Anacostia River Toxics TMDLs

Virtual Public Meeting

July 22, 2021

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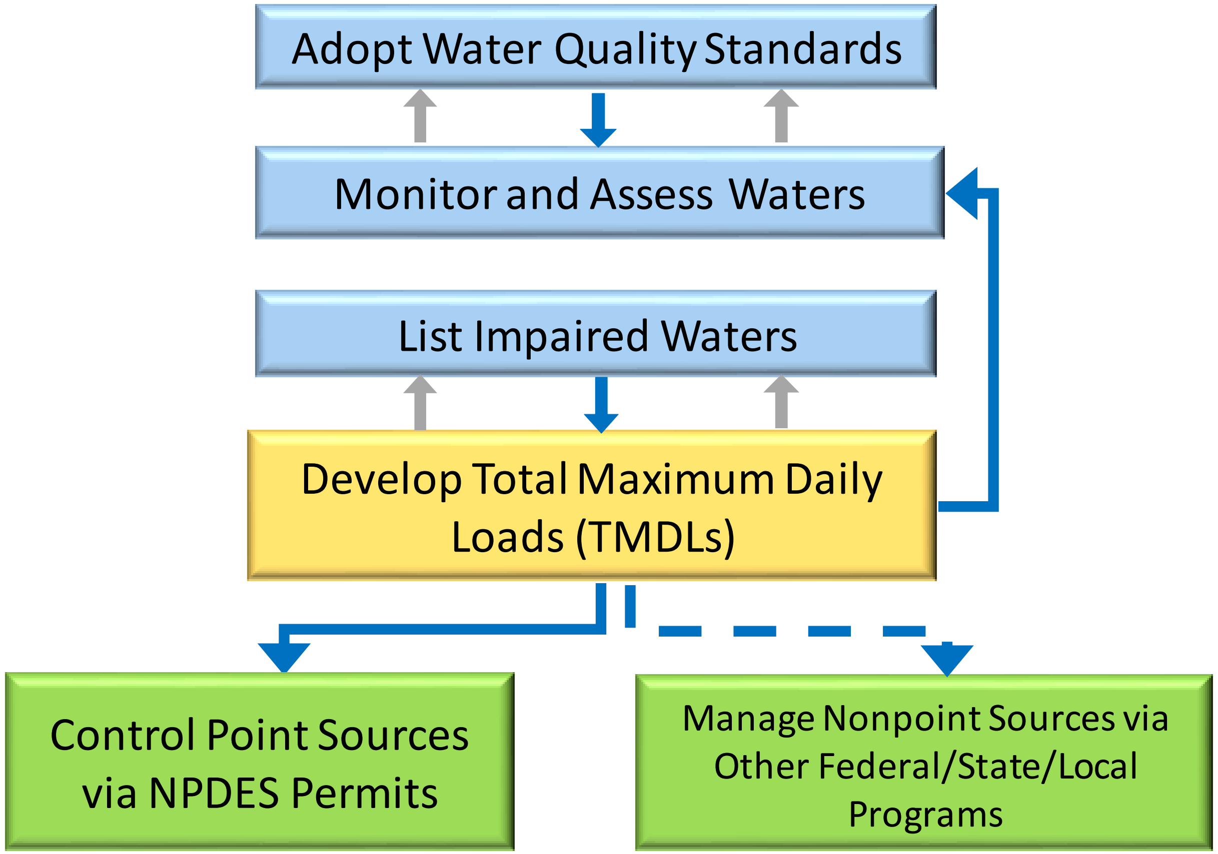
Presentation Overview

- Welcome
- Total Maximum Daily Load (TMDL) Program
- Anacostia River Toxics History and Impairment
- TMDL Endpoints
- Modeling Approach
- Allocations and Other TMDL Components
- Feedback and Questions

Welcome

- Presenter introductions
- Virtual presentation logistics

Clean Water Act Framework



What is a Total Maximum Daily Load?

- The calculation of the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards (WQS).
- Required under Section 303(d) of the Clean Water Act.
- TMDL = ΣWLA + ΣLA + MOS
  - WLA = Wasteload Allocation to point sources
  - LA = Load Allocation to nonpoint sources
  - MOS = Margin of Safety

Hint: Σ is a mathematical symbol meaning "sum of"

Utility of a TMDL

- Planning tool for achieving water quality standards
- Integrates water quality information and pollutant sources
- Analytic underpinning for watershed decisions
- Present opportunities for stakeholder involvement and collaboration amongst multiple stakeholders

Anacostia River Toxics TMDLs

2003
Toxic pollutant TMDLs developed by DC and approved by EPA

2009
DC TMDLs challenged because loads were not expressed in daily terms

2010
Court vacated EPA's approval but stayed vacatur

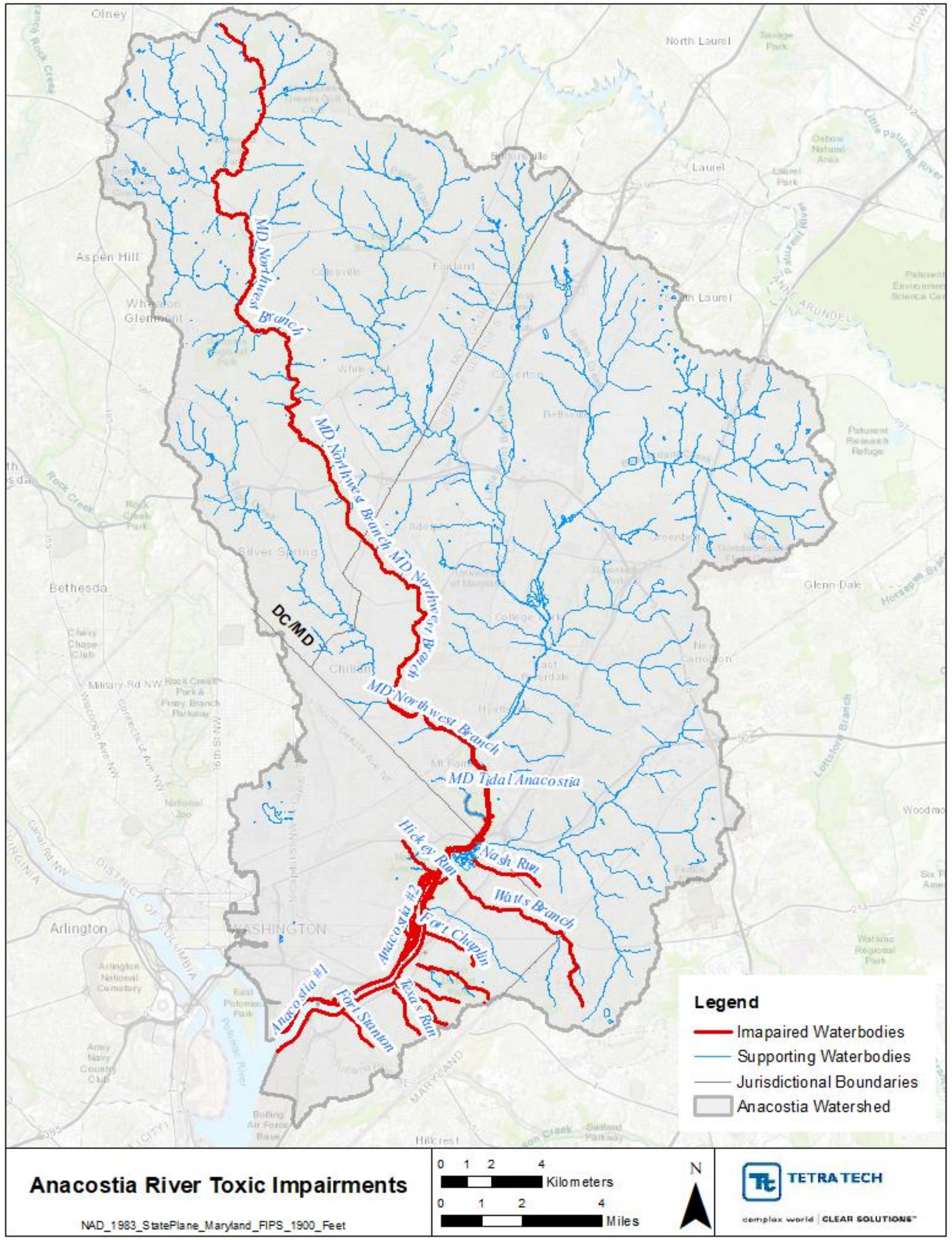
2014
Large monitoring dataset made available by DOEE's ongoing Remedial Investigation

2021
Replacement TMDLs will be submitted by DOEE

Current Toxic Impairments

Segment	Jurisdiction	Arsenic	Copper	Zinc	4,4 DDD	4,4 DDE	4,4 DDT	Chlordane	Dieldrin	Heptachlor epoxide	PAHs
Anacostia #1	DC	•	•	•	•	•	•	•	•	•	•
Anacostia #2	DC	•	•	•	•	•	•	•	•	•	•
Kingman Lake	DC	•					•	•			•
Nash Run	DC	•						•	•	•	•
Popes Branch	DC					•		•		•	•
Watts Branch	DC							•	•		
Hickey Run	DC					•		•			•
Fort Dupont Creek	DC	•									
Fort Chaplin Run	DC	•									
Fort Davis Tributary	DC	•									
Fort Stanton Tributary	DC	•									•
Texas Avenue Tributary	DC	•			•	•	•	•	•	•	•
MD-ANATF	MD									•	
Northwest Branch	MD									•	

Extent of Impairment



Toxic Pollutants

Metals

- Arsenic, copper, zinc
- Occur naturally but contamination occurs through anthropogenic activities
- Exposure to high doses can be harmful
- Collect in sediment and accumulate in aquatic plants and animals

Organochlorine Pesticides

- Chlordane, DDT (DDD and DDE), dieldrin, heptachlor epoxide
- Banned by EPA or withdrawn by U.S. manufacturers
- Wide variety of harmful effects on humans and aquatic life
- Persistent in the environment
- Resistant to degradation and accumulate in sediment and animal tissue

PAHs

- Grouped as PAH 1, PAH 2, PAH 3
- From incomplete combustion of gas, oil, coal, wood, trash, or other organic substances
- Often exist in complex mixtures
- Wide variety of harmful effects on humans and aquatic life
- Sorb to sediment particles, settling to the river or stream bottom

Applicable Water Quality Criteria

- Water column criteria (to protect aquatic life and/or human consumption of fish) are available for all of the TMDL pollutants
  - DOEE adopted EPA's updated criteria recommendations for many of these pollutants in 2020
- All applicable numeric and narrative criteria and/or listing thresholds (water column, fish tissue, sediment) were reviewed for use as TMDL endpoints

TMDL Endpoints

- At what pollutant concentration will water quality be met?
- Selected TMDL endpoints highlighted yellow.
- Some pollutants were grouped due to chemical similarities.
- The final TMDLs will be protective of all applicable water quality standards.

