



WATAR 5 YEARS OF PROGRESS

Delaware Department of Natural Resources and Environmental Control

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November 15, 2016

PRESENTATION OUTLINE

Part 1 - General WATAR concept and overview of past 5 years of data collection

Part 2 - Technical – How are the data being used?

Part 3 – The next 5 years . . .

PART 1

GENERAL WATAR CONCEPT AND OVERVIEW OF
PAST 5 YEARS OF DATA COLLECTION

WHAT IS WATAR?

WATERSHED APPROACH TO TOXICS ASSESSMENT AND RESTORATION

- **Whole Basin Management framework** – “...programs from throughout DNREC work in an integrated manner to assess different geographic areas of the State defined on the basis of drainage patterns”
- **Focus on Persistent, Bioaccumulative, and Toxic (PBT) compounds** – Risk drivers for fish advisories
- **Linking Sources and Sinks** – advanced sampling and analysis utilizing multiple lines of evidence
- **Clean Water Act (1972), 303d listing and TMDL implementation tool** - assess impact of toxics in waterways
- **HSCA site prioritization tool** – target DNREC remediation efforts

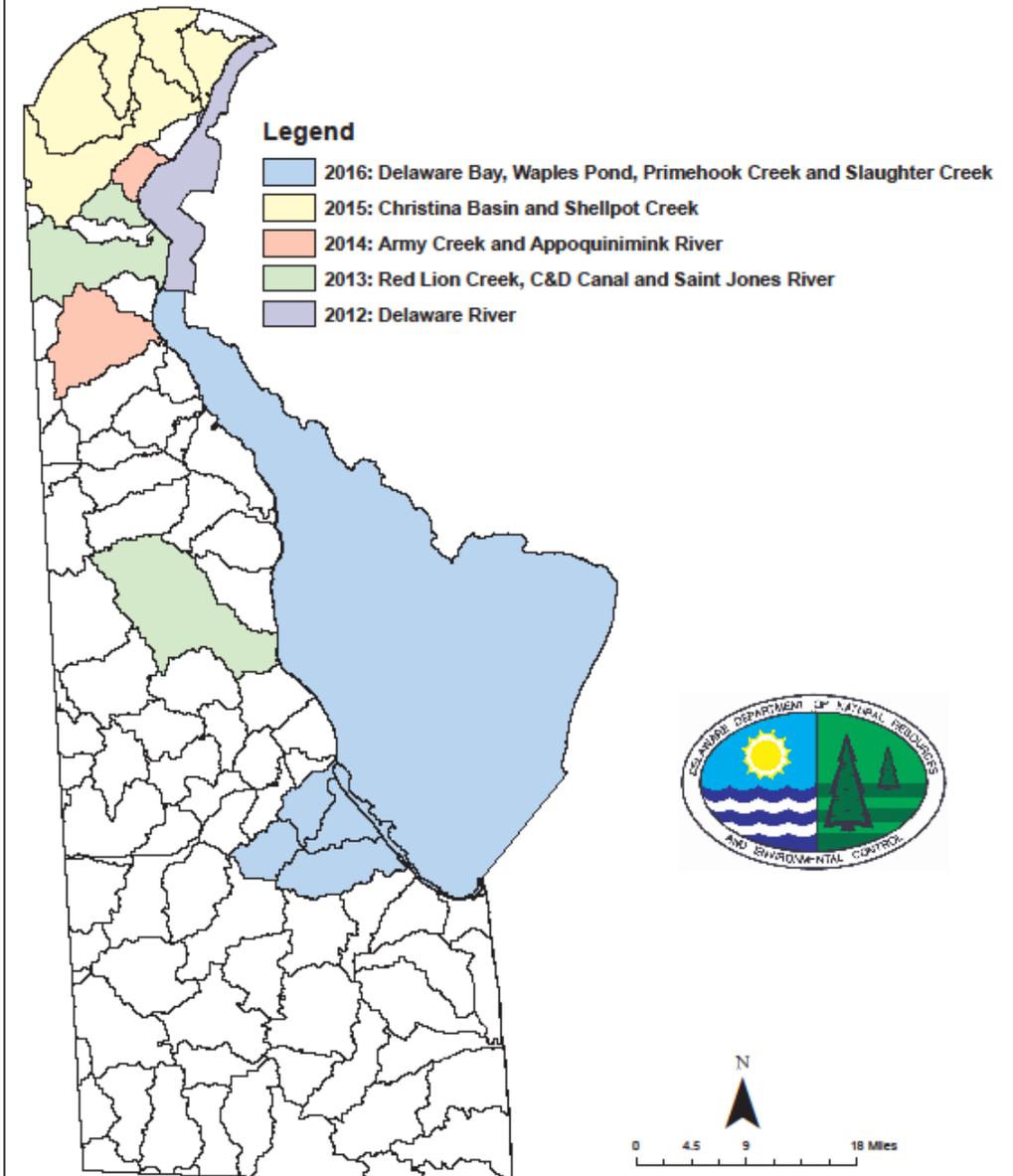
OBJECTIVES OF WATAR

- Compile existing toxics data for the surface waters, sediments, and biota
- Create a “clearing house” of data for regulatory and remedial decision making and prioritization
- Sample current levels of toxic substances in priority waters
- Develop HSCA sediment guidance
- Establish TMDLs for toxics as needed
- Identify high priority remediation projects that have potential for significant watershed scale results
- Facilitate technology transfer to incorporate WATAR into management decisions
- A shorter timeframe for removal of fish advisories throughout the State

WATERSHEDS SAMPLED

- **2012** - Delaware River
- **2013** - Red Lion Creek, C&D Canal, Saint Jones River
- **2014** - Army Creek, Appoquinimink River
- **2015** - Christina River Basin (Christina River, White Clay Creek, Red Clay Creek, Brandywine Creek) and Shellpot Creek
- **2016** - Delaware Bay, Waples Pond, Prime Hook Creek, Slaughter Creek, Red Clay Creek Trout Study

Watershed Approach to Toxic Assessment and Restoration (WATAR) Study Map



SAMPLE STATION SELECTION CRITERIA

- Within 303(d) listed watershed
- Provides coverage of entire watershed
- Previous data available for comparison/trend assessment
- Fills a data gap
- Proximity to former/current waste site
- Co-located with USGS gage
- Known fishing spot and/or upstream of drinking water intake
- Close to Stateline (interstate waters)
- Accessibility
- Safety (listed last but was always first)

SAMPLING TIMING

- Targeted fall, steady, low flow conditions
- Not worst case for mass loading but possibly for bioavailability
- Lower probability of rainfall & other severe weather events making sustained sampling effort under desired conditions more favorable & safer
- Chemical equilibrium between phases (water, sediment and fish) more likely, allowing for comparisons between observed & predicted partitioning
- Lipid concentrations more steady for most fish species in fall
- Nice time of year to be in the field!

MEDIA SAMPLED & ANALYTICAL PARAMETERS

SURFACE WATER

- PCBs by EPA Method 1668
- Dioxins and Furans by EPA Method 1613
- Organochlorine Pesticides by EPA Method 1699
- PAHs + Alkylated Homologs by EPA Method 8270/1625

General WATER parameters and sorbents

- BC of Suspended Sediments
- PC, POC, DOC
- Chl-a
- TSS
- DO, T, Cond, pH

SEDIMENT

- PCBs by EPA Method 1668
- Dioxins and Furans by EPA Method 1613
- Organochlorine Pesticides by EPA Method 8081
- PAHs + Alkylated Homologs by EPA Method 8270 SIM
- Mercury by EPA Method 7471

General SEDIMENT parameters and sorbents

- TOC/BC
- Bulk Density
- Specific Gravity of Solids
- % Moisture
- Grain Size

FISH TISSUE

- PCBs by EPA Method 1668
- Dioxins and Furans by EPA Method 1613
- Organochlorine Pesticides by EPA Method 1699
- PAHs + Alkylated Homologs by EPA Method 8270/1625
- Total Mercury by EPA Method 1631
- Methyl Mercury by EPA Method 1630
- % lipid

Other for Water, Sediment and Fish

- Chlorinated Benzenes in Red Lion Watershed
- Metals in Christina Basin (Sediment only)
- Ambient toxicity (Water only – DRBC)

WATER SAMPLE COLLECTION METHODS



High Volume Samples



Bankside



Passive Samplers



20 Liter Kegs



Wading - Midstream



From Boat

SEDIMENT SAMPLE COLLECTION METHODS



Wading - Bank Sampling



Ponar From Boat



Sediment Coring



Ponar over water



Homogenization



Wading With Ponar

FISH SAMPLE COLLECTION METHODS



Electrofishing - Zodiac



Shocking Pram



Gill Netting



Trot Lines



Backpack Shocking



Hook & Line

2012 – DELAWARE RIVER

Two monitoring efforts completed, one on contaminants in striped bass and the other on biogeochemical cycling of mercury, both in tidal Delaware River. Results documented in:

