290.00	2	12
Predator	Rock Bass	580.00	1	10
Benthivore-generalist	Sunfish sp.	250.00	10	89
Predator	Smallmouth Bass	360.00	1	4
Benthivore-generalist	White Sucker	110.00	3	24
Benthivore-generalist	Yellow Bullhead	56.00	7	39

Scenario 1 based on all species

Summary Statistics	
n	35
min (pg/L)	25.0
max (pg/L)	580.0
mean (pg/L)	240.0
median (pg/L)	250.0
geometric mean (pg/L)	160.0
weighted mean (pg/L) sample size	140.0
weighted mean (pg/L) indivduals; n= 254	160.0

Scenario 2 based on Feeding Strategy

Summary Statistics	
Scenario 2	Mean (pg/L)
Benthivore-Generalists	140
Predators	310

Scenario based on using Advisory Species

Scenario	pg/L
American Eel	25
Yellow Bullhead	56

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Mountain Run Fish Tissue tPCB Concentrations (ng/g) - Predators
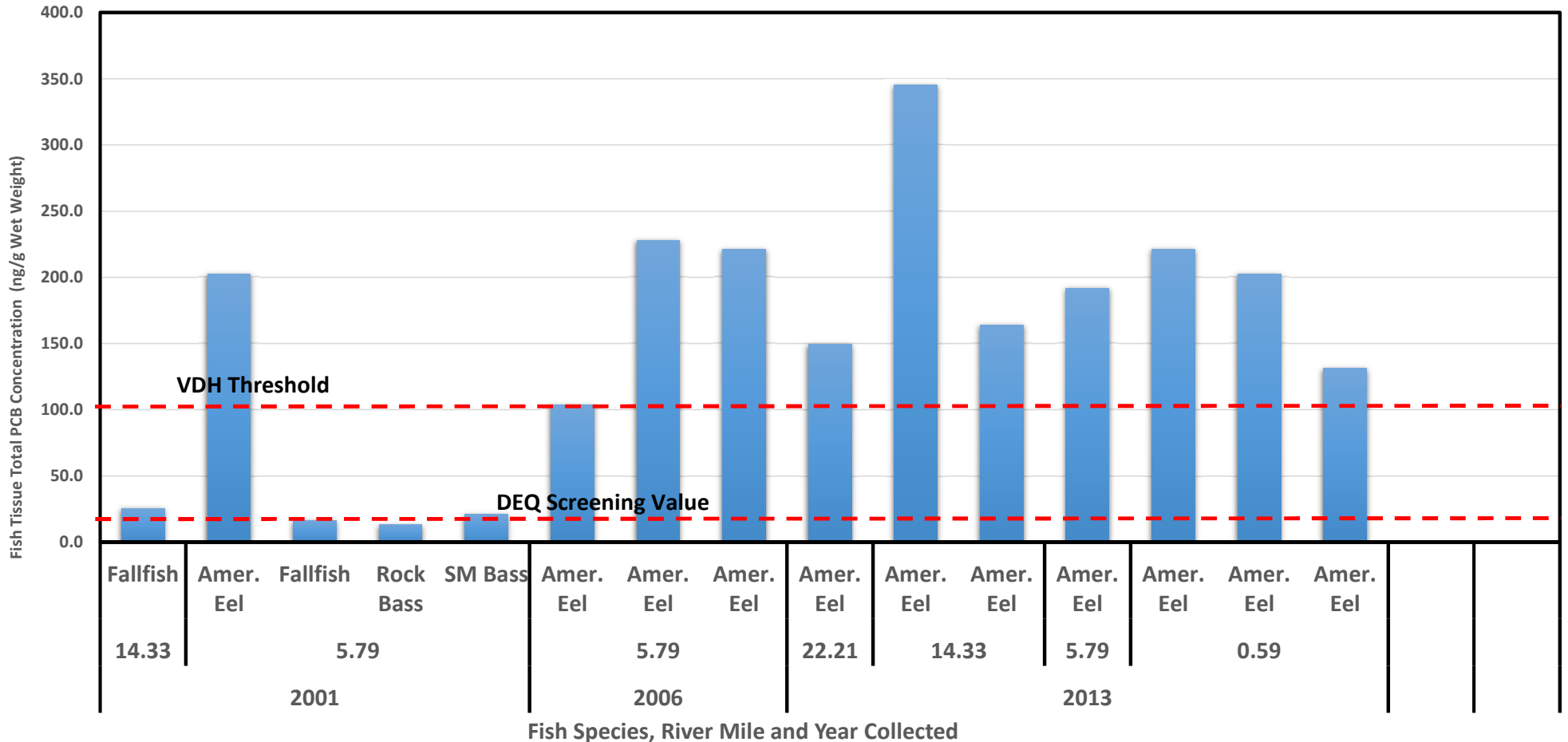
Modeling PCBs
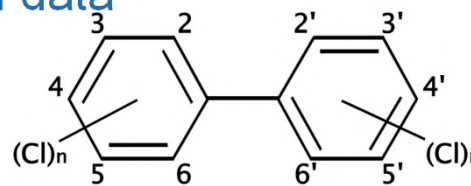
Mountain Run PCB TMDL TAC Meeting

July 26, 2022

Model Process

- PCB model consists of 3 major components:
    1. Hydrology
    2. Sediment transport
    3. PCB fate and transport