Pollutant Group	Pollutant		Chronic Aquatic Life (µg/L)	Acute Aquatic Life (µg/L)	Human Health (µg/L)	Fish Tissue (mg/kg)
Metals (µg/L)	Arsenic, dissolved		150	340	0.14	-
	Copper, dissolved		8.96	13.44	-	-
	Zinc, dissolved		118.14	117.18	26000	-
Organochlorine Pesticides (µg/L)	DDT	4,4 DDD	0.001	1.1	0.00012	-
		4,4 DDE	0.001	1.1	0.000018	-
		4,4 DDT	0.001	1.1	0.00003	-
	Chlordane		0.0043	2.4	0.00032	-
	Dieldrin		0.056	0.24	0.0000012	-
	Heptachlor epoxide		0.0038	0.52	0.000032	0.00934
PAH1 (2 + 3 ring) (µg/L)	Acenaphthene		50	-	90	-
	Anthracene		-	-	400	-
	Fluorene		-	-	70	-
	Napthalene		600	-	-	-
PAH2 (4 ring) (µg/L)	Benzo[a]anthracene		-	-	0.0013	-
	Chrysene		-	-	0.13	-
	Fluoranthene		400	-	20	-
	Pyrene		-	-	30	-
PAH3 (5 + 6 ring) (µg/L)	Benzo[a]pyrene		-	-	0.00013	-
	Benzo[b]fluoranthene		-	-	0.0013	-
	Benzo[k]fluoranthene		-	-	0.013	-
	Dibenzo[a,h]anthracene		-	-	0.00013	-
	Indeno[1,2,3-c,d]pyrene		-	-	0.0013	-

Sources of Toxic Pollutants: DC

Point Sources

- Municipal Separate Storm Sewer System (MS4)
- Multi-sector General Permit (MSGP)
- Combined Sewer System (CSS)
- Individual NPDES permits
  - Washington Navy Yard
  - Pepco Environment Management Services
  - Super Concrete
  - Blue Plains Wastewater Treatment Plant

Nonpoint Sources

- Contaminated Sites
- Maryland upstream loads
  - Presented for all DC pollutants for which MD does not have impairment listings

Sources of Toxic Pollutants: MD

Point Sources

- NPDES Regulated Stormwater
  - All NPDES stormwater permittees are presented as an aggregate under the Phase I MS4 counties

Nonpoint Sources

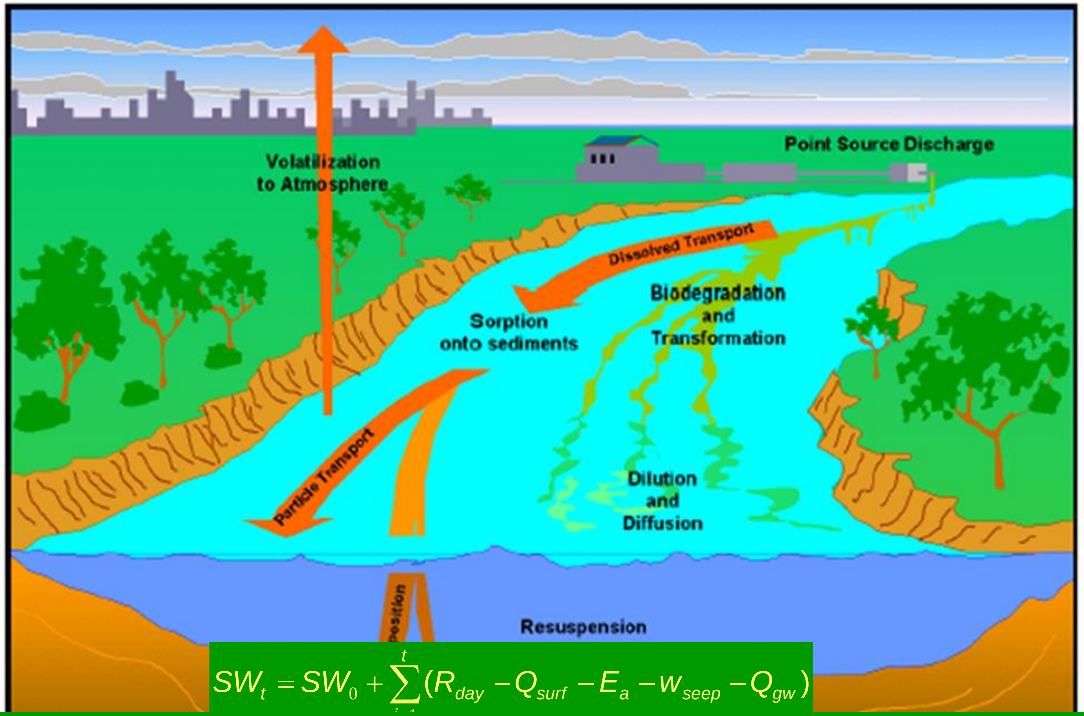
- Non-regulated watershed runoff
  - Non-urbanized areas (i.e., primarily forest) of the watershed

Other Potential Sources of Toxic Pollutants

- Atmospheric deposition
  - Included as a pollutant loading pathway to surface and groundwater simulated in the watershed model
  - Other greater sources of toxic pollutants in the watershed
- Resuspension and diffusion from bed sediments
  - Model simulated conditions within the water column and sediment as a single system
  - Considered an internal load

Modeling Approach: Concepts

- Environmental simulation models are simplified mathematical representations of complex real-world systems
- Models use known interrelationships among variables to predict change in response to a varying forcing function (e.g., weather, tides)
- Models should demonstrate ability to represent real-world conditions (calibration, validation)



$$SW_t = SW_0 + \sum^{t}(R_{day} - Q_{surf} - E_a - w_{seep} - Q_{gw})$$

$$sed = 11.8 \cdot (Q_{surf} \cdot q_{peak} \cdot area_{hru})^{0.56} \cdot K \cdot C \cdot P \cdot LS \cdot CFRG$$

Modeling Approach: Types of Models

Landscape Loading / Watershed Models	• Runoff of water and dissolved materials on and through the land surface • Erosion of sediment and associated constituents from the land surface
Receiving Water Models	• Flow of water through streams and into lakes and estuaries • Transport, deposition, and transformation in receiving waters
Linked Models	• Combination of landscape and receiving water models

Modeling Approach: Model Selection for Anacostia Toxics TMDL

- Conducted a Model Selection Process
- Determined a linked watershed/receiving water model is best suited to capture critical Anacostia River characteristics
- Linked model represents connections between watershed sources, legacy riverbed contamination, and impact of the Potomac River
- Also enabled nontidal contaminant sources to be characterized using site-specific data, when available