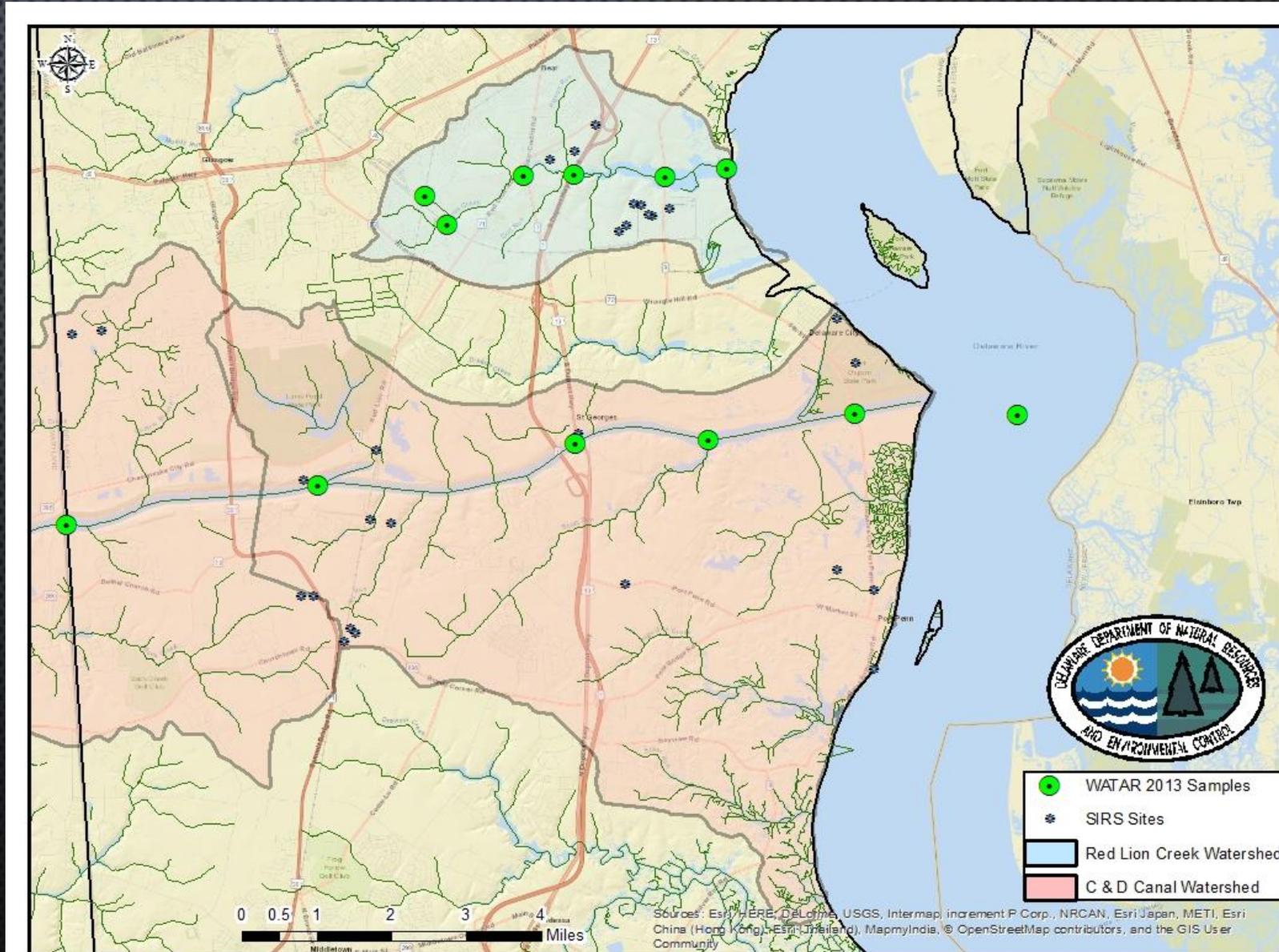
- Greene R. 2013. Assessment of 2012 Delaware Toxics in Biota Data. Report dated August 19, 2013. Delaware Department of Natural Resources and Environmental Control, Dover, DE.
- Gosnell K, et. al. 2016. Seasonal Cycling and Transport of Mercury and Methylmercury in the Turbidity Maximum of the Delaware Estuary. *Aquatic Geochemistry* 22(4): 313 – 336.
- Buckman K, et. al. Landscape Influences on MeHg Bioaccumulation in an Urban Estuary: Delaware River USA. *In review*.

2013 – RED LION CREEK, C&D CANAL

12 Sediment Samples
10 Surface Water Samples
10 Fish Tissue Samples

Preliminary Results:

- **Red Lion Creek** – Source area between Rt 9 & Rt 13 confirmed. Tidal effect from Del R seen. Potential PCB source in headwater. Fish improved. No biologically significant toxicity observed.
- **C+D Canal** – Slight W to E gradient apparent with possible source areas at Summit and near mouth of Scott Run. Fish improved.



2013 – SAINT JONES RIVER WATERSHED

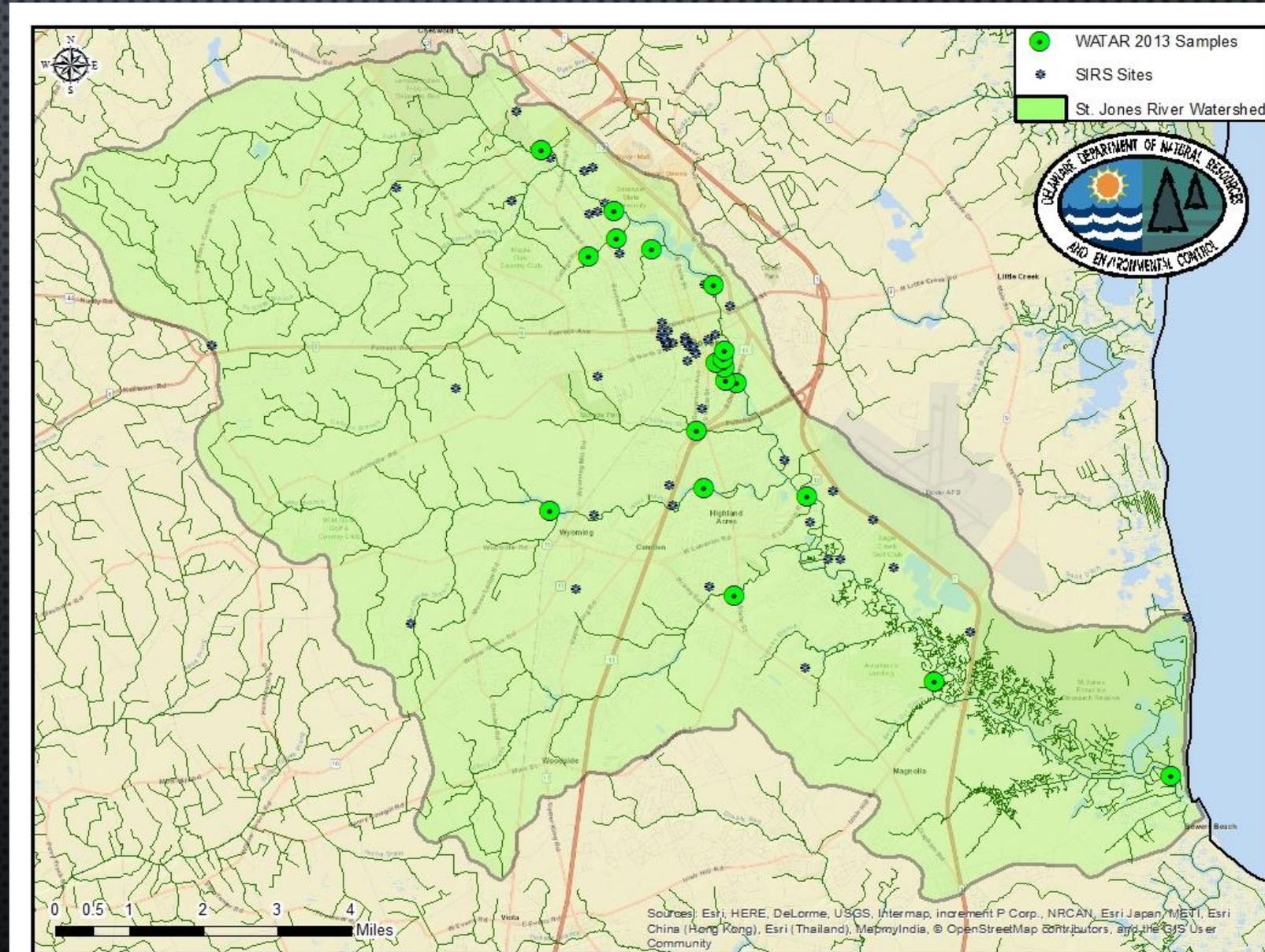
26 Sediment Samples

16 Surface Water Samples

9 Fish Tissue Samples

Preliminary Results:

- Elevated PAHs & PCBs between Silver Lake & Rt 13.
- Mirror Lake Remediation to be discussed, as will Tar Ditch PAH project.
- Fish improved overall. Hg in fish upstream of Silver Lake.