- Model calibrated using observed data:
    1. Stream gage flow data
    2. Suspended sediment concentration data
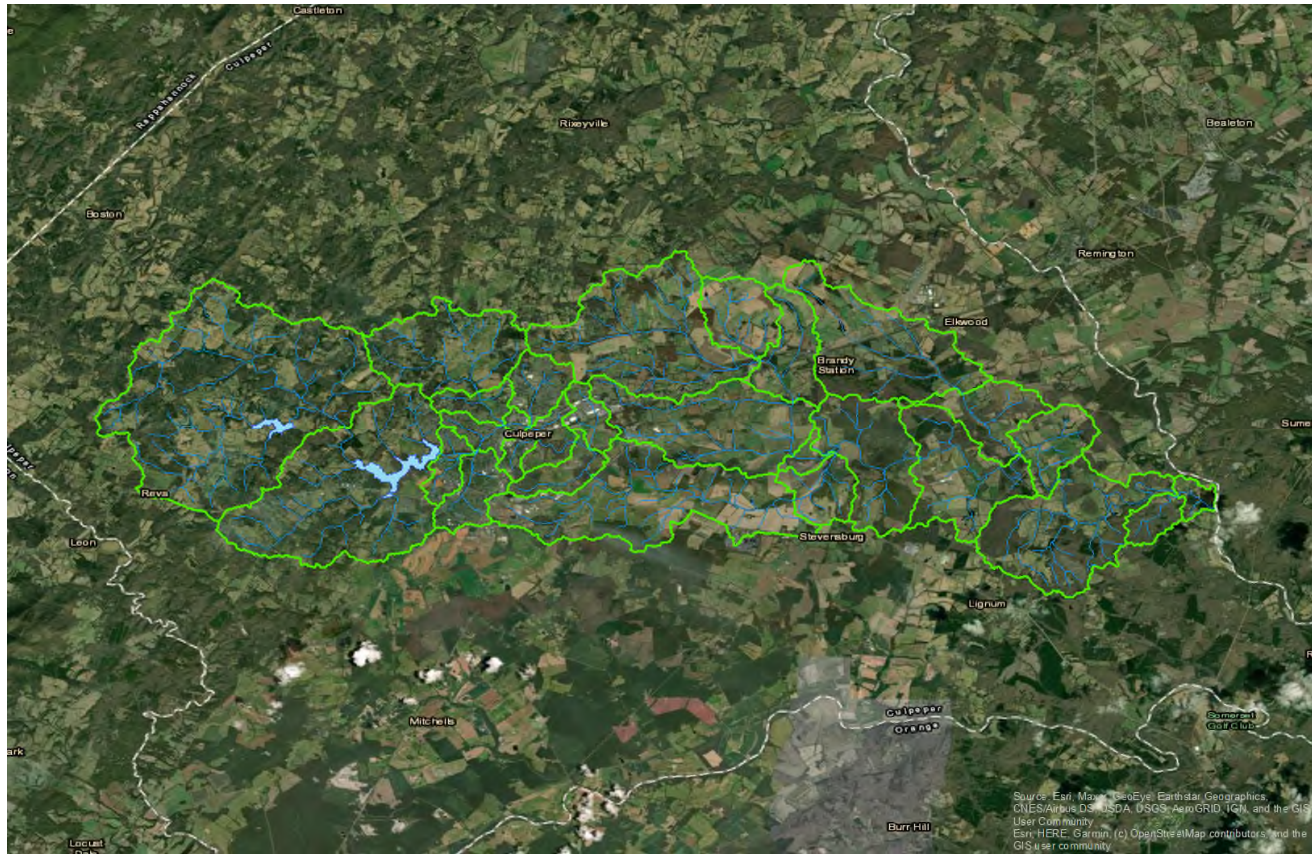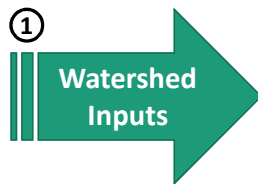   3. PCB concentration data

http://prairierivers.org/what-is-a-watershed/

https://photogallery.sc.egov.usda.gov/netpub/server.np

https://upload.wikimedia.org/wikipedia/commons/thumb/4/49/Polychlorinated_biphenyl_structure.svg/2000px-Polychlorinated_biphenyl_structure.svg.png
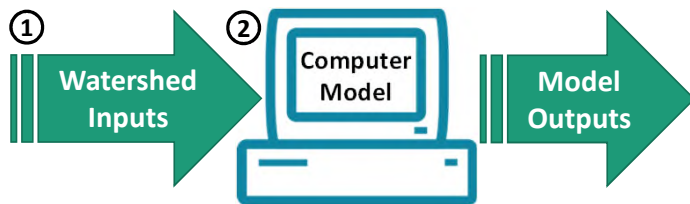
DEQ

Mountain Run Sub-Watersheds

How is the model used?

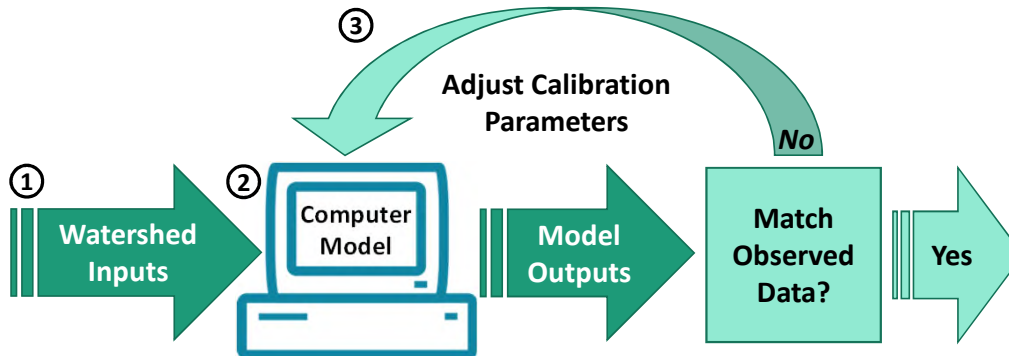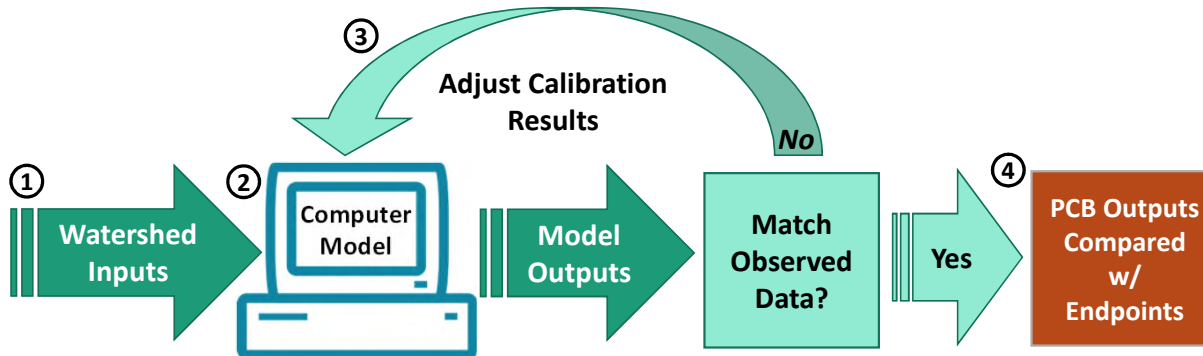1. Watershed inputs are used to develop model.

Watershed Inputs

DEQ

How is the model used?