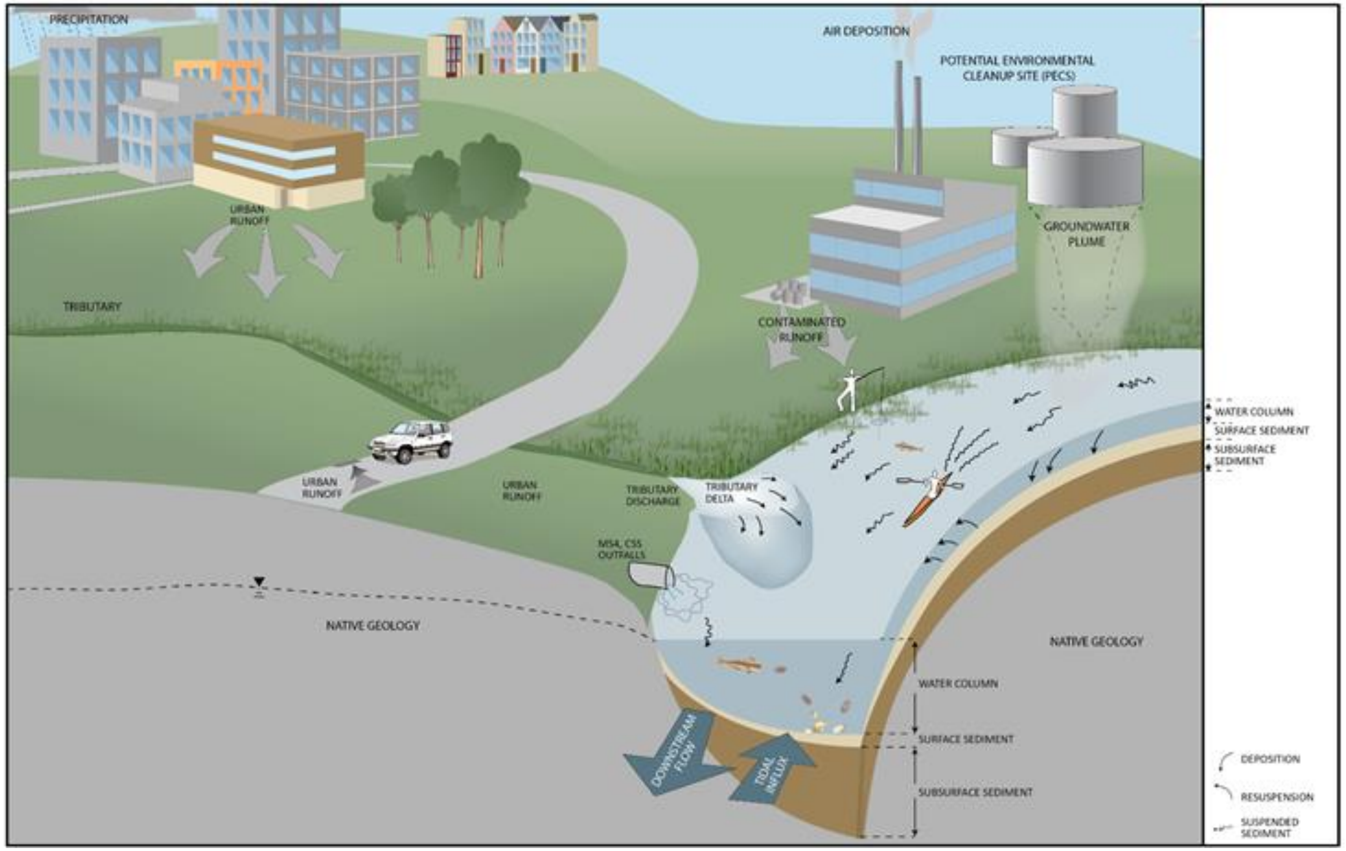
Modeling Approach: Model Development

- The Anacostia Remedial Investigation (RI) model system (Anacostia River Sediment Project model (ARSP)) served as a starting point for the development of the Anacostia River Toxics TMDL model
  - LSPC - watershed model
  - EFDC - receiving water model
- The RI model system calibrated and validated for simulation of:
  - Hydrology
  - Hydrodynamics
  - Sediment loading and transport
  - Loading of select priority pollutants
- The TMDL model adapted to add the 10 TMDL pollutant parameters.

Modeling Approach: Toxic Pollutant Sources

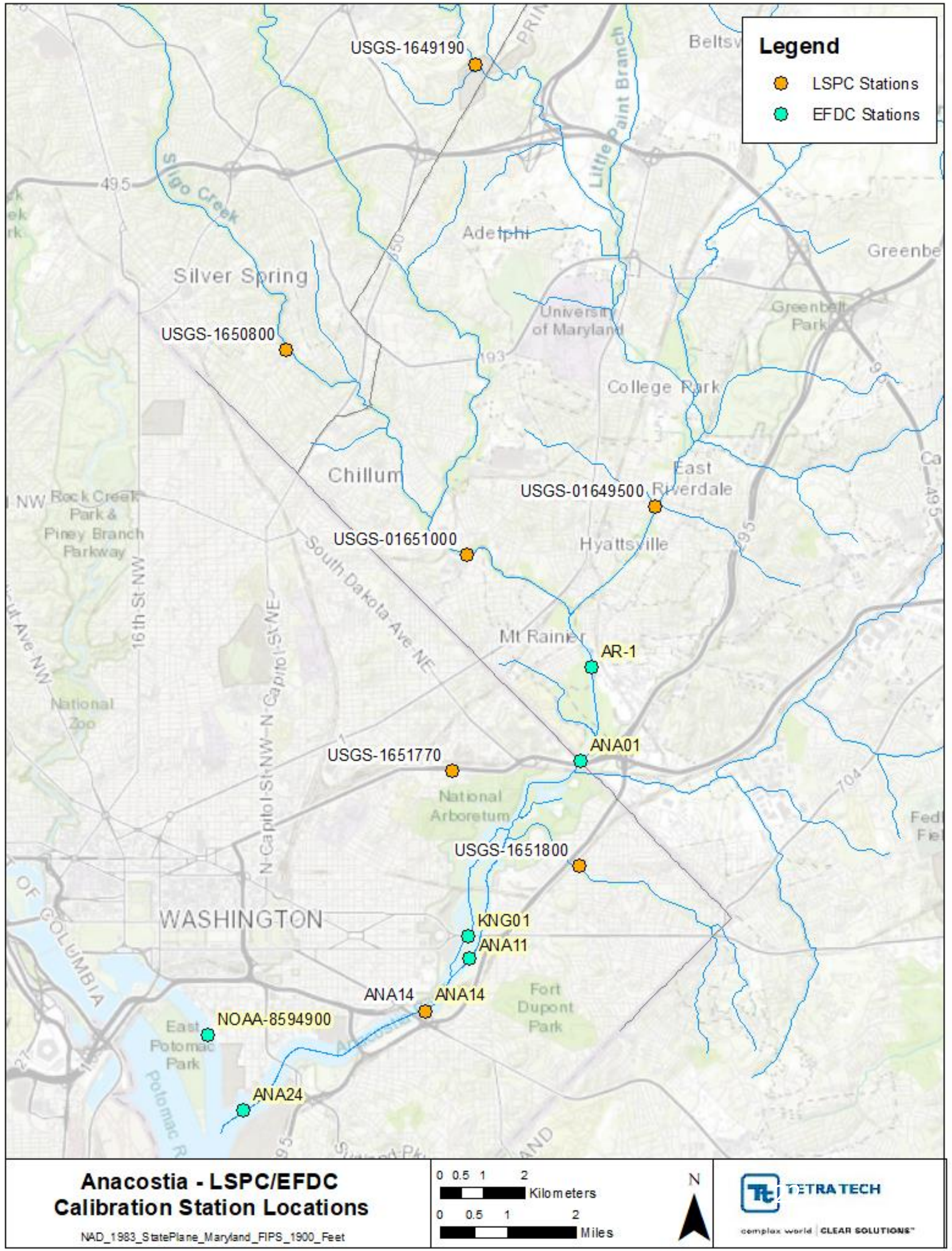
Used site-specific data characterize sources/pathways, including:

- Stormwater/surface runoff from various landuses (of solids and pollutants)
- Atmospheric deposition
- Spills and/or leaks from contaminated sites and industrial operations
- Legacy contaminants of concern in bed sediments of the Anacostia River
- Groundwater contributions to streams and the Anacostia River directly
- Point source discharges:
  - Individually permitted wastewater National Pollution Discharge Elimination System (NPDES) dischargers
  - MSGP
  - MS4 dischargers
  - Combined Sewer Overflows (CSOs)



Model Calibration

- Model calibration involves evaluation of the predictive capability of model results with observed data (in order)
  - Streamflow and water surface elevation (USGS, NOAA)
  - Sediment concentration/load (USGS, ICPRB, DOEE)
  - Toxic constituent concentration/load (USGS, DOEE)
- Data availability governs the time period for calibration
- Model results were visually and statistically compared with observed data collected during the 2014 – 2017 time period
- Watershed model (LSPC) calibrated first at 7 locations, tidal model (EFDC) calibrated second at 6 locations



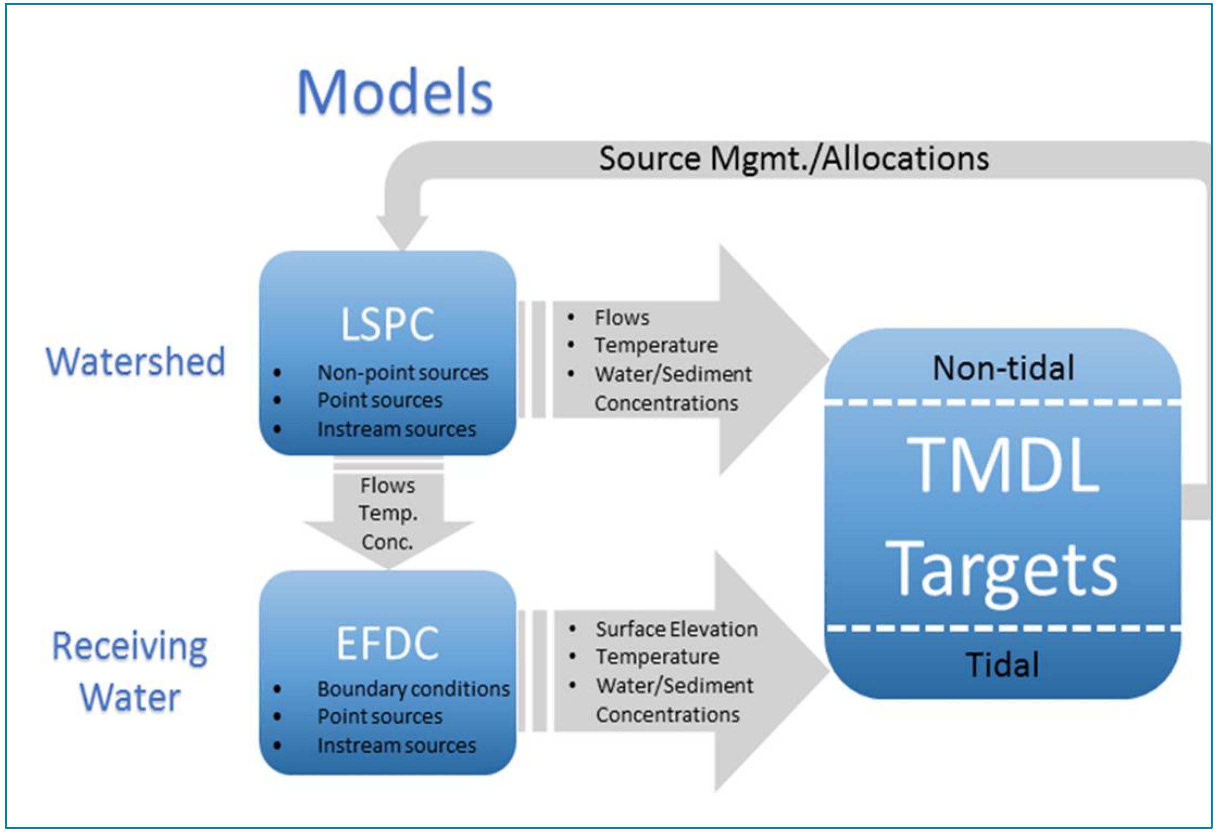
Modeling Approach: Application in TMDL Calculation