2014 – ARMY CREEK WATERSHED

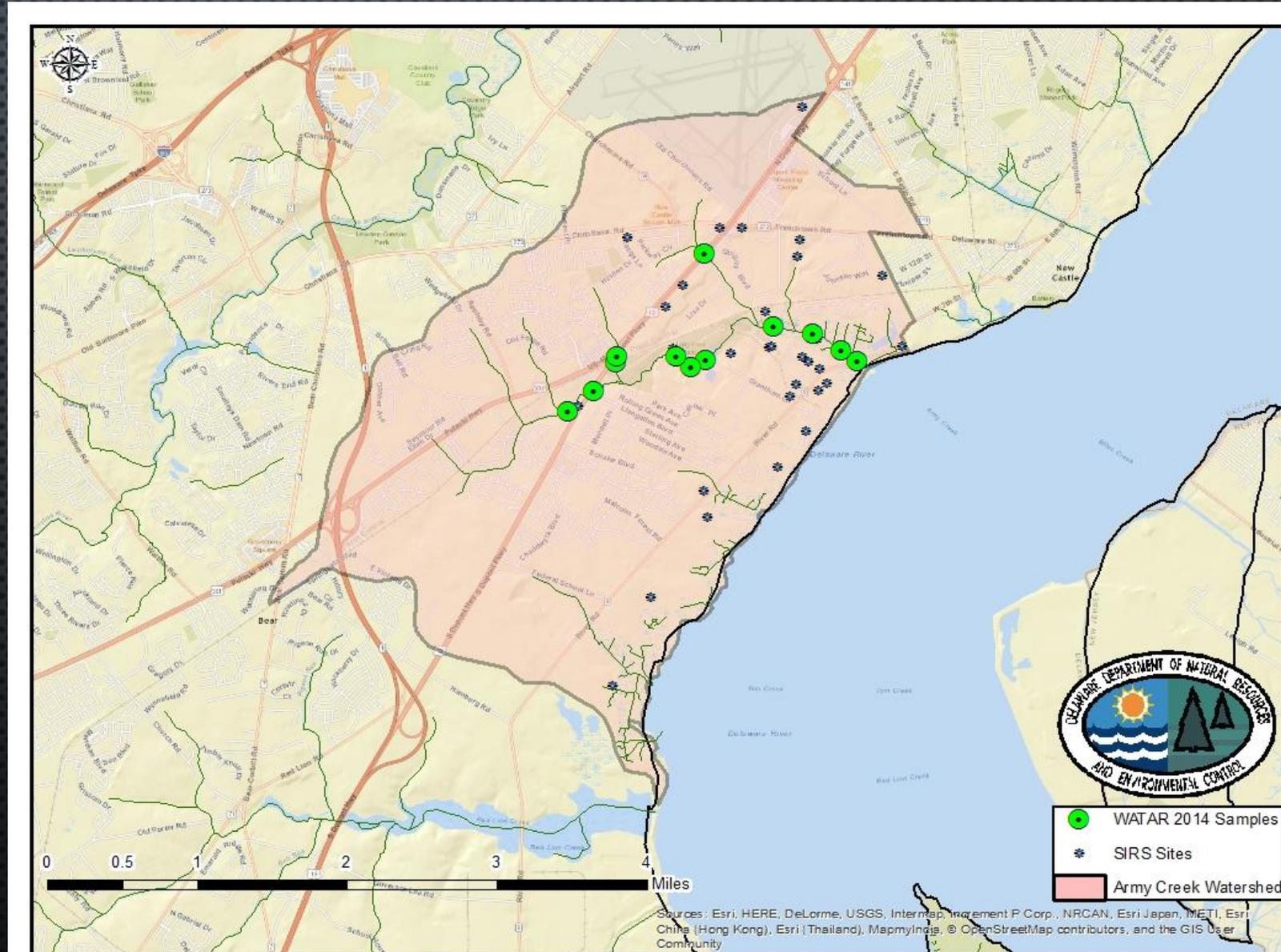
12 Sediment Samples

6 Surface Water Samples

6 Fish Tissue Samples

Preliminary Results:

- PCB in all media decrease from Rt 13 downstream to Rt 9, with a step increase evident in Army Pond.
- Tribs relatively clean.
- Fish improved overall. Dieldrin in fish elevated at Rt 13.

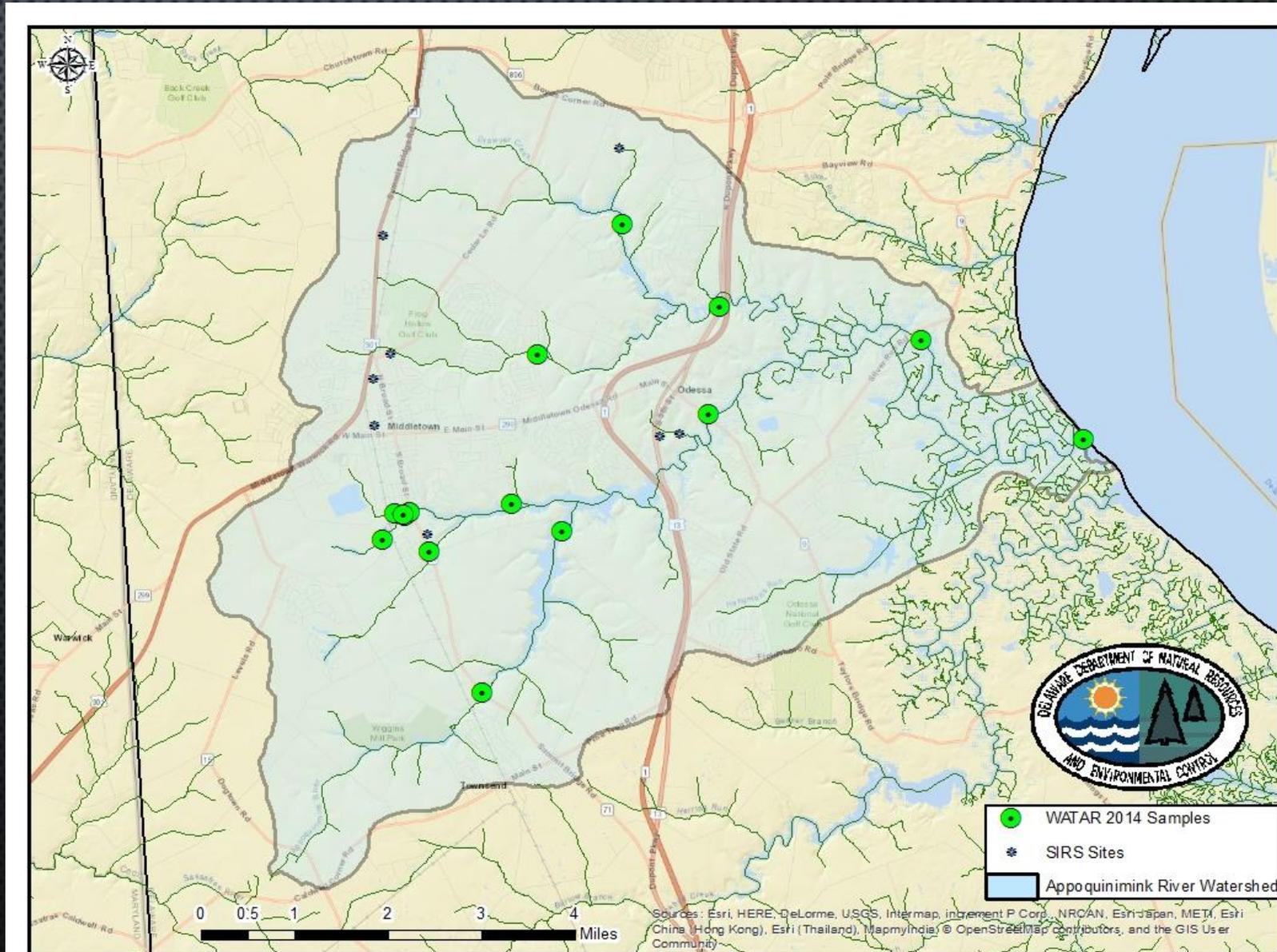


2014 – APPOQUINIMINK WATERSHED

14 Sediment Samples
9 Surface Water Samples
9 Fish Tissue Samples

Preliminary Results:

- Tidal transport of PCBs into Appo & Drawyer Cr from Del R evident based on PCB 209 tracer
- Overall, tributaries not heavily impacted
- Fish somewhat improved, although hi freq/low mag exceedance of dieldrin