1. Watershed inputs are used to develop model.

2. Model simulates watershed processes (flow, pollutant fate and transport).

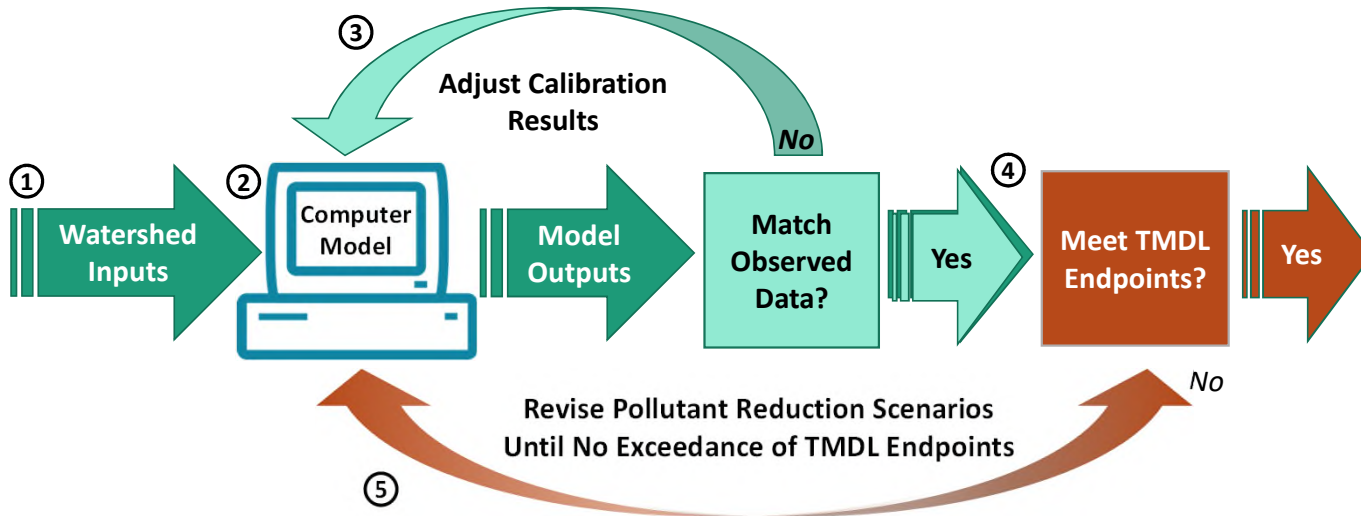① **Watershed Inputs** ② Computer Model **Model Outputs**

DEQ

How is the model used?

1. Watershed inputs are used to develop model.

2. Model simulates watershed processes (flow, pollutant fate and transport).

3. Model is calibrated to observed data.

③ **Adjust Calibration Parameters**

No

① **Watershed Inputs**

② **Computer Model**

Model Outputs

Match Observed Data?

Yes
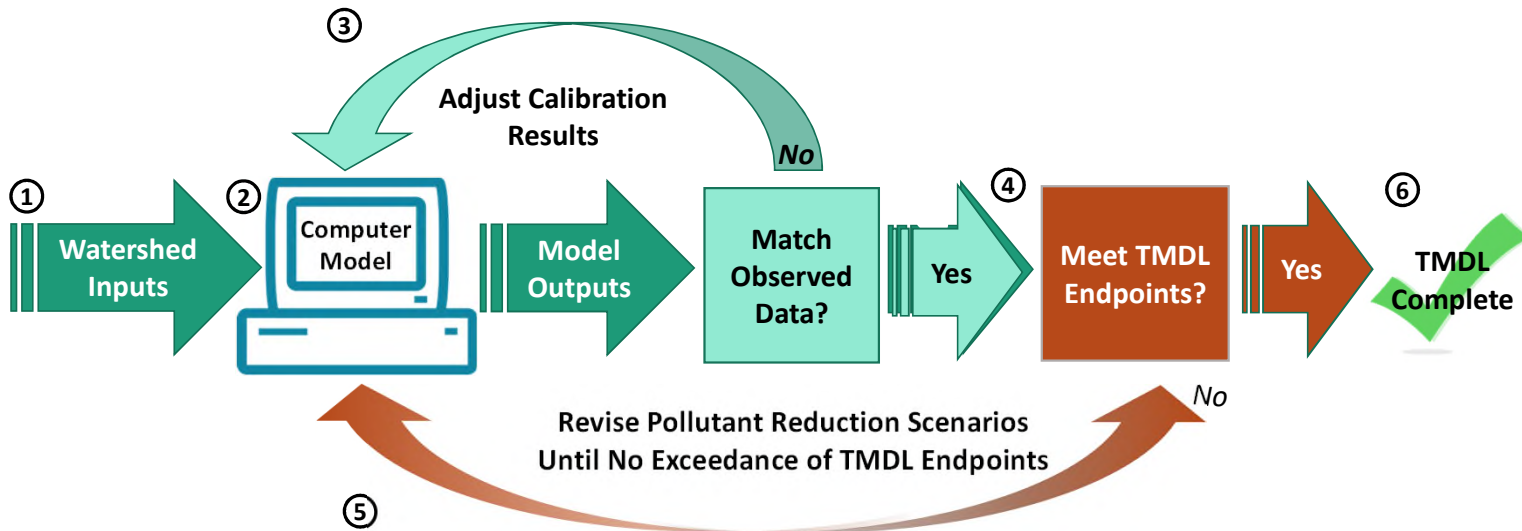
DEQ

How is the model used?

1. Watershed inputs are used to develop model.

2. Model simulates watershed processes (flow, pollutant fate and transport).

3. Model is calibrated to observed data.

4. Calibrated PCB outputs are compared with TMDL endpoints.

③ **Adjust Calibration Results**

No

① **Watershed Inputs**

② **Computer Model**

Model Outputs

Match Observed Data?

Yes

④ **PCB Outputs Compared w/ Endpoints**

DEQ

How is the model used?

1. Watershed inputs are used to develop model.

2. Model simulates watershed processes (flow, pollutant fate and transport).

3. Model is calibrated to observed data.

4. Calibrated PCB outputs are compared with TMDL endpoints.

③ **Adjust Calibration Results** *No*

① **Watershed Inputs** ② **Computer Model** **Model Outputs** **Match Observed Data?** Yes ④ **Meet TMDL Endpoints?** Yes

Revise Pollutant Reduction Scenarios Until No Exceedance of TMDL Endpoints

⑤ *No*

5. Model allows evaluation of multiple pollution reduction scenarios.

How is the model used?