Watershed Model – LSPC (non-tidal) applies watershed characteristics and weather data to simulate:

- Land-based processes:
  - Rainfall and hydrologic processes
  - Water temperature
  - Pollutant loading (build-up wash-off)
- (Simple) instream processes:
  - Hydraulics, sediment, and pollutant fate and transport

Receiving Water Model – EFDC (tidal) applies waterbody characteristics and boundary conditions (watershed input, other stream input, weather, point sources) to simulate detailed instream:

- Hydrodynamics (circulation, temperature
- Sediment and pollutant fate and transport
- Pollutant kinetics



Baseline Scenario

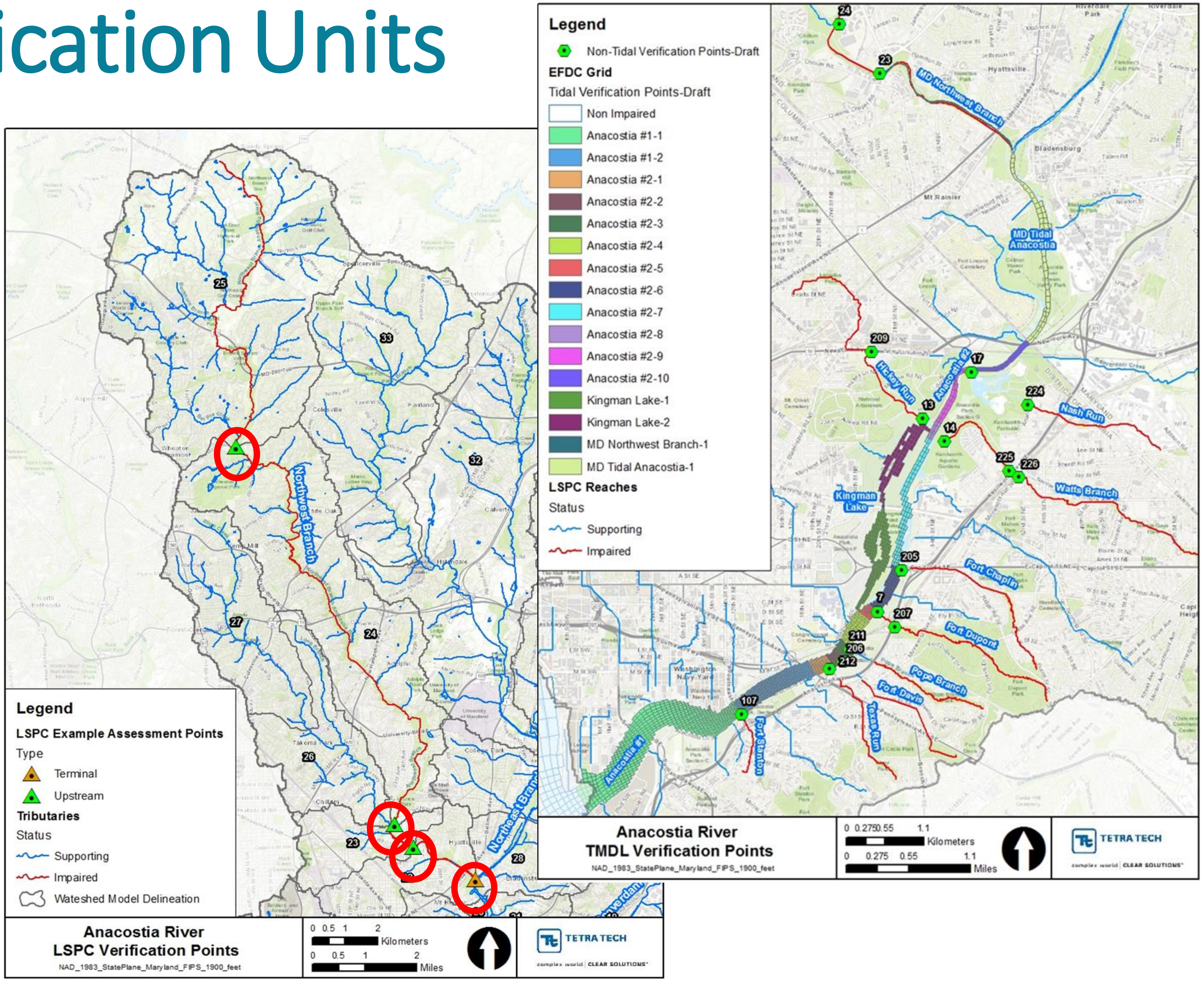
- Corresponds to existing conditions
- Sources are represented at current levels
- TMDL reductions are based on this starting point

TMDL Scenario

- TMDL allocations are identified through a process of reducing modeled pollutant loads in order to achieve the applicable TMDL endpoints
- The TMDL allocation scenario was developed through an iterative process
  - Implemented initial watershed reductions until endpoints were met in the non-tidal tributaries
  - Evaluated whether watershed reductions were sufficient to meet the endpoints in the tidal portions of Anacostia River
  - Implemented additional reductions where necessary, re-evaluated, and so on

TMDL Scenario: Verification Units

- Compliance with TMDL endpoints was checked at specific points to determine adequacy of reductions
- LSPC – checked at each pourpoint
- EFDC – checked at 16 tidal segments



TMDL Scenario: Reduction Process

Watershed Reductions

- NPDES point source discharges lacking DMR data set to criteria
- Watershed loadings were reduced on a land use basis in each subwatershed using top-down approach (ranged from 50 – 99%, except for PAH1)
- If landuse reductions were insufficient to meet the end points, streambed sediment toxic constituent concentrations were reduced universally for the entire watershed

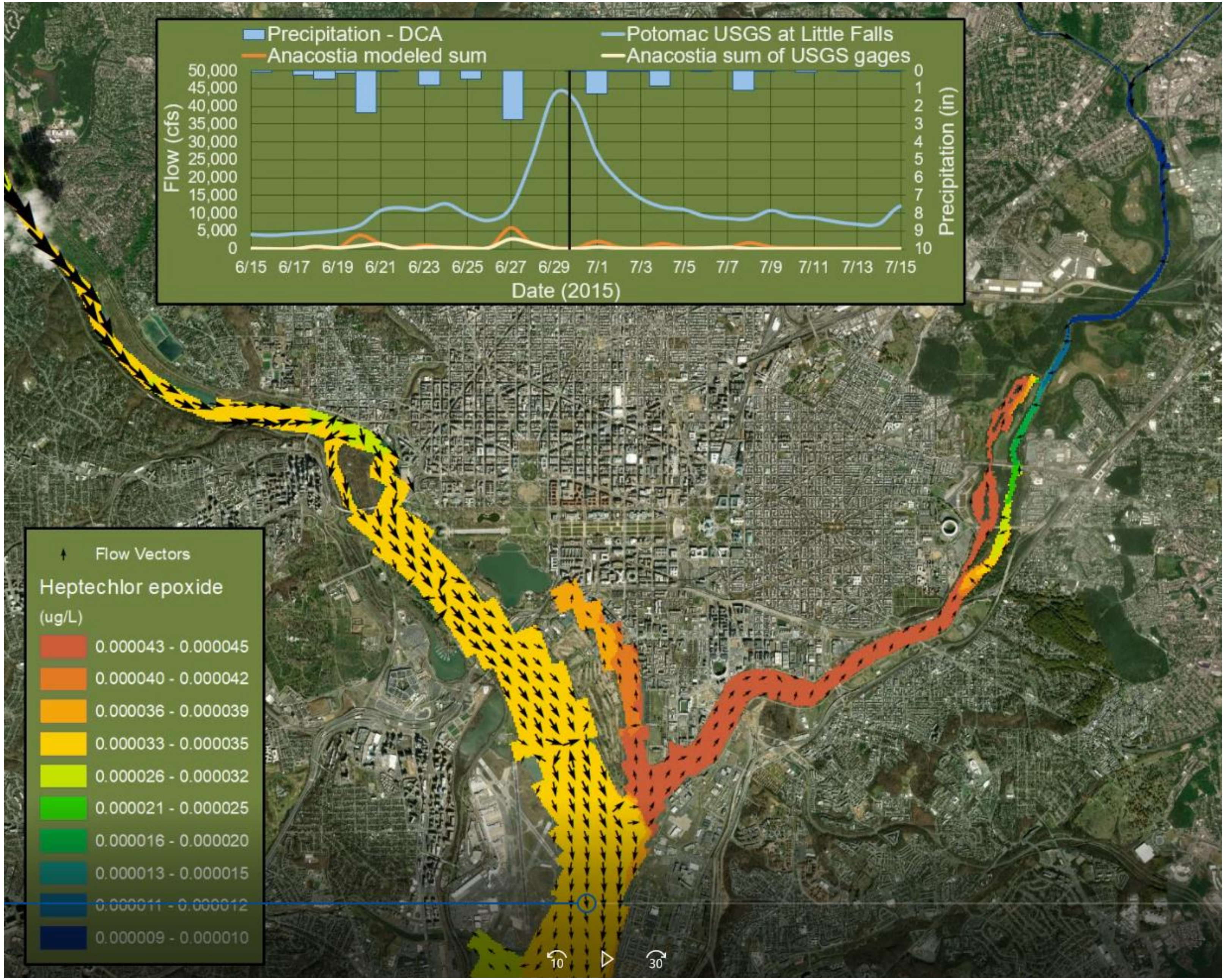
Tidal Anacostia River Evaluation

- Applied EFDC to evaluate impacts of initial watershed reductions on tidal areas
- Endpoints for 8 pollutants were <u>not</u> met under certain wet and dry conditions
  - Bed sediment a source during dry conditions, Potomac influence during wet conditions