2015 – CHRISTINA BASIN, SHELLPOT WATERSHED

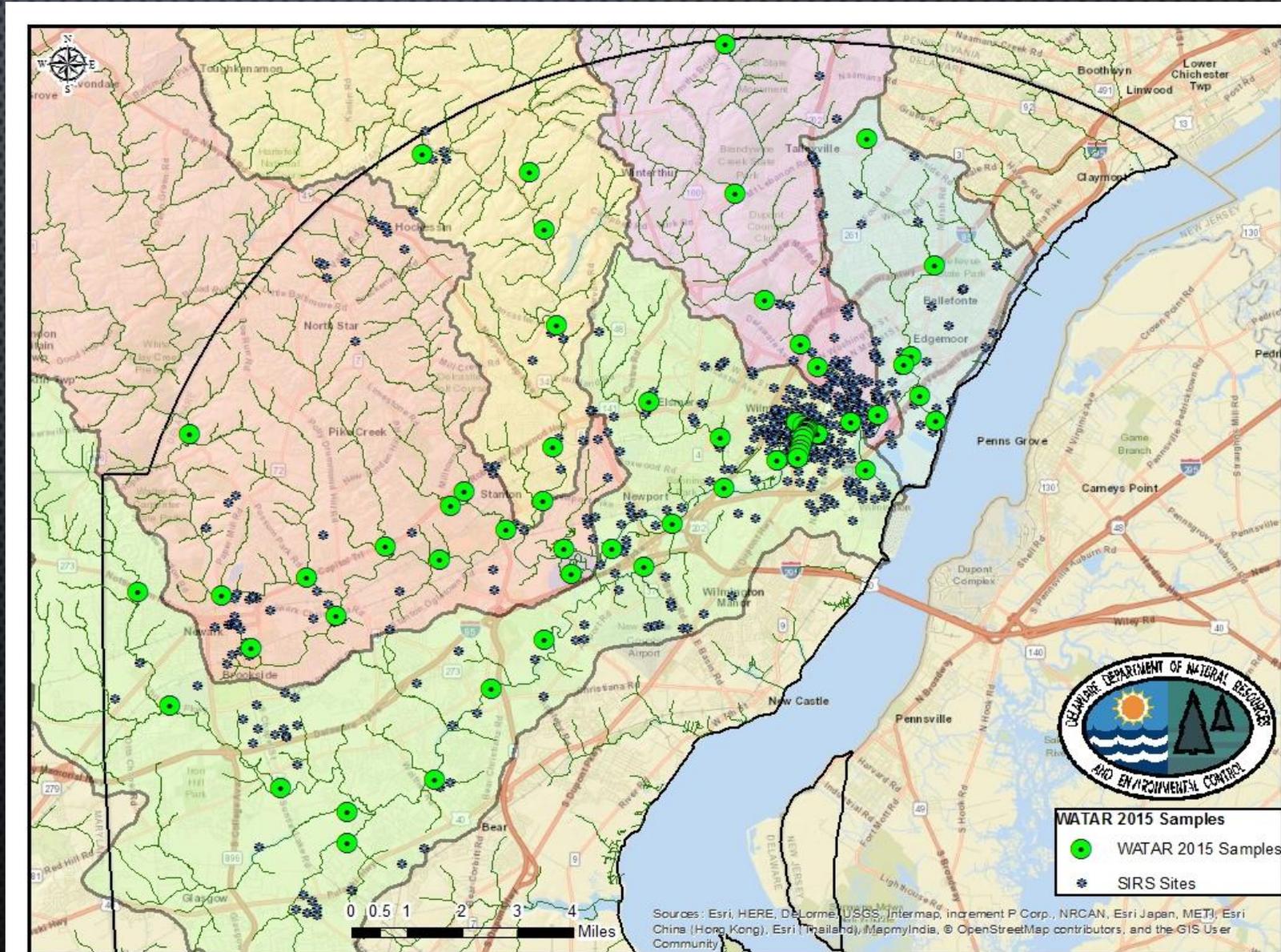
65 Sediment Samples

25 Surface Water Samples

25 Fish Tissue Samples

Preliminary Results:

- Lower Christina, tidal Brandywine & lower Shellpot AOCs
- Tribs not heavily contaminated, although uptick in DDX in RCC
- Fish improved overall.
- No ambient tox



2016 – WAPLES POND, PRIME HOOK CREEK AND SLAUGHTER CREEK

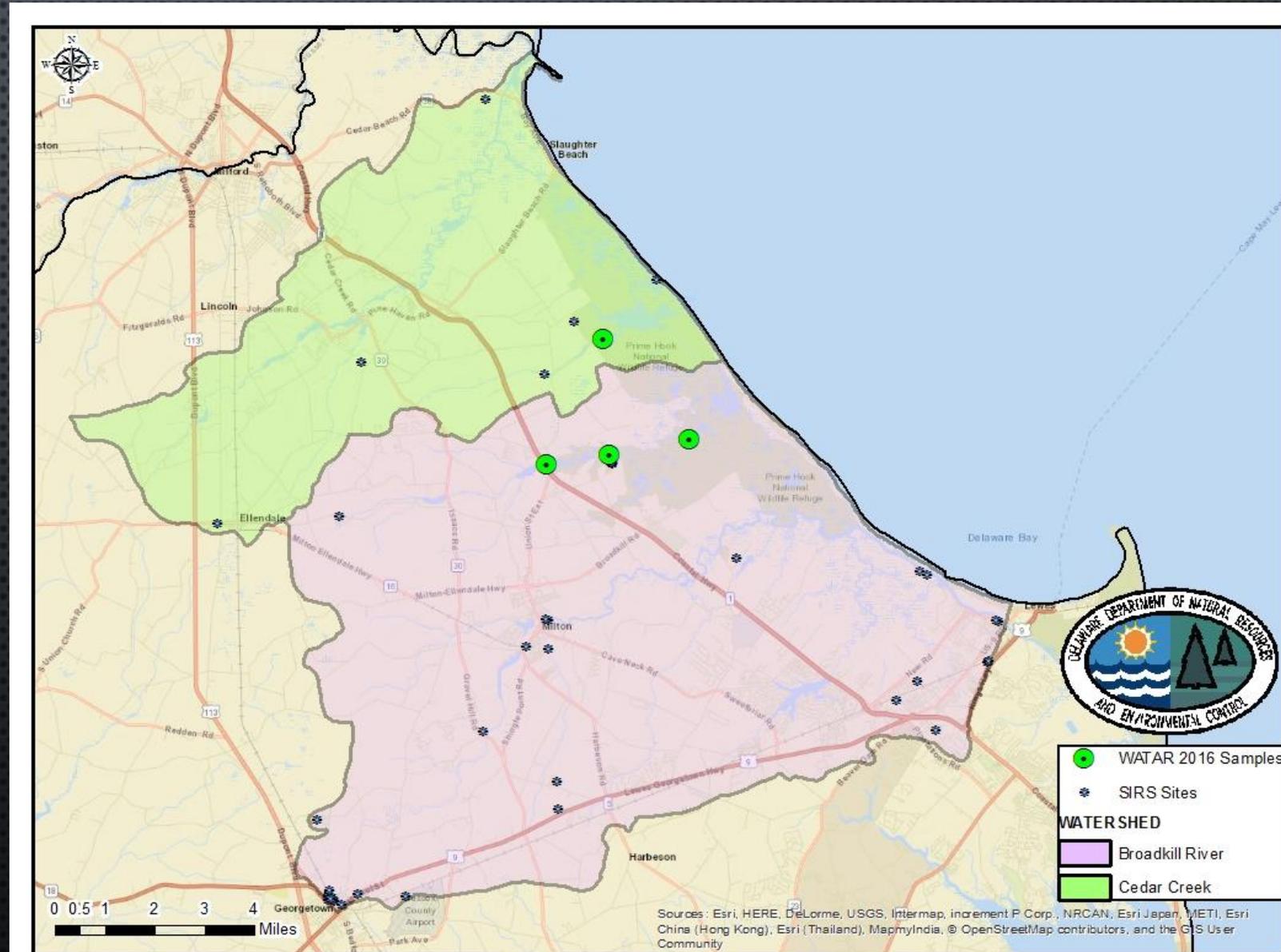
4 Sediment Samples

4 Surface Water
Samples

6 Fish Tissue Samples

Preliminary Results:

➤ No data yet



OTHER WATER SAMPLING DURING 2016

- Red Clay Creek Kinetic Uptake Study of Contaminants in Stocked Trout (n = 4 fish samples and 4 surface water samples)
- Delaware Estuary Contaminants in Fish (n = 37 fish samples, including striped bass, bluefish, white perch and weakfish)
- Mirror Lake Year 3 Sampling (n = 7 bulk sediment samples, 7 sediment pore water passive samples, 9 surface water passive samples, 8 surface water grab samples and 4 fish samples)



PART 2

TECHNICAL – HOW ARE THE DATA BEING USED ?

HOW ARE THE DATA BEING USED ?

- Inform and Implement the Delaware Estuary PCB TMDL (including PMPs) 
- Document improvements (trends) in fish contamination and support revised fish consumption advisories 
- Improve/Justify 303(d) listing/delisting decisions 
- Identify target areas for follow-up investigation/remediation 
- Develop State-specific BAFs & BSAFs and associated human health water quality criteria
- Test and validate role of black carbon in PCB partitioning
- Support NRDA evaluations/actions
- Complement ambient toxicity testing by the Delaware River Basin Commission
- Improve assessments for DNREC's Source Water Assessment and Protection Program (drinking water) in the Christina Basin

PCB MASS LOADING FROM DE WASTE SITES



Purpose: estimate PCB load from waste sites to surface water via overland flow + groundwater transport