1. Watershed inputs are used to develop model.

2. Model simulates watershed processes (flow, pollutant fate and transport).

3. Model is calibrated to observed data.

4. Calibrated PCB outputs are compared with TMDL endpoints.

③ Adjust Calibration Results — No

① Watershed Inputs → ② Computer Model → Model Outputs → Match Observed Data? → Yes → ④ Meet TMDL Endpoints? → Yes → ⑥ TMDL Complete

No

⑤ Revise Pollutant Reduction Scenarios Until No Exceedance of TMDL Endpoints

5. Model allows evaluation of multiple pollution reduction scenarios.

6. Stakeholders select acceptable reduction scenario to achieve TMDL.

DEQ

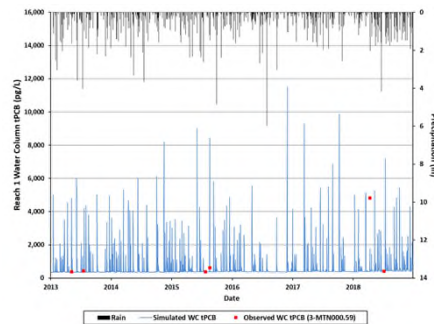**Only use the following slides if needed to clarify and answer questions.**

DEQ

Model Calibration

- Compares **Observed Sampling** with **Simulated Output**

- "**Weight-of-evidence**" Approach

Graphical Analysis

Quantitative Analysis

Statistics	Value
Number of Observed Data Points	62
Percentage within 5-day window	**81%**
Percentage above 5-day maximum	14%
Percentage below 5-day minimum	5%

DEQ

Hydrology Component

- Simulates the watershed water balance
- Meteorology (precipitation and evapotranspiration) is the driving force
- Accounts for:
  - Spring flow
  - Major withdrawals (municipal water supply and industrial cooling water)
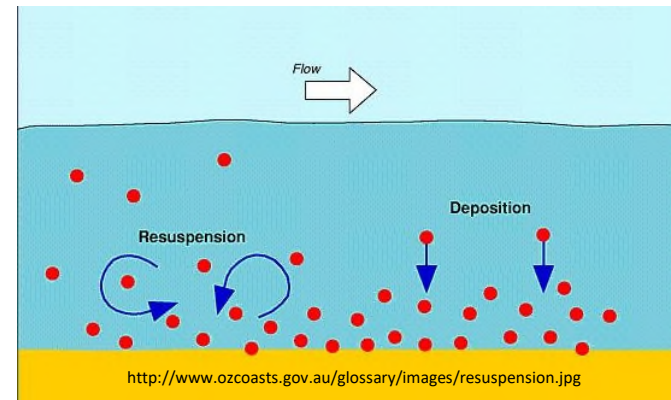 - Major discharges (water treatment plants, industry)

http://prairierivers.org/what-is-a-watershed/

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DEQ

Sediment Component

- Simulated total suspended solids (TSS) concentrations calibrated against observed suspended sediment concentration (SSC) data
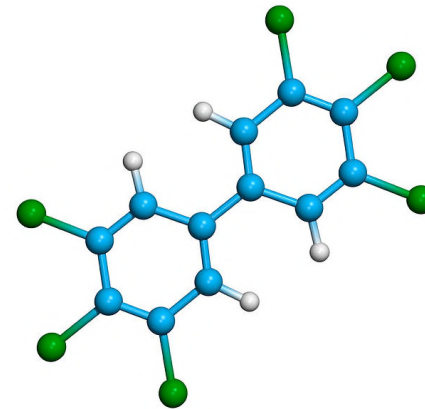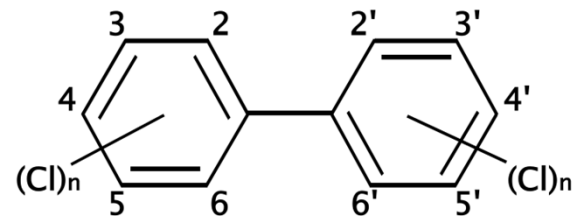
- Two Phase calibration process

Soil detachment and washoff (erosion)

In-stream sediment resuspension and deposition

DEQ

PCB Fate and Transport Component

- Simulated "dissolved" PCB concentration (tPCB) calibrated with DEQ observed water column PCB concentration data

- Adsorption and desorption coefficients were used to model how sediment-attached PCBs enter the water column

- Calibrated for all segments

PCB molecules

https://upload.wikimedia.org/wikipedia/commons/thumb/4/49/Polychlorinated_biphenyl_structure.svg/2000px-Polychlorinated_biphenyl_structure.svg.png

http://images.fineartamerica.com/images-medium-large/polychlorinated-biphenyl-molecule-dr-tim-evans.jpg

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DEQ

Calibration Process

- Sources with *Fixed Loading Rates* – loading rates established by permit, previous studies, or sampling data

  - Permitted Facilities

  - PREP Spills

  - Contaminated Sites

  - Atmospheric Deposition

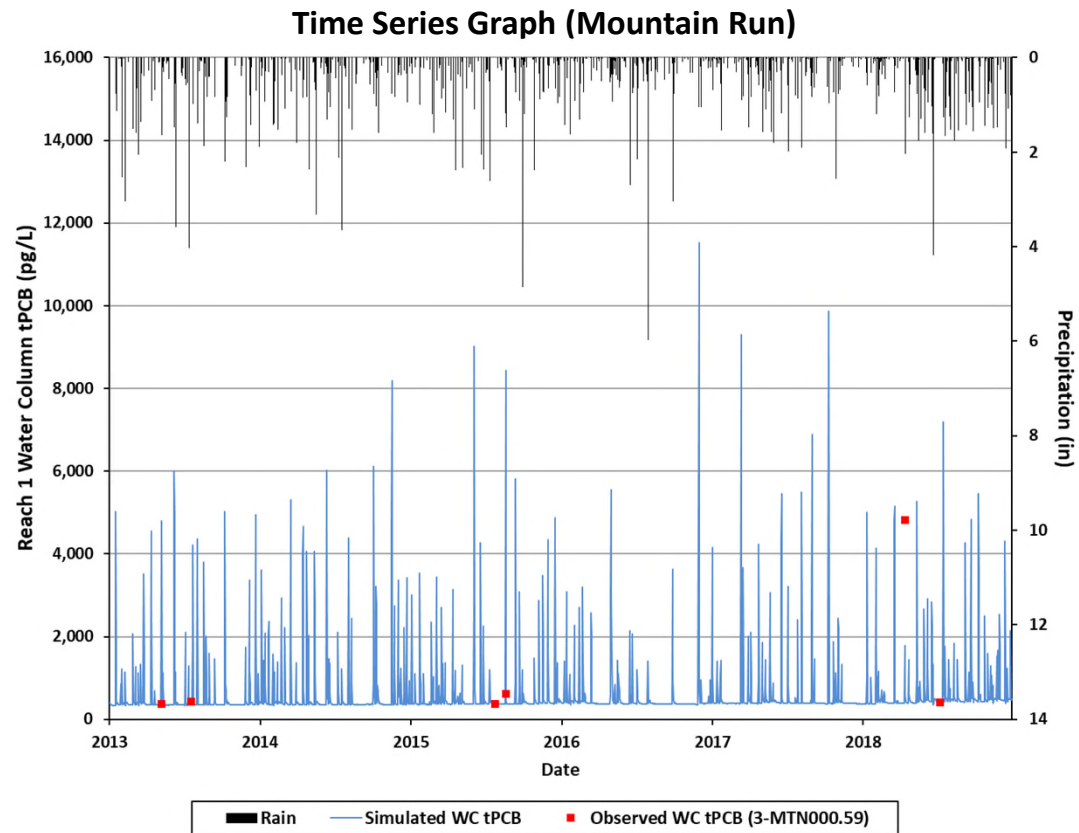 - "Background" Conditions – Forest, Agricultural and Residential Land Uses