TMDL Scenario: Evaluating Tidal Portions

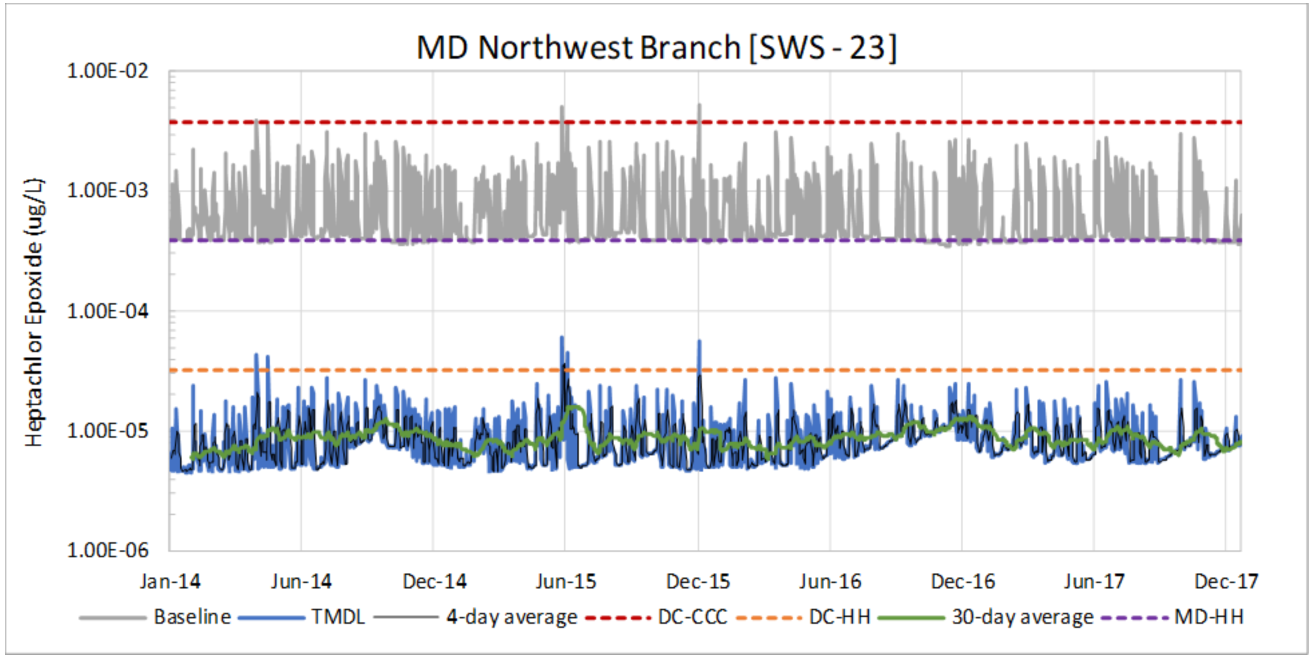
Analysis

- Flows and pollutants can persist in downstream areas
- Due to deeper bathymetry downstream, and influence of Potomac River relative to upstream verification units

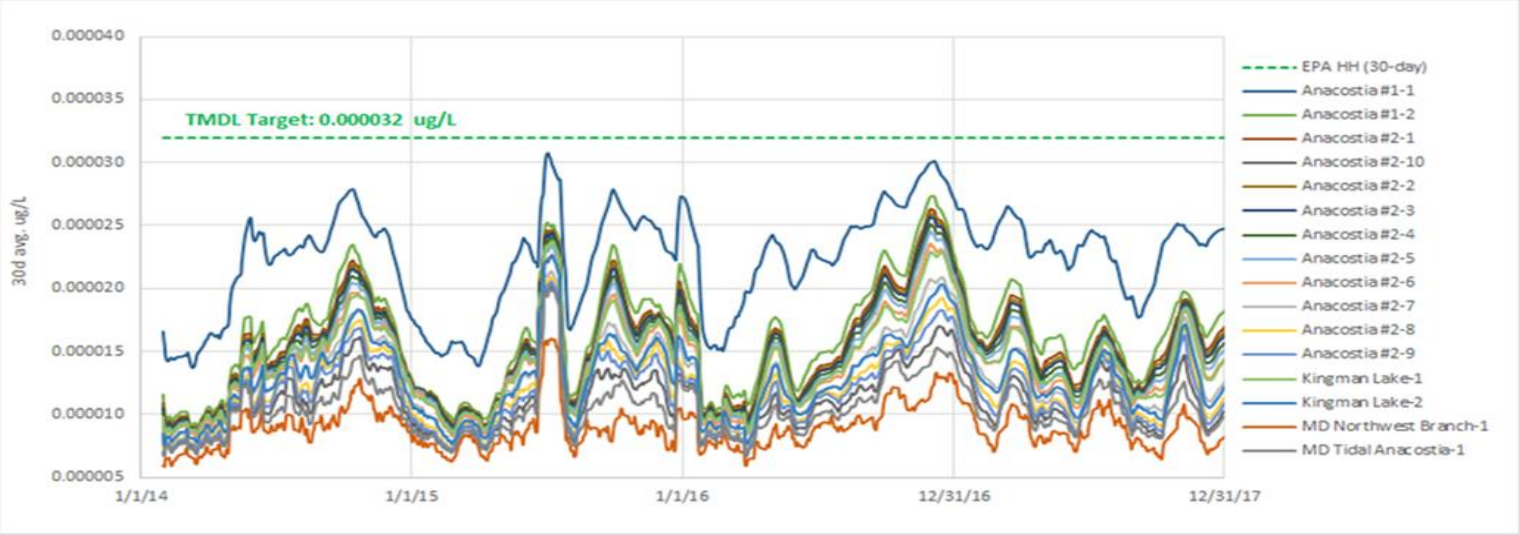


TMDL Scenario:
Additional Reductions

Wet Conditions
- Additional watershed reductions implemented
- Additional reductions were evaluated in EFDC to ensure endpoint attainment during wet conditions



Dry Conditions
- Bed sediment contamination acts as a source to water column during dry periods
- Bed sediment concentrations were reduced until endpoints in water column were met



TMDL Final Watershed Reduction Percentages

Contaminant	Range of urban land use reductions required	Range of agricultural land use reductions required	Universal bed sediment reductions
Arsenic	0 – 99.98%	0%	—
Chlordane	81.07 – 99.77%	0%	—
Copper	0 – 99%	0%	—
DDT	87.69 – 99.85%	0%	—
Dieldrin	100%	0 – 100%	90%
Heptachlor epoxide	85 – 99.9%	0%	—
PAH1	0%	0%	—
PAH2	0 – 100%	0 – 99.25%	80%
PAH3	100%	0 – 87%	98%
Zinc	0 – 84%	0%	—