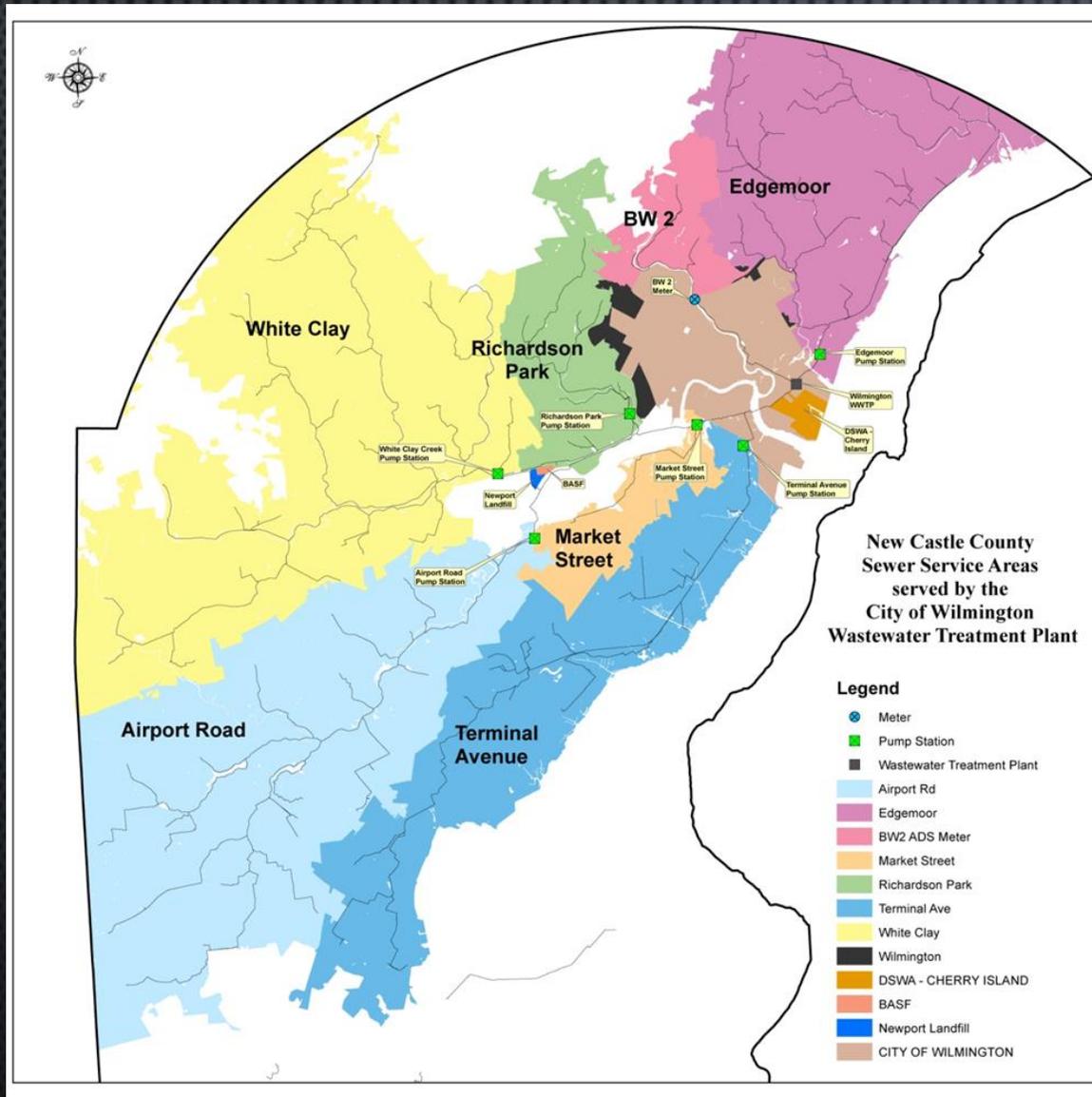
Collaboration between SIRS & WAS served as catalyst for WATAR

Phase I completed 2009 (n = 32, Christina Basin); Phase II completed 2015 (n = 29, rest of DE)

Provides individual & cumulative loading, relative ranking & framework for tracking

Directly supports the DRBC PCB TMDL

WILMINGTON & NCC SEWERSHED TRACKBACK



City of Wilm has NPDES permit to discharge treated ww to Del Est

PCB discharge exceeds WLA established by EPA as part of TMDL

Permit has special condition to reduce PCB load through PMP

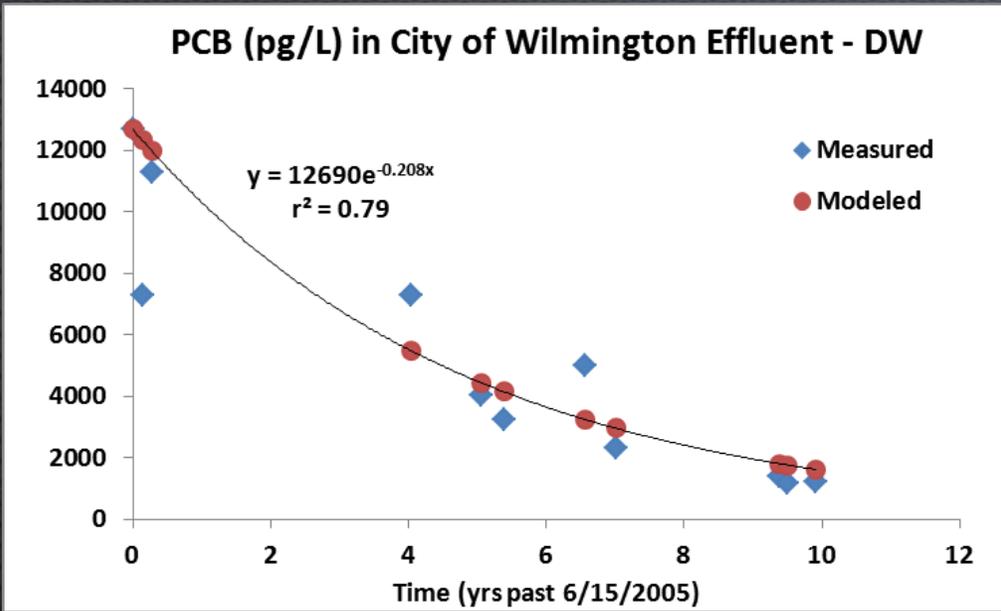
Key element of PMP is a PCB trackback to id sources