DEQ

Calibration Process

- Sources with *Calibrated Loading Rates* – loading rates established by sampling data
  - In-Stream Sediment
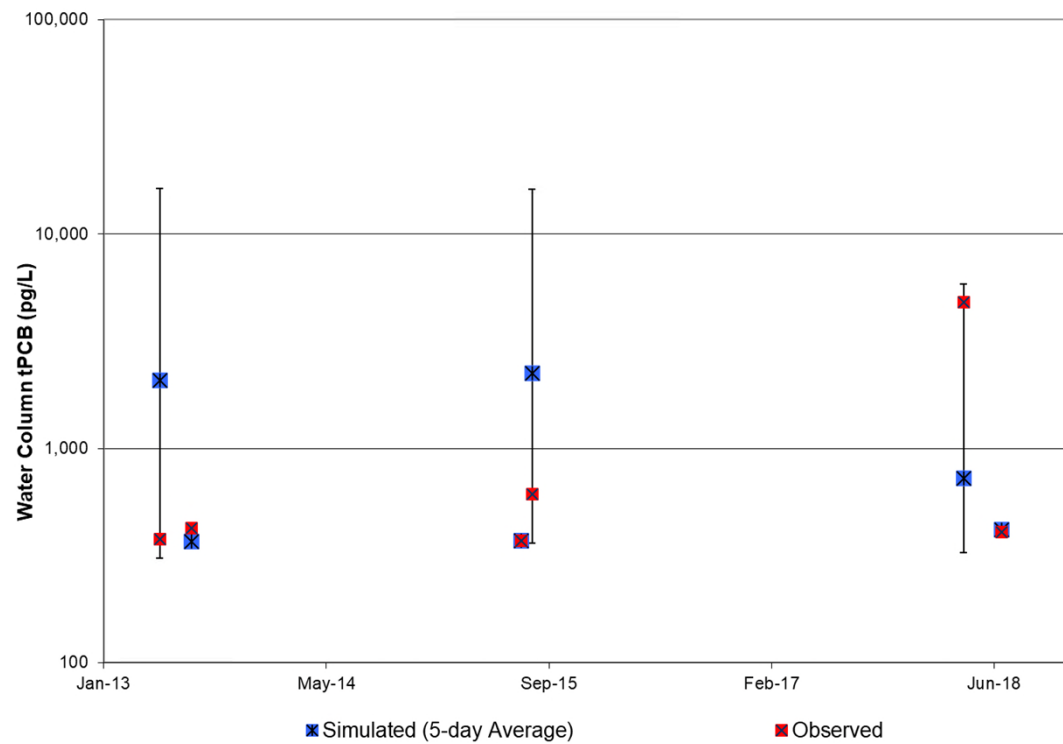 - Commercial/Industrial Conditions – Highly impervious areas

DEQ

PCB Calibration Graphical Analysis

Time Series Graph (Mountain Run)

PCB Calibration Graphical Analysis

5-Day Calibration Window Plot (Mountain Run, Station at Reach 1)

PCB Calibration Window Statistics

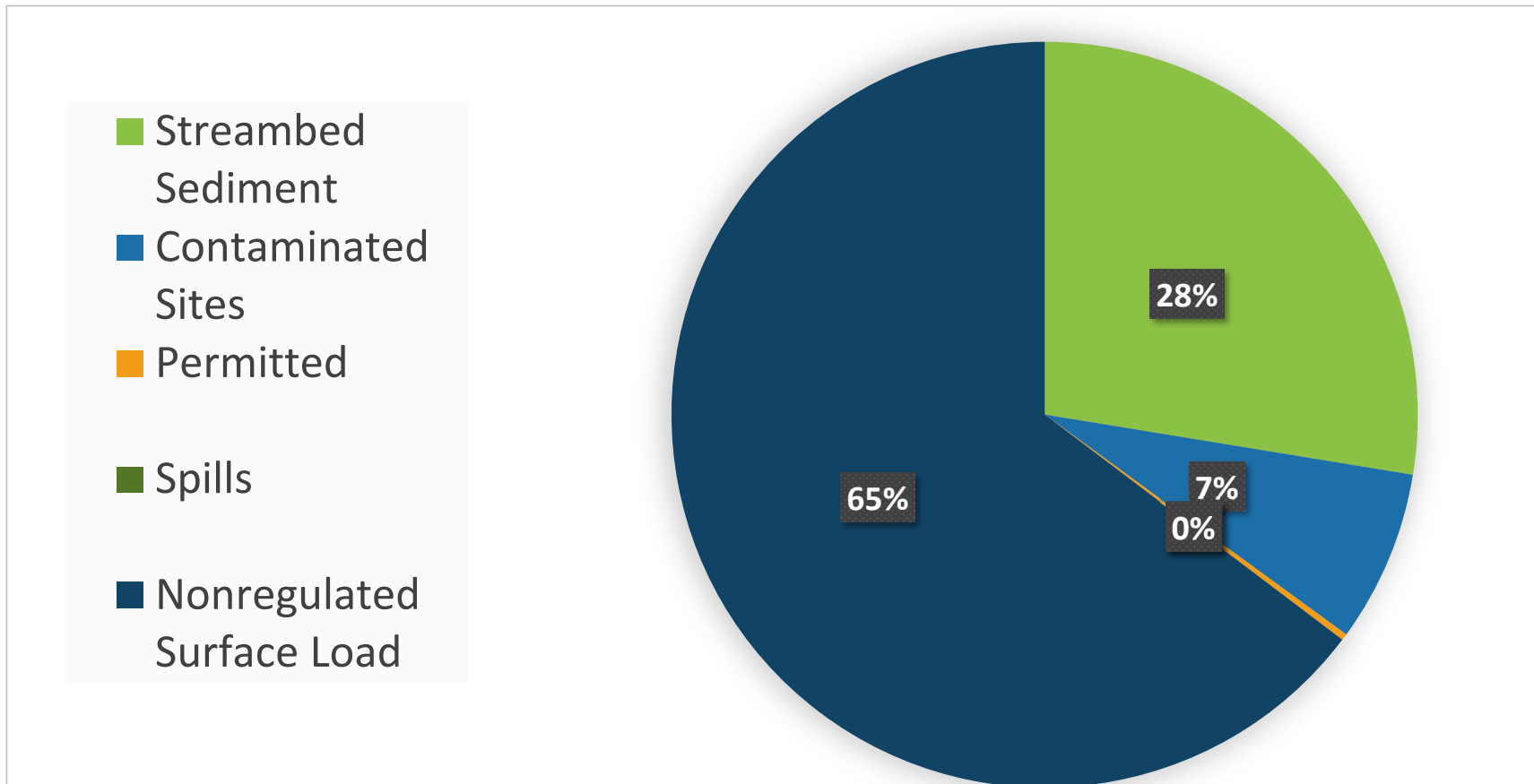**Calibration Window Summary Statistics**
(Mountain Run, All Stations)