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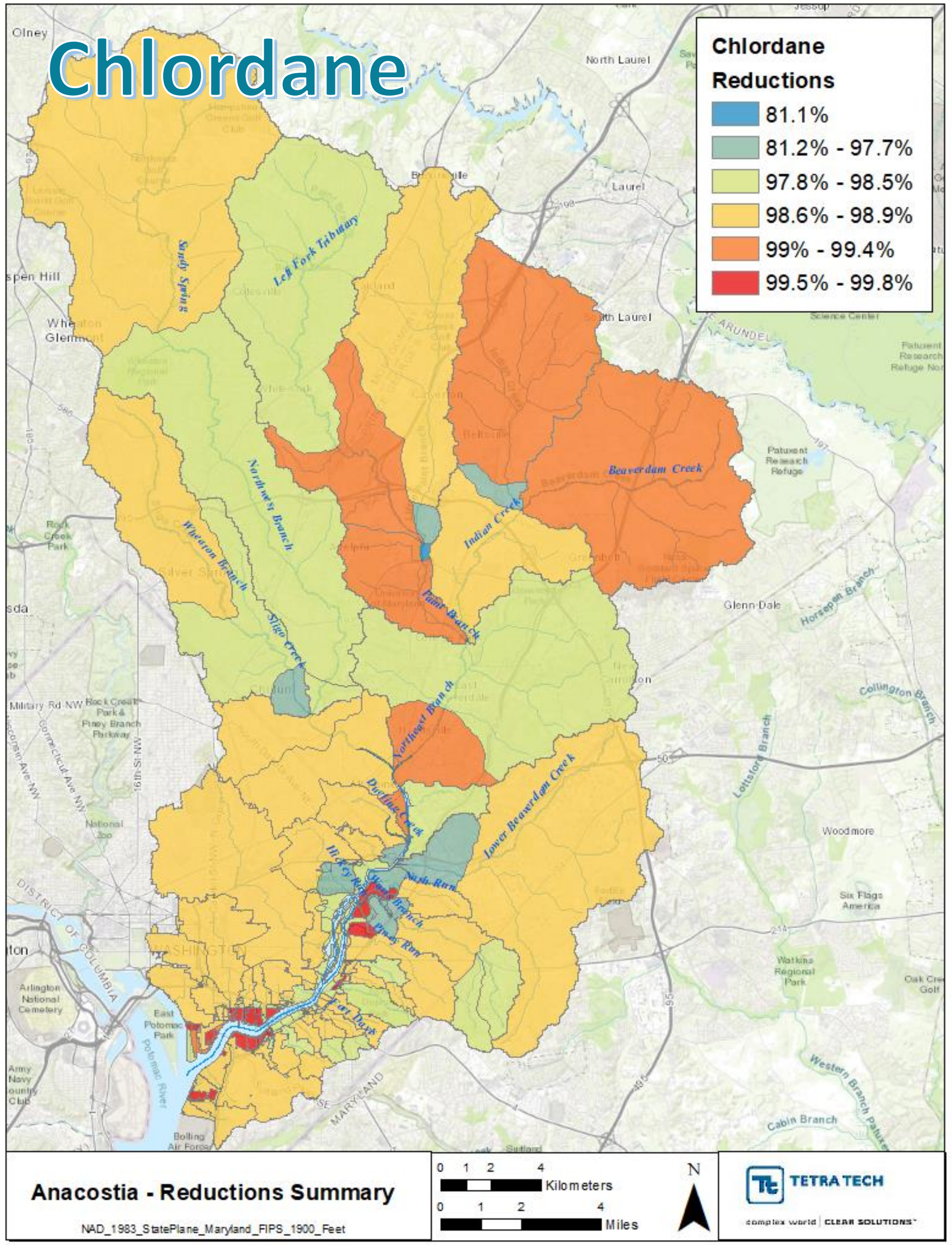
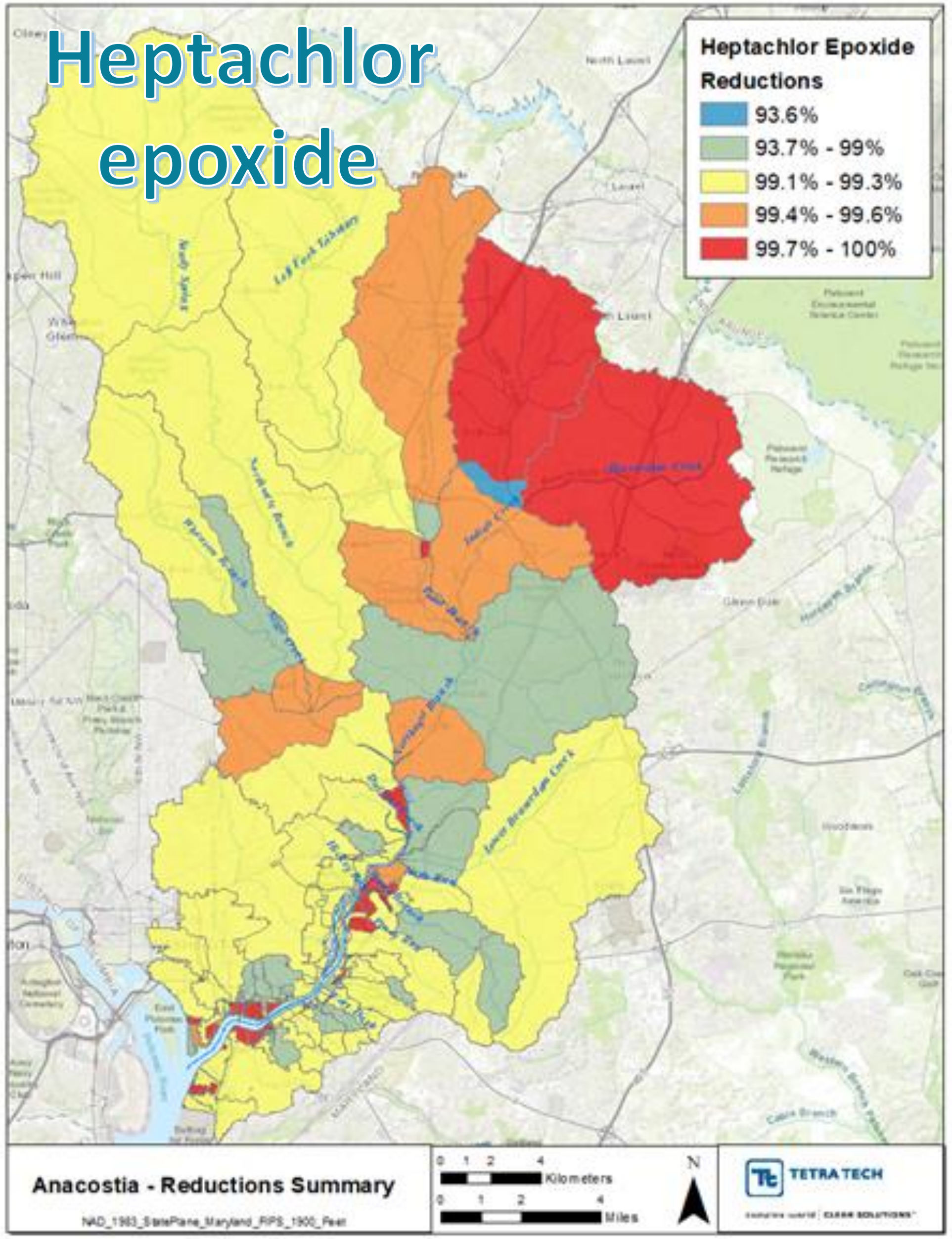




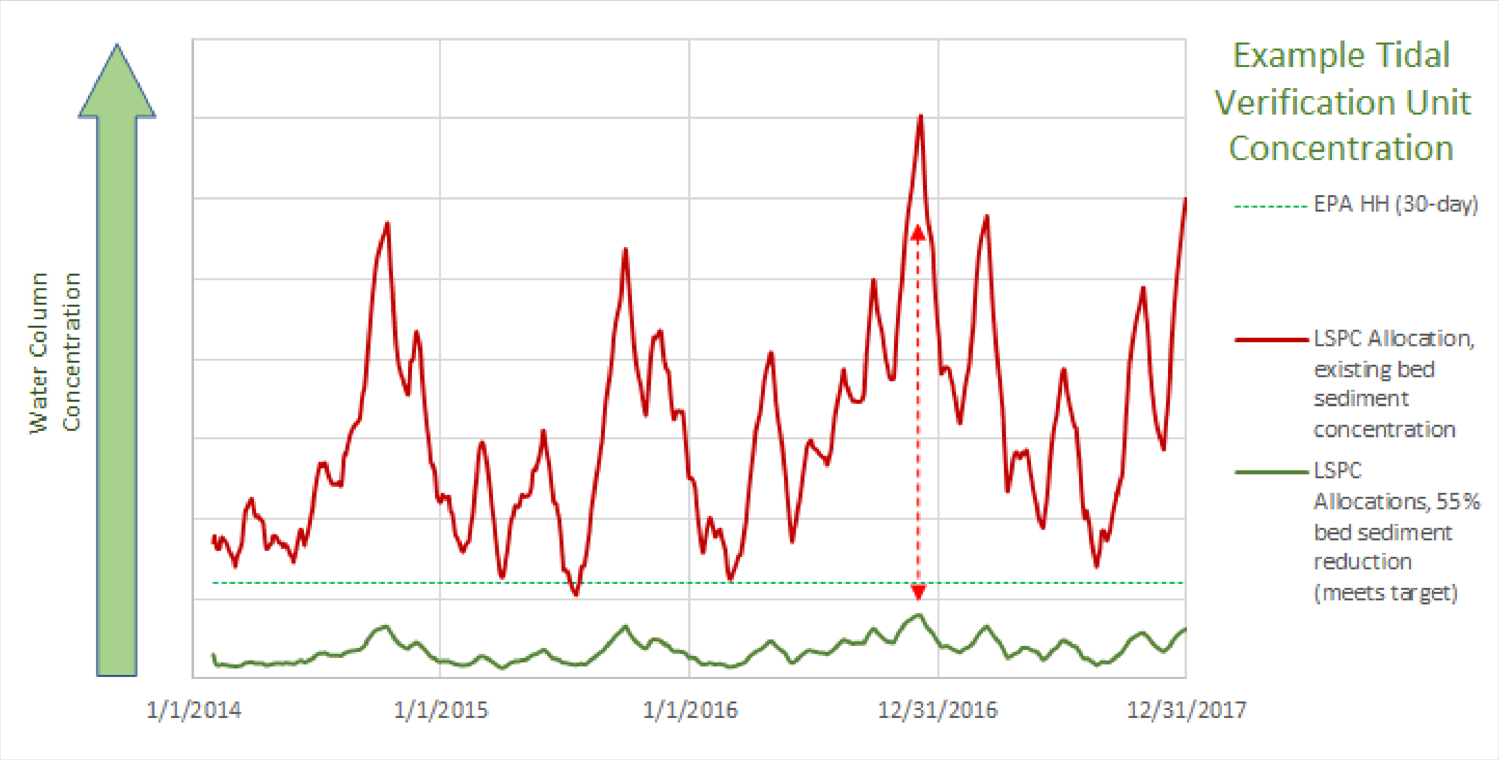
TMDL: Natural Attenuation

Natural Attenuation

The process by which contaminants in soil and groundwater decrease in concentration by various means and without human intervention (e.g., sorption and burial by overlying clean sediment).