Sewershed includes City & NCC

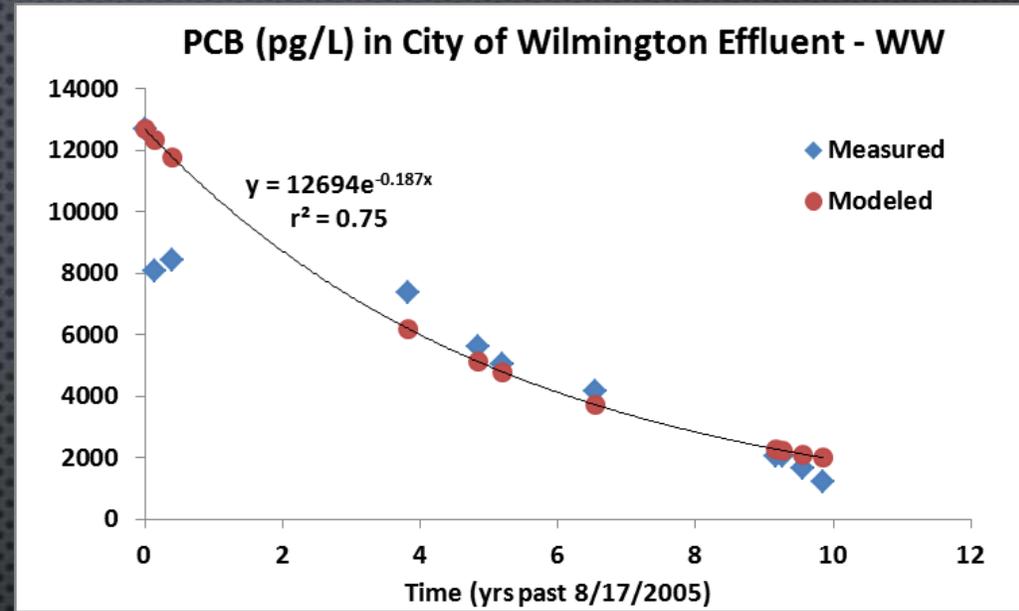
WATAR team assisted in data assessment

~90% PCB REDUCTION – WILMINGTON WWTP

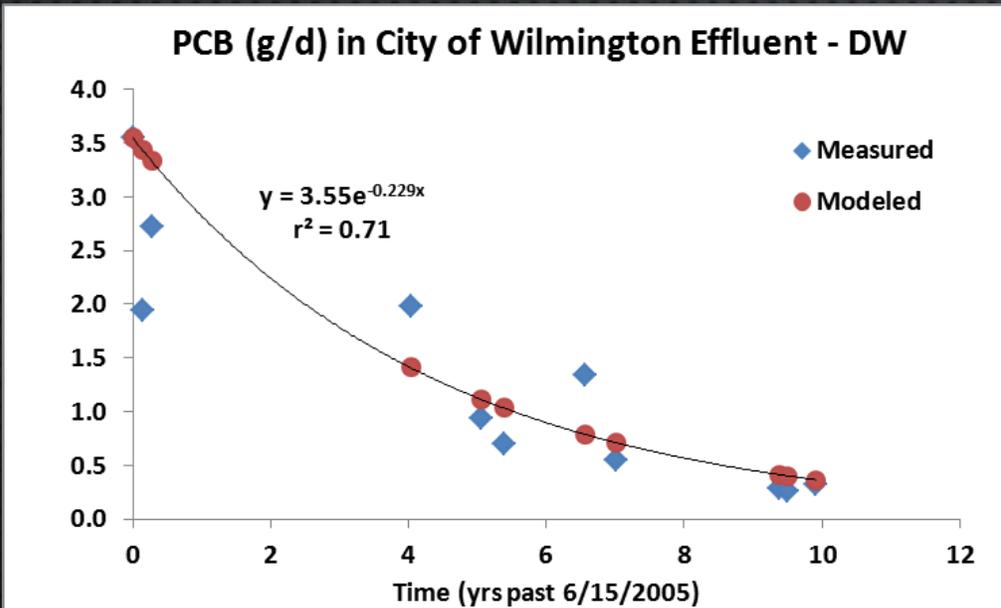
Dry weather concentrations



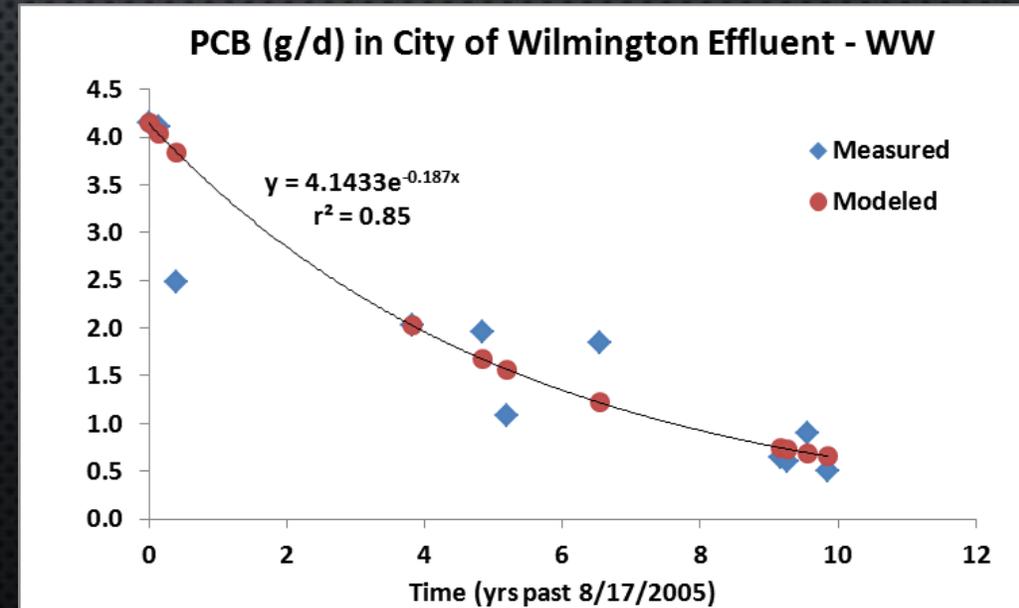
Wet weather concentrations



Dry weather mass loading

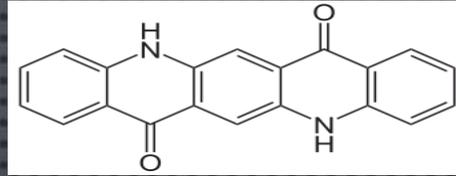


Wet weather mass loading

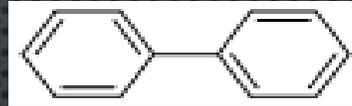


FINGERPRINTING TO ID INADVERTENT PRODUCTION

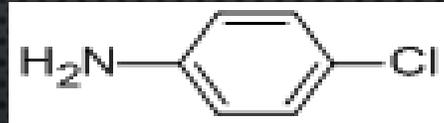
- BASF Newport manufactures Quinacridone pigment (QA). WW to sewer.



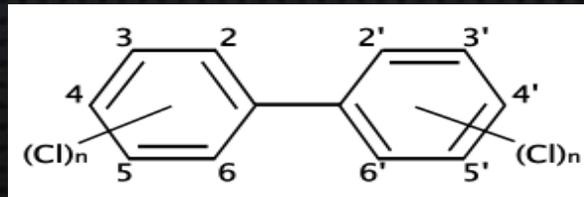
- Therminol VP-1 is used in QA synthesis. It contains ~26.5% Biphenyl, the basic building block of PCBs.



- Manufacturing process also involves chlorinated anilines (*used as a diazo component*).



- Side-reaction of chloroanilines in the presence of biphenyl may produce PCBs through a free radical mechanism or other means.



AMTRAK FORMER FUELING FACILITY - WILMINGTON



- Amtrak is major ongoing source of PCB to surface water
- Congener data collected through PMP resulted in revised conceptual site model
- DNREC, EPA, COE & DRBC working with Amtrak on comprehensive cleanup, including pilot test of ISS of sediments in Eastern Drainage Ditch

COORDINATION ON NCC/DELDOT MS4 PCB PMP



Setting the Standards for Innovative Environmental Solutions

SAMPLING AND ANALYSIS PLAN

ARMY CREEK AND APPOQUINIMINK RIVER WATERSHEDS

Pollution Minimization Plan (PMP) for
Polychlorinated Biphenyls (PCBs)

National Pollutant Discharge Elimination System (NPDES)

Permit Number: DE 0051071
State Permit Number: WPC 3063A/96

December 31, 2014

Prepared for:

DUFFIELD ASSOCIATES, INC.
5400 Limestone Road
Wilmington, DE 19808-1232

Prepared by:

ENVIRONMENTAL STANDARDS, INC.
1140 Valley Forge Road
P.O. Box 810
Valley Forge, PA 19482-0810

DNREC assisted in
SAP design &
suggested an
approach for data
assessment/display

MS4 sampling
sequenced to
complement WATAR
sampling

Compliance through
progress



Setting the Standards for Innovative Environmental Solutions

SAMPLING AND ANALYSIS PLAN

CHRISTINA BASIN AND SHELLPOT CREEK WATERSHEDS

POLLUTION MINIMIZATION PLAN (PMP) FOR
POLYCHLORINATED BIPHENYLS (PCBS)

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

PERMIT NUMBER: DE 0051071
STATE PERMIT NUMBER: WPC 3063A/96

June 3, 2016

Prepared for:

DUFFIELD ASSOCIATES, INC.
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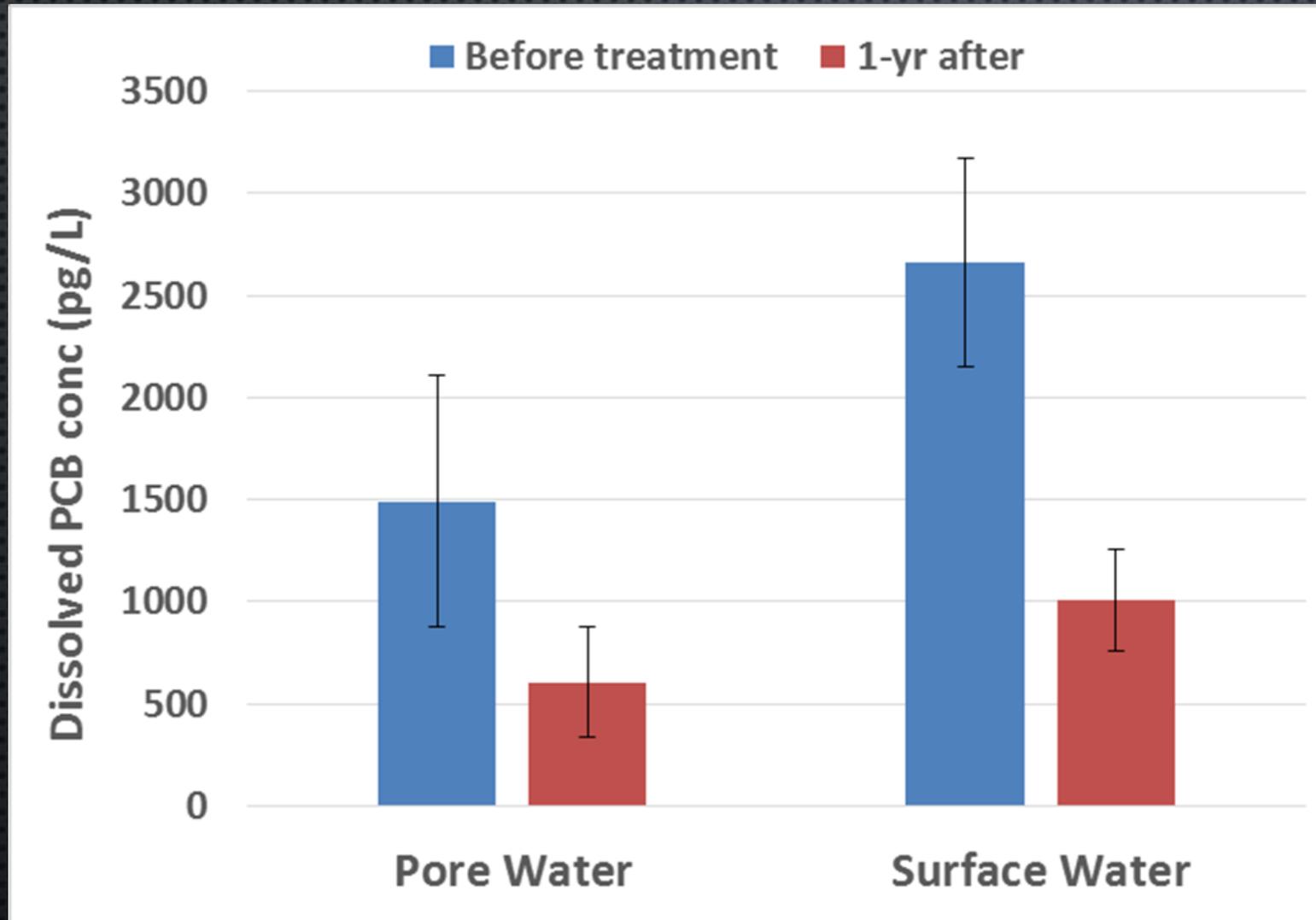
Prepared by:

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P.O. Box 810
Valley Forge, PA 19482-0810

MIRROR LAKE REMEDIATION & RESTORATION



REDUCTION IN PCB BIOAVAILABILITY - MIRROR LAKE



- 78% reduction of dissolved phase PCB in sediment pore water.
- 72% reduction of dissolved phase PCB in water column.
- Led to 60% reduction of PCB in resident fish in 1 year.
- This would have taken ~20 years via natural attenuation.