Statistics	Value
Number of Observed Data Points	62
Percentage within 5-day window	**81%**
Percentage above 5-day maximum	14%
Percentage below 5-day minimum	5%

Calibration Window Criterion:

    - ≥ 50% *Within* 5-Day Window for **ALL** Stations

    - Approximately equal bias *Above* and *Below* windows

    - Majority of 5-Day Averages to be ± 100% of observed sample

- PCB calibration window criteria
  were met for ALL calibration segments

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PCB Allocations

DEQ

Annual Relative Contributions to PCB Concentrations at the Mountain Run Watershed Outlet

Legend:
- Streambed Sediment
- Contaminated Sites
- Permitted
- Spills
- Nonregulated Surface Load

28%
7%
0%
65%

DEQ

Mountain Run PCB Allocations

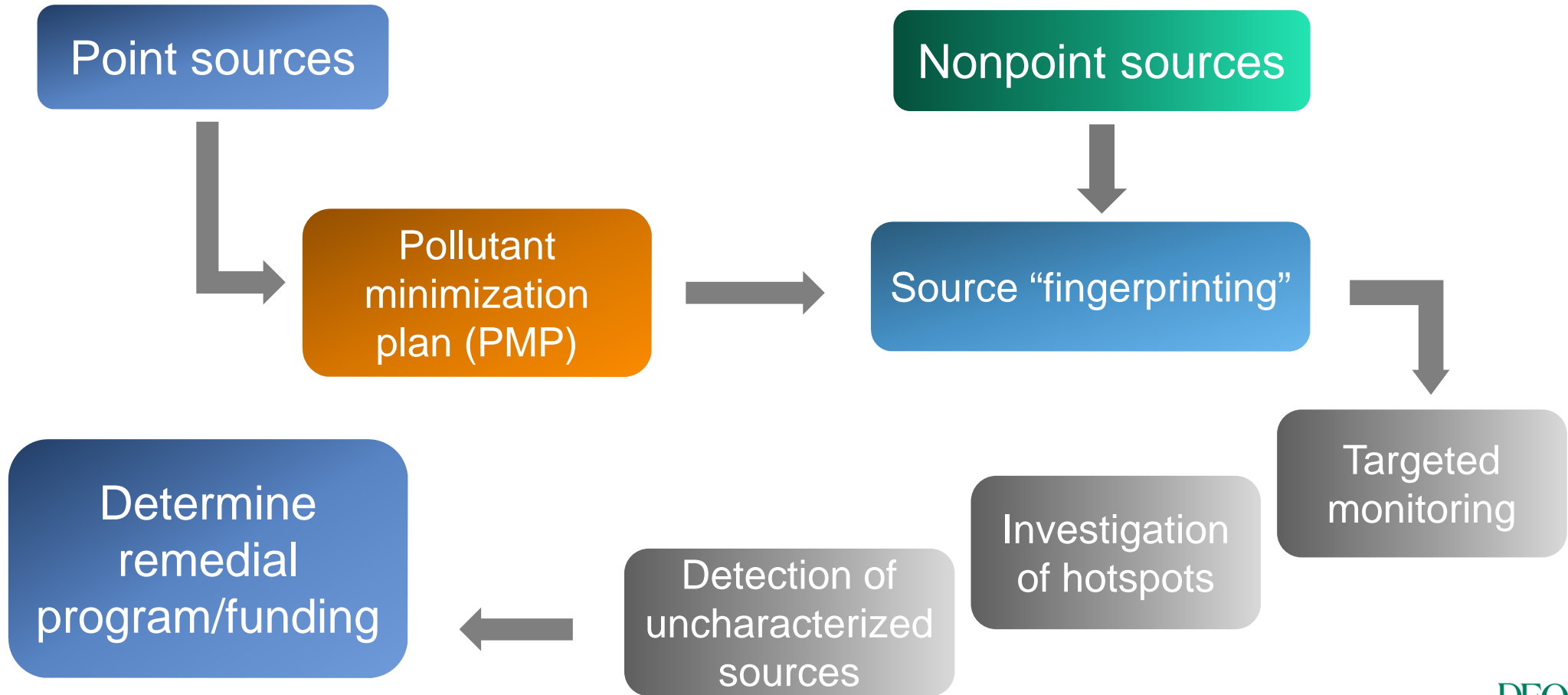| Allocation Scenario	Required PCB Loading Reductions to Meet TMDL Endpoint (%)					TMDL Endpoint Exceedance (%)			Daily Mean tPCB conc (pg/L)	Daily Median tPCB con (pg/L)
	Loads from Permitted Sources	Loads from Contaminated Sites	Loads from Nonregulated Surface Sources	Loads from Streambed Sediments	Spills	Scenario 1 240 pg/L	Scenario 2 310 pg/L	Scenario 3 640 pg/L		
Existing Conditions	0	0	0	0	0	100	100	14	669	329
Scenario 1 (≤10% Exceedance of 240 pg/L)	18	99	99	25	100	10	2	0	209	201
Scenario 2 (≤10% Exceedance of 310 pg/L)	_†	99	99	0	100	100	10	0	276	268
Scenario 3 (0% Exceedance of 640 pg/L)	_§	99	97	0	100	100	14	0	284	270