- Load allocations to bed sediment are not prescribed in the TMDL as natural attenuation is the mechanism that will achieve the prescribed bed sediment reductions over time
- Applied the model framework to verify that natural attenuation can be expected to result in attaining endpoints over time due to ongoing contaminant flux
- Model analysis estimated the time needed for existing bed sediment pollutant concentrations to decrease to the level necessary to support meeting TMDL targets in the water column after the reductions to the watershed loads

TMDL: Natural Attenuation Analysis



ID Bed sediment targets for each VU

- Target is the required overall percent bed sediment reduction identified during the allocation analysis
- E.g., If required reduction is 55%, bed sediment target is 55% lower than existing bed sediment concentrations
- Calculate area-weighted average bed sediment concentration by verification unit for the allocation scenario using bed sediment concentrations from the beginning of the model period

Run Trend Analysis Scenario

- Apply existing bed sediment concentrations to the allocation scenario and run EFDC
- Analyze trends in bed concentrations over the 4 yr period

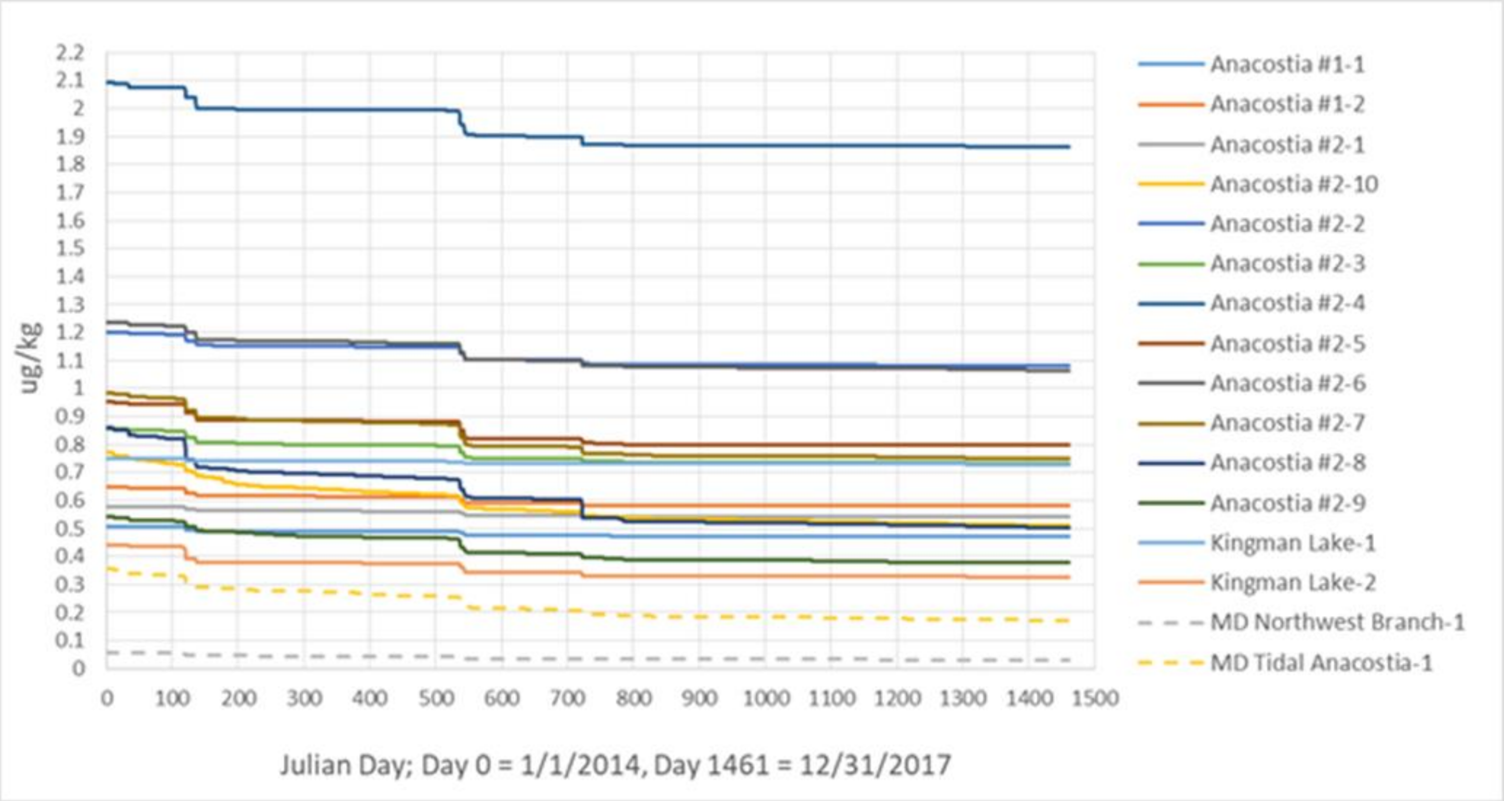
Extrapolate Future Bed Sediment Concentrations

- From trend analysis identify bed sediment concentration changes from the beginning of the 4-year simulation to the end.
- Using linear regression, extrapolate future bed sediment concentrations forward in time

Calculate Time Required for Attenuation to Targets

- For each VU
- Calculate time required to reach desired sediment concentrations

TMDL: Natural Attenuation Analysis



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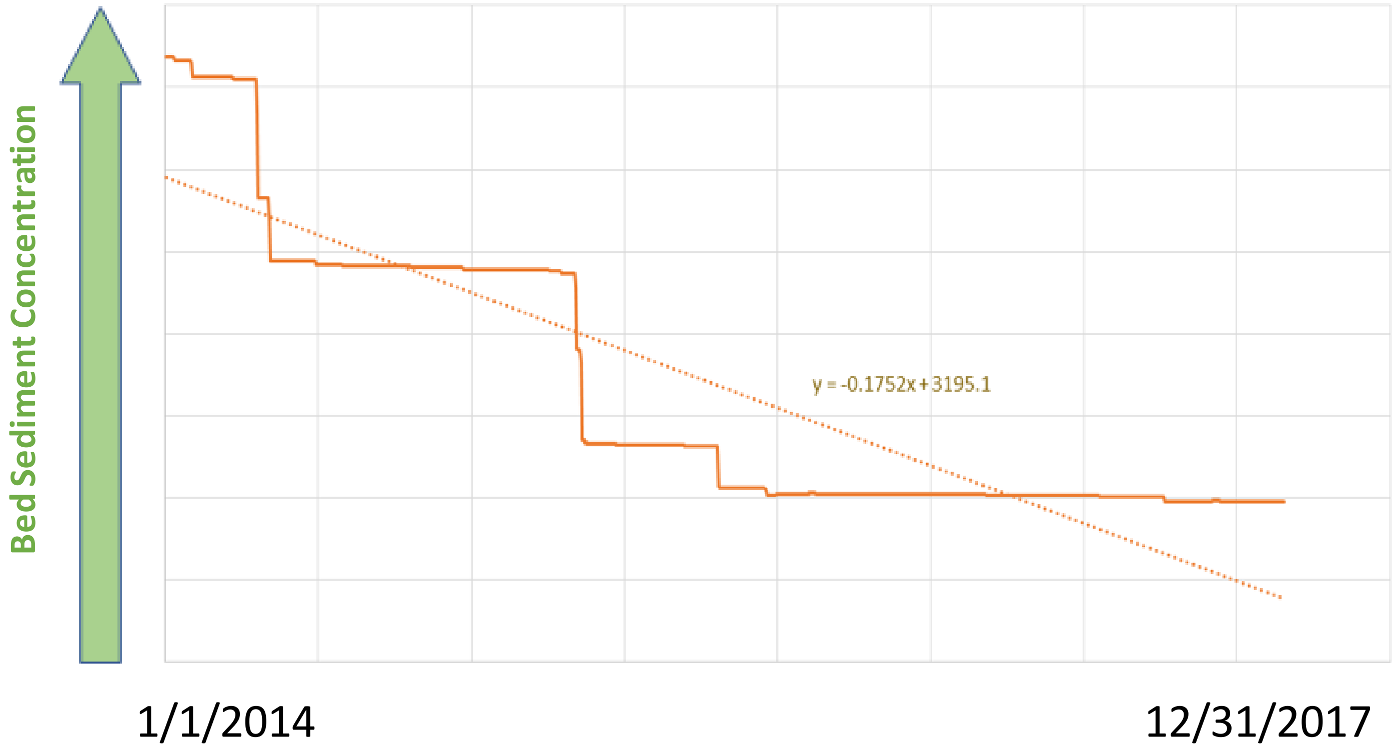