MECO DITCH/LITTLE MILL CREEK



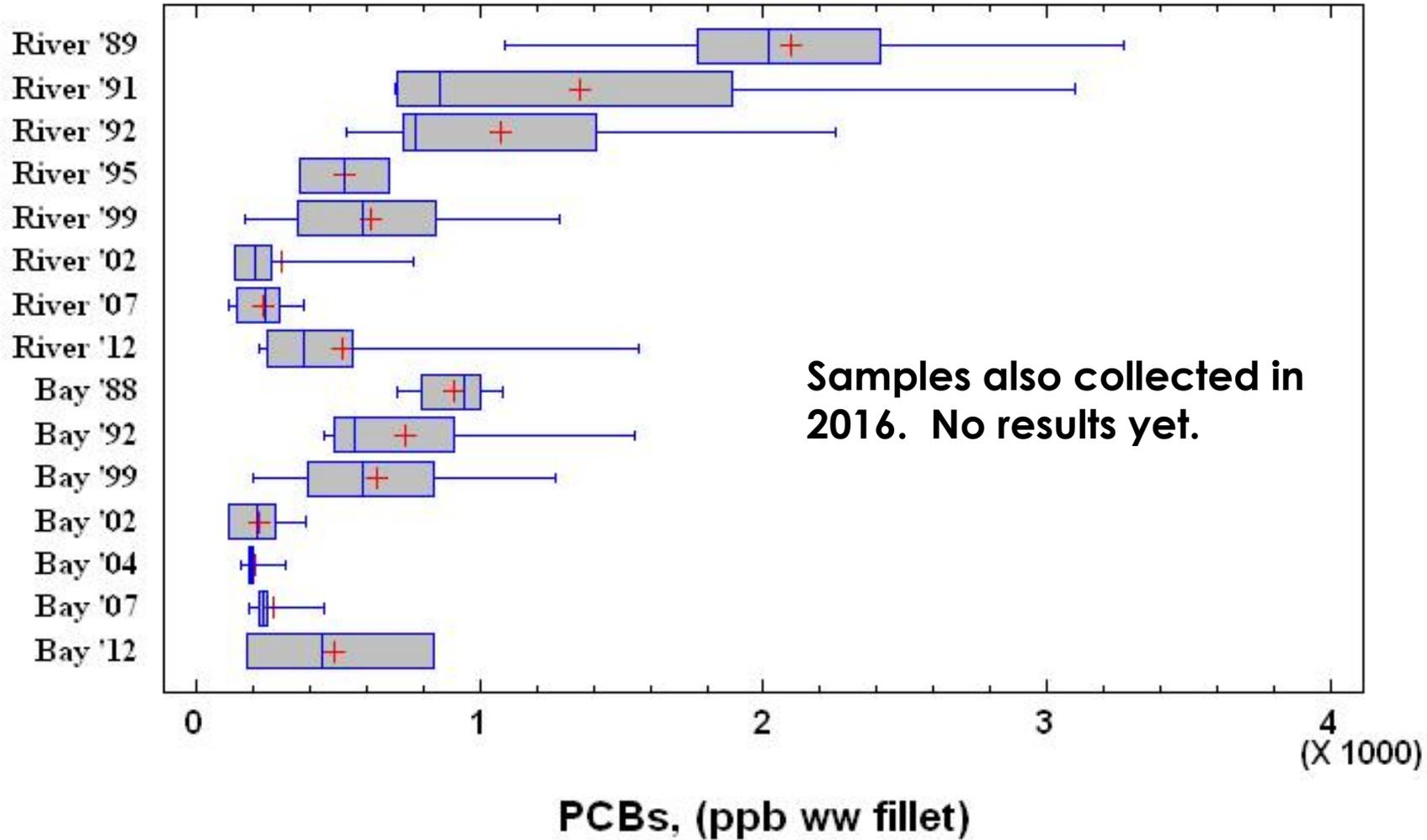
UPDATED FISH ADVISORIES USING WATAR DATA

Less Restrictive Advisories Issued:

- October 23, 2013: Delaware River
- July 3, 2014: C & D Canal, Red Lion Creek, and Saint Jones Watershed
- September 11, 2015: Army Creek and Appo Watershed
- June 7, 2016: Christina Basin and Shellpot Creek