_† & _§   Reserve load from Town of Culpeper WWTP is 5% (scenario 2) and 118% (scenario 3) under what can be discharged and meet TMDL condition
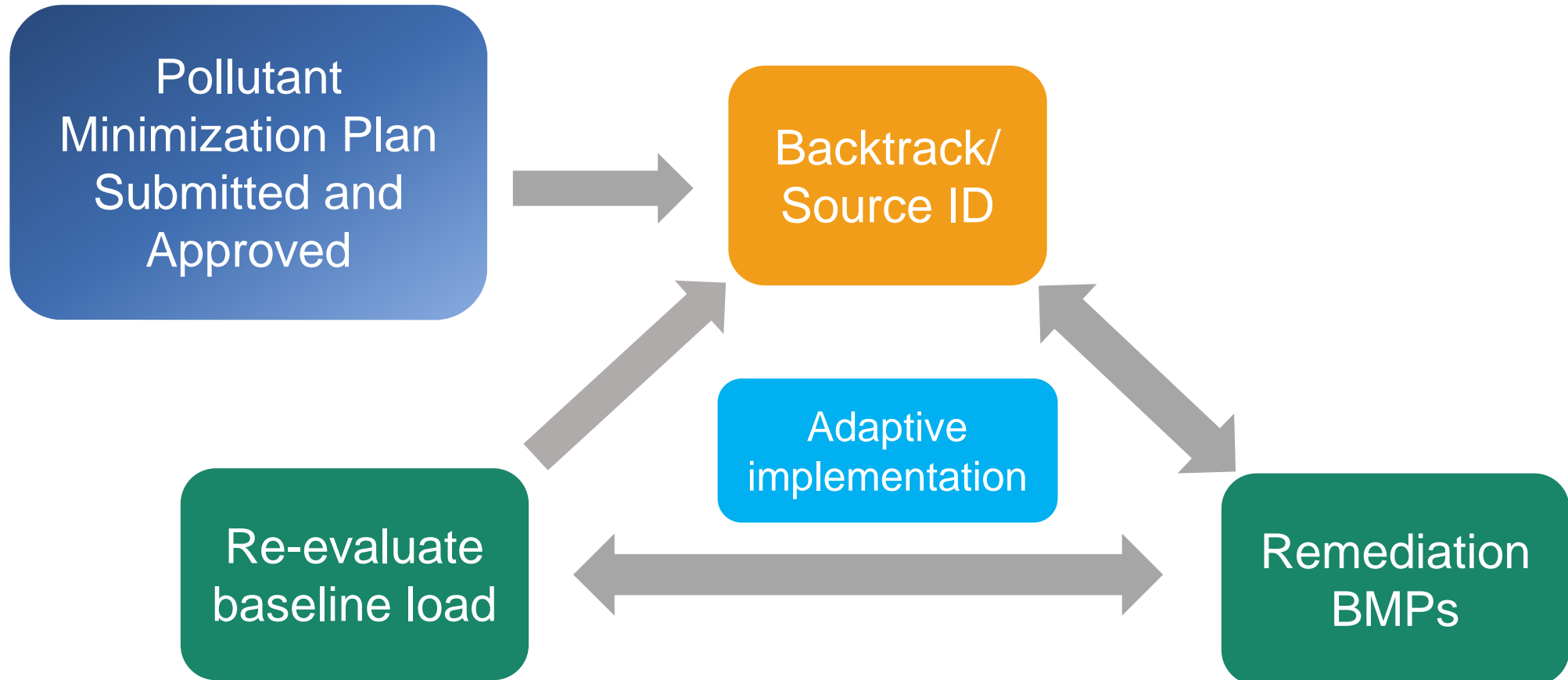
Mountain Run PCB Allocations (Proposed)

- Proposed scenario includes the revised (impending) application of the WQC
  - "Long Term Average" included in a footnote
- Continue to use the BAF derived scenario 2
  - TMDL Endpoint = 310 pg/L
- Incorporate within an appendix of the TMDL study report

| Allocation Scenario | Required PCB Loading Reductions to Meet the TMDL Endpoint (%) | | | | | Exceedance of 580 pg/L (%) | Daily Mean tPCB conc. (pg/L) | Daily Median tPCB conc. (pg/L) |
	Loads from Permitted Sources	Loads from Known Contaminated Sites	Loads from Nonregulated Surface Sources	Loads from Streambed Sediments	Spills			
Existing Conditions	0	0	0	0	0	14	669	329
Allocated Conditions*	-	99	55	0	100	12	440	294

DEQ

TMDL Implementation Process

Point sources

Nonpoint sources

Pollutant minimization plan (PMP)

Source "fingerprinting"

Targeted monitoring

Determine remedial program/funding

Detection of uncharacterized sources

Investigation of hotspots

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Developing a Pollutant Minimization Plan for PCBs