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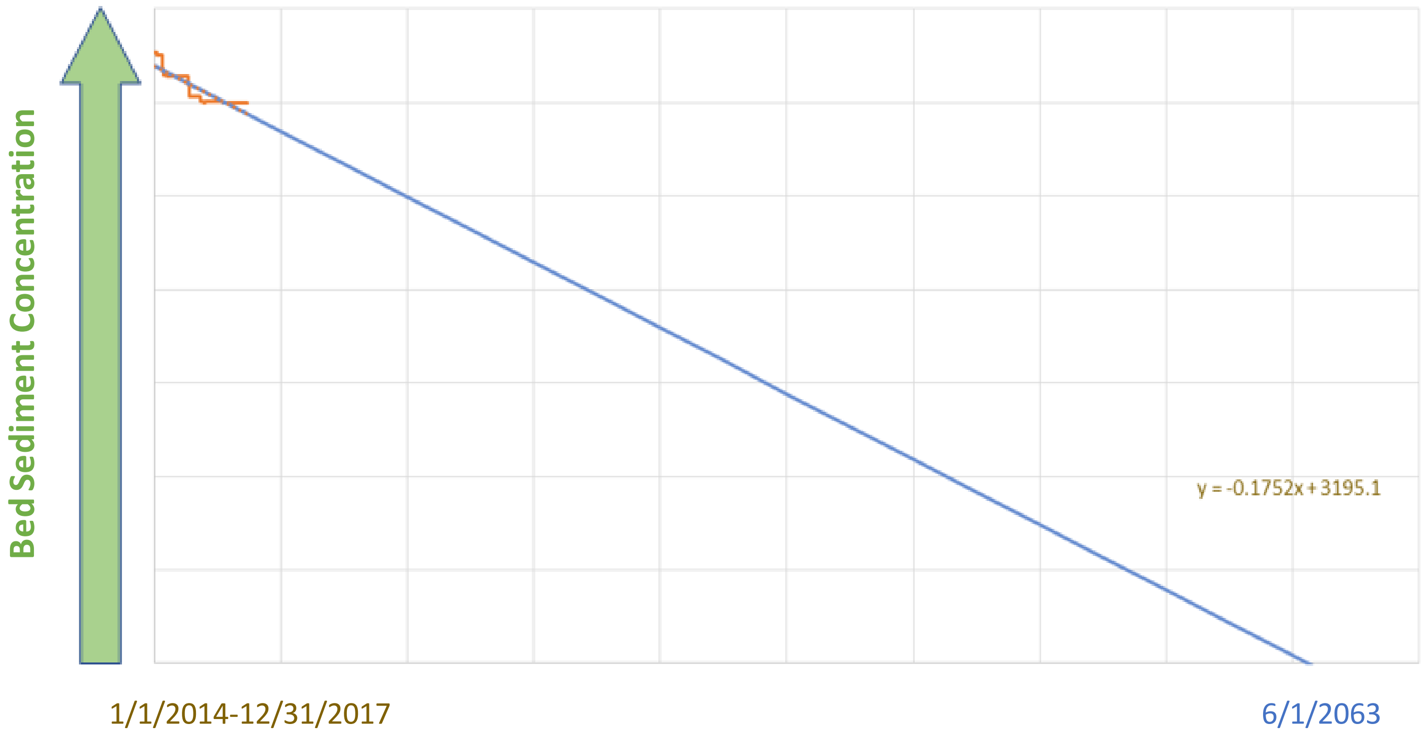

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TMDL: Natural Attenuation Analysis

Verification Unit	Linear regression equation	Date achieved	Achievement (years)
Anacostia #1-1	y = -0.0789x + 2265.8	8/16/2092	79
Anacostia #1-2	y = -0.1752x + 3195.1	12/6/2063	50
Anacostia #2-1	y = -0.1293x + 3270.3	4/1/2083	69
Anacostia #2-10	y = -0.493x + 2269.3	8/9/2026	13
Anacostia #2-2	y = -0.3094x + 5223.4	3/22/2060	46
Anacostia #2-3	y = -0.4056x + 4894.5	1/15/2047	33
Anacostia #2-4	y = -0.2289x + 2883.2	6/26/2048	35
Anacostia #2-5	y = -0.3251x + 3814	2/13/2046	32
Anacostia #2-6	y = -0.6958x + 6786.3	9/14/2040	27
Anacostia #2-7	y = -0.3525x + 2298.5	11/8/2031	18
Anacostia #2-8	y = -0.7222x + 2491.5	6/12/2023	9
Anacostia #2-9	y = -0.3473x + 1814.5	4/21/2028	14
Kingman Lake-1	y = -0.0431x + 3151.9	3/23/2214	200
Kingman Lake-2	y = -0.3135x + 2707.8	8/25/2037	24
MD Northwest Branch-1	y = -0.0991x + 402.2	2/10/2025	11
MD Tidal Anacostia-1	y = -0.7493x + 2175.1	12/12/2021	8

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TMDL Scenario: Daily Loads

- Daily loads for each of the 10 pollutants were calculated using the LSPC model's reach output (flow and concentration time series output)
  - Daily load timeseries was calculated for each of the impaired segments (flow x concentration)
  - The maximum of the daily load was identified for each of the impaired segments
- Ratios of the WLA and LA from the annual average loadings calculated for each impaired segment were used to parse the maximum daily load between the WLA and LA
- The daily loads are based on pollutants in the reach after they have reached the stream from the land
  - Pollutant loads in the stream are subject to various transformation processes after reaching the stream

TMDL Allocations

- Provided a total of 63 annual and daily allocations for the waterbodies impaired for toxics pollutants across DC and MD

Heptachlor epoxide TMDLs in MD

Segment	LA (g/day)	WLA (g/day)	Heptachlor Epoxide TMDL (g/day)
Northwest Branch	0.0006	0.2351	0.2357
MD-ANATF[1]	0.0001	0.0164	0.0164

[1]Daily loads presented for MD-ANATF loads include upstream loads from the Northeast Branch, Northwest Branch, and direct drainage.
Note: The MOS is implicit.

Heptachlor epoxide TMDLs in DC

Segment	Assessment Unit ID	LA (g/day)	WLA (g/day)	Heptachlor Epoxide TMDL (g/day)
Nash Run	DCTNA01R_00	0.0003	0.0053	0.0055
Popes Branch[1]	DCTPB01R_00	0	0.0022	0.0022
Texas Avenue Tributary[1]	DCTTX27R_00	0	0.0021	0.0021
Anacostia #2[2]	DCANA00E_02	0.002	0.122	0.1239
Anacostia #1[3]	DCANA00E_01	0.003	0.057	0.0595

[1]No LA is given for these segments because all stormwater runoff is captured by the DC MS4.
[2]Daily loads presented for Anacostia #2 include upstream loads from MD-ANATF, tributaries, and direct drainage.
[3]Daily loads presented for Anacostia #1 include upstream loads from Anacostia #2, tributaries, and direct drainage.
Note: The MOS is implicit.

Annual Load Allocations

Jurisdiction	Pollutant	Baseline load (g/year)	Load Reduction (%)	Cumulative[1] Annual Allocation (g/year)
DC	Arsenic	230,080	96.63	7758.93
	Copper	1,77,265	5.48	1659002.13
	Zinc	2,847,024	1.65	2800152.88
	Chlordane	1,597	98.28	27.51
	DDT	135	98.89	1.50
	Dieldrin	313	100	0.01
DC and MD	Heptachlor epoxide	285	97.5	7.12
DC	PAH 1	20,696	0	137176.63
	PAH 2	49,746	99.98	8.11
	PAH 3	41	100	0.85

[1]Cumulative annual load allocations from the downstream most segment of the Anacostia River (Anacostia #1).

Implicit MOS

- Modeled total DDT and used the most stringent of the degradate criteria (DDE) as the TMDL endpoint
- Grouped the 13 PAHs in three groups and used the most stringent criterion within each group as the TMDL endpoint
- Developed TMDLs based on the entire simulated period of 2014-2017 to incorporate the widest range in environmental conditions
- Set NPDES facilities lacking DMR data for use in setting existing conditions at criteria
- Chose to set non-detect monitoring data points at half the detection limit, potentially overestimating baseline concentrations but being more protective due to the uncertainty associate with non-detect data
- DC's more stringent criteria (10^{-6}) used across the watershed to meet downstream water quality
- Set regulated WWTP WLAs at the maximum allowable permitted concentration as opposed to actual discharges

Critical Conditions

- EPA regulations require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters
- Ways critical conditions were considered:
  - Used a dynamic model and analyzed all flow conditions in the basin
  - Used a dynamic model that capture nonpoint and stormwater source loads from the watershed delivered at times other than the critical period
  - Used a continuous model simulation period from 2014-2017, accounting for seasonal variation
  - Determined WLAs based on maximum flows from dischargers set by design flows specified in NPDES permits

Reasonable Assurance

- Section 303(d) of the Clean Water Act requires that a TMDL be "established at a level necessary to implement the applicable water quality standard."
- Documenting adequate reasonable assurance increases the probability that regulatory and voluntary mechanisms will be applied so that the pollution reduction levels specified in the TMDL are achieved and, therefore, applicable water quality standards are attained.

Reasonable Assurance for TMDL Implementation: DC

- Anacostia River Sediment Project and DC contaminated sites
- Stormwater and CSO load reductions through MS4 Permit and DC Water LTCP
- DC TMDL Consolidated Implementation Plan (2016)
- Post-TMDL monitoring

Reasonable Assurance for TMDL Implementation: MD

- Phase I MS4 WLA Implementation Plans
- Source trackdown studies to assist MDE in identifying heptachlor epoxide contamination in the watershed
- Stormwater BMP implementation
- MDE Fish Tissue Consumption Advisory Monitoring

Summary

- 61 TMDLs for the various toxic pollutant impairments in DC, for the two segments of the mainstem Anacostia River, Kingman Lake, and nine tributaries
- Two (2) TMDLs for the heptachlor epoxide impairments in MD, for the Northwest Branch and MD-ANATF
- Provided TMDLs and annual loads for a number of point and nonpoint sources in DC and MD
- Implicit MOS

Next Steps

- DOEE and MDE released public notice of the draft Toxic Pollutant TMDLs for the Anacostia River, its tributaries, and Kingman Lake on 7/9/2021
- 30-day public comment period from 7/9/2021-8/7/2021
- Will review and respond to all comments received, make any necessary edits, and submit final TMDLs to EPA for action
- Upon approval by EPA, these TMDLs will replace the 2003 TMDLs

Additional Information

District of Columbia:

- Public notice: https://doee.dc.gov/service/total-maximum-daily-load-tmdl-documents
- WQS: D.C.M.R Title 21-11
- Submit written comments to: george.onyullo@dc.gov

Maryland:

- Public notice: https://mde.maryland.gov/programs/Water/TMDL/DraftTMDLforPublicComment/Pages/index.aspx
- WQS: COMAR 26.08.01 and COMAR 26.08.02
- Submit written comments to: mde.tmdlcoordinator@maryland.gov

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Questions?