Pollutant Minimization Plan Submitted and Approved

Backtrack/ Source ID

Adaptive implementation

Re-evaluate baseline load
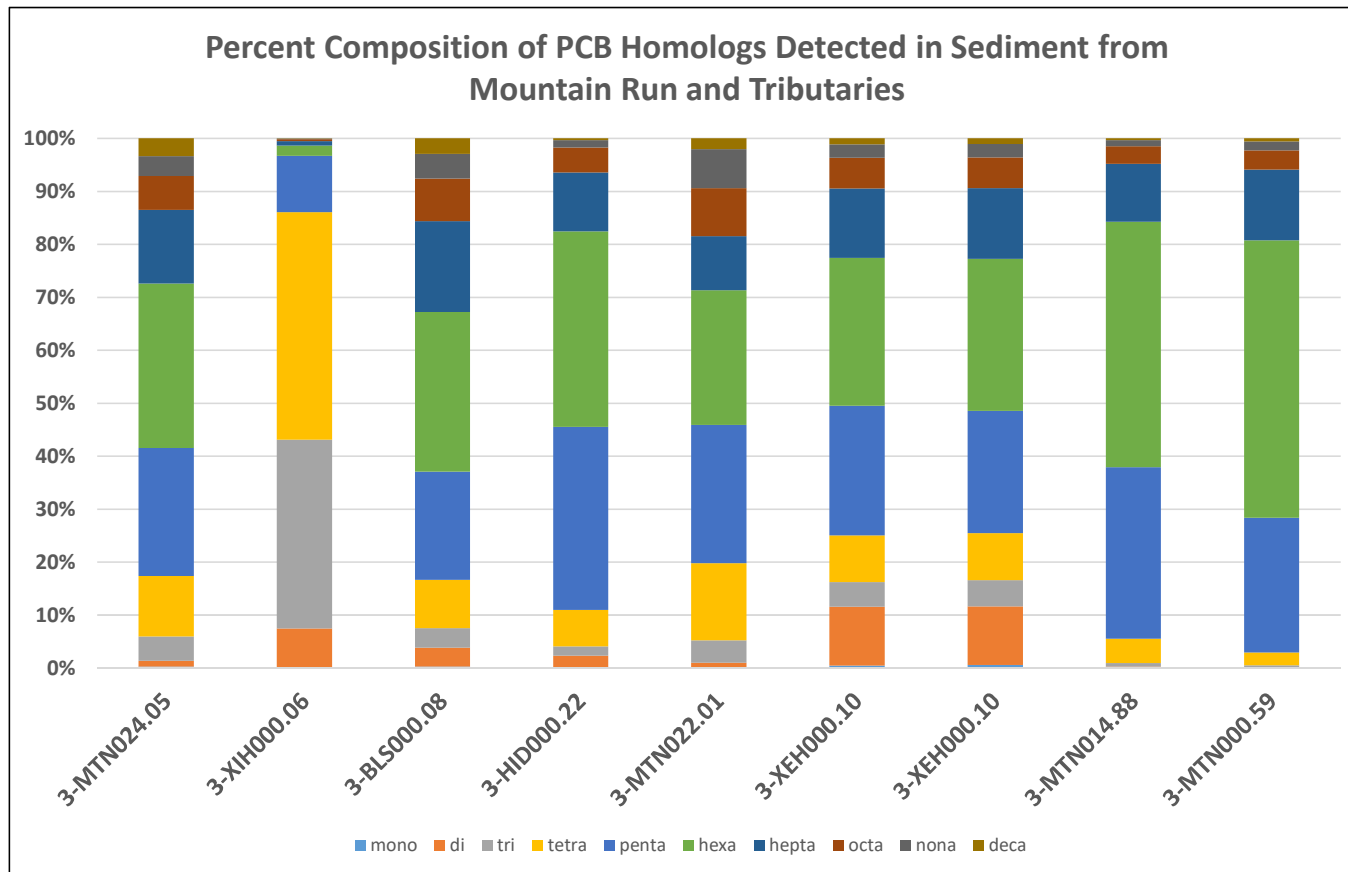
Remediation BMPs

Point Source/Nonpoint Source:

"Fingerprinting"
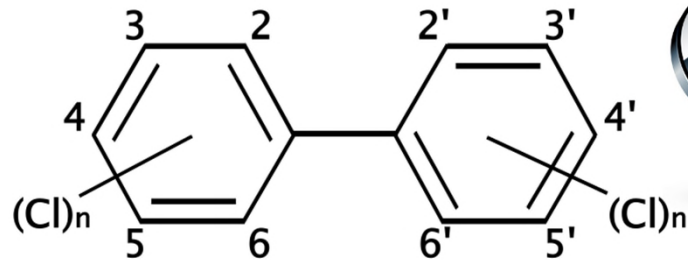
Objective: **To identify a specific pattern or "fingerprint" of congeners that could be indicative of a pollution source**

1. # of fingerprints in the system
2. Chemical composition in each fingerprint
3. contribution of each fingerprint in each sample

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Example "Fingerprint" for Sediment

Percent Composition of PCB Homologs Detected in Sediment from Mountain Run and Tributaries

Next Steps

- Finalize and share the draft TMDL study
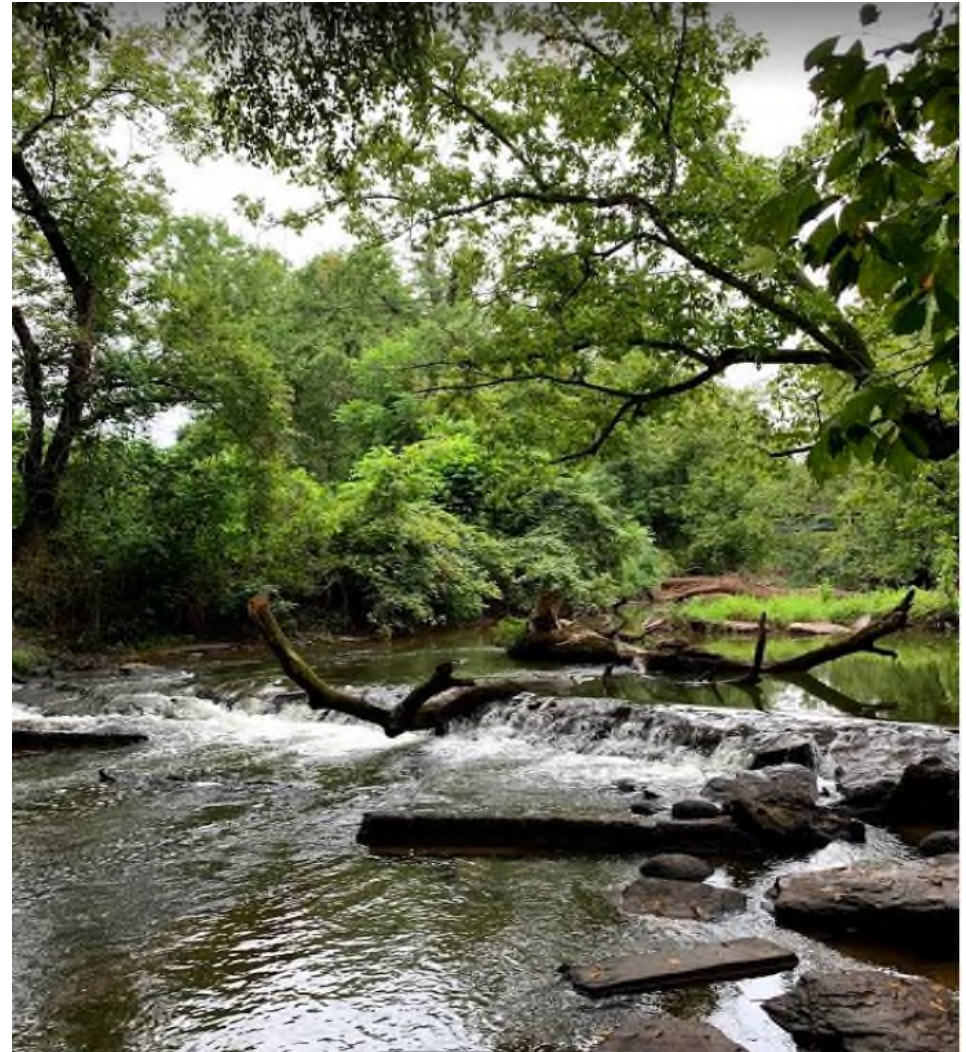- Final public meeting

Photo: October Greenfield, Friends of the Rappahannock

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Questions

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Photo: October Greenfield, Friends of the Rappahannock

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