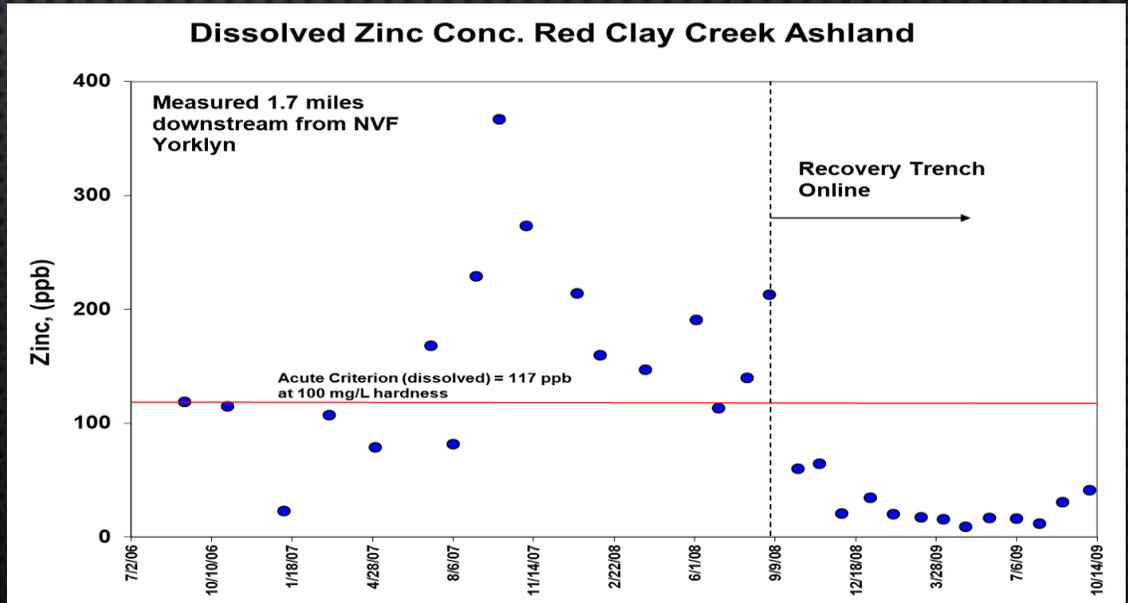
PCB IN STRIPED BASS - DELAWARE ESTUARY



RED CLAY CREEK ZINC DELISTING

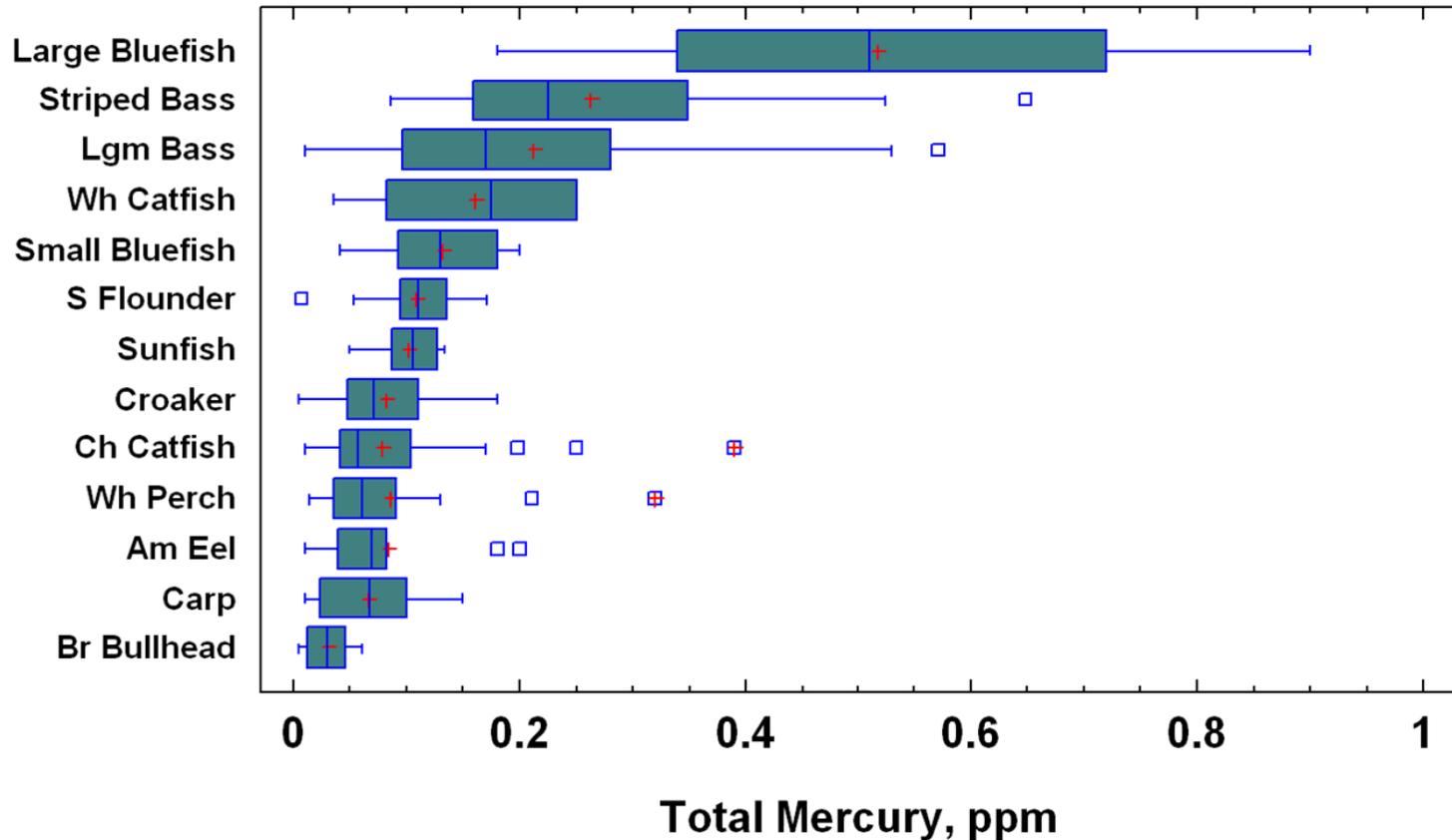


- NVF Yorklyn manufactured vulcanized fiber from 1900 to ~2005.
- Copious amounts of zinc released to groundwater, which then moved to Red Clay Creek.
- Zinc TMDL adopted, appealed & revised based on lognormal probability analysis.
- Zinc recovery system installed Fall 2008.
- Criteria no longer exceeded. Zinc delisted.
- Site being repurposed.



DELAWARE RIVER MERCURY DELISTING

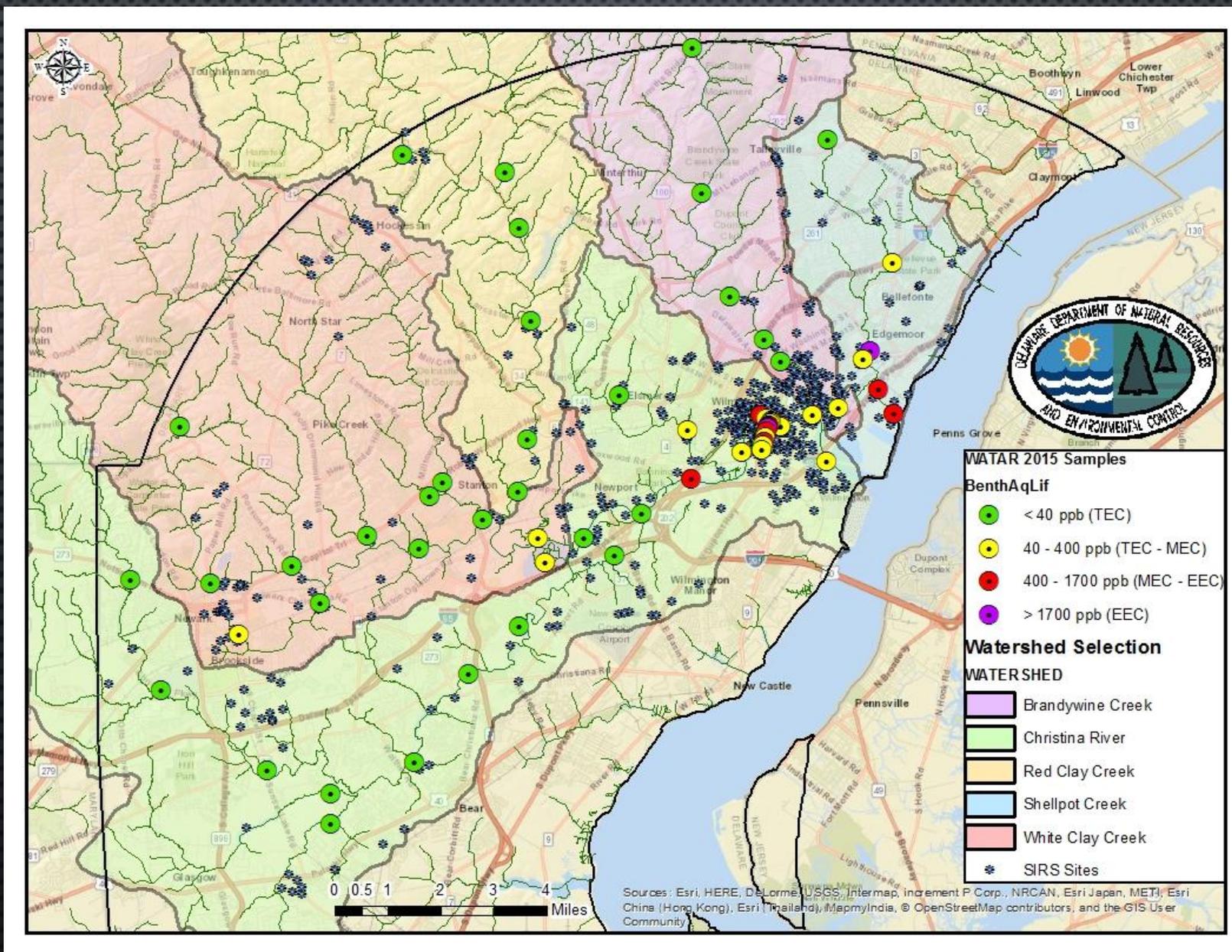
Mercury in Delaware Fish 1993 - 2006



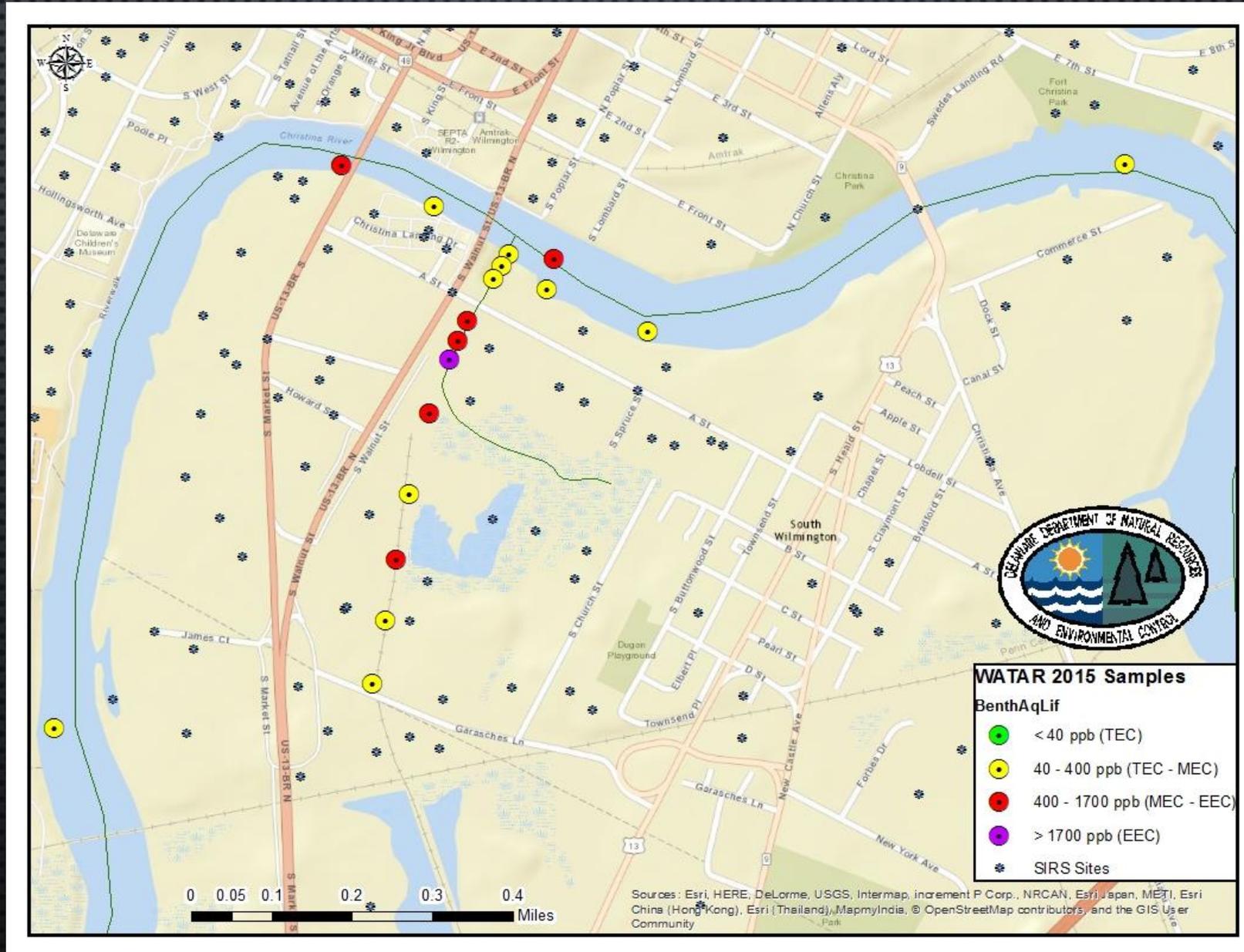
- DNREC & DRBC partnered with UCONN to study Hg cycling in Zone 5 of Del R.
- Between 2002 – 2012, dissolved Hg in water dropped ~70%.
- Over same period, Hg in Del River striped bass fell ~50%, leading to delisting in 2014.
- Bay still listed for Hg. New data for stripers & bluefish being collected 2016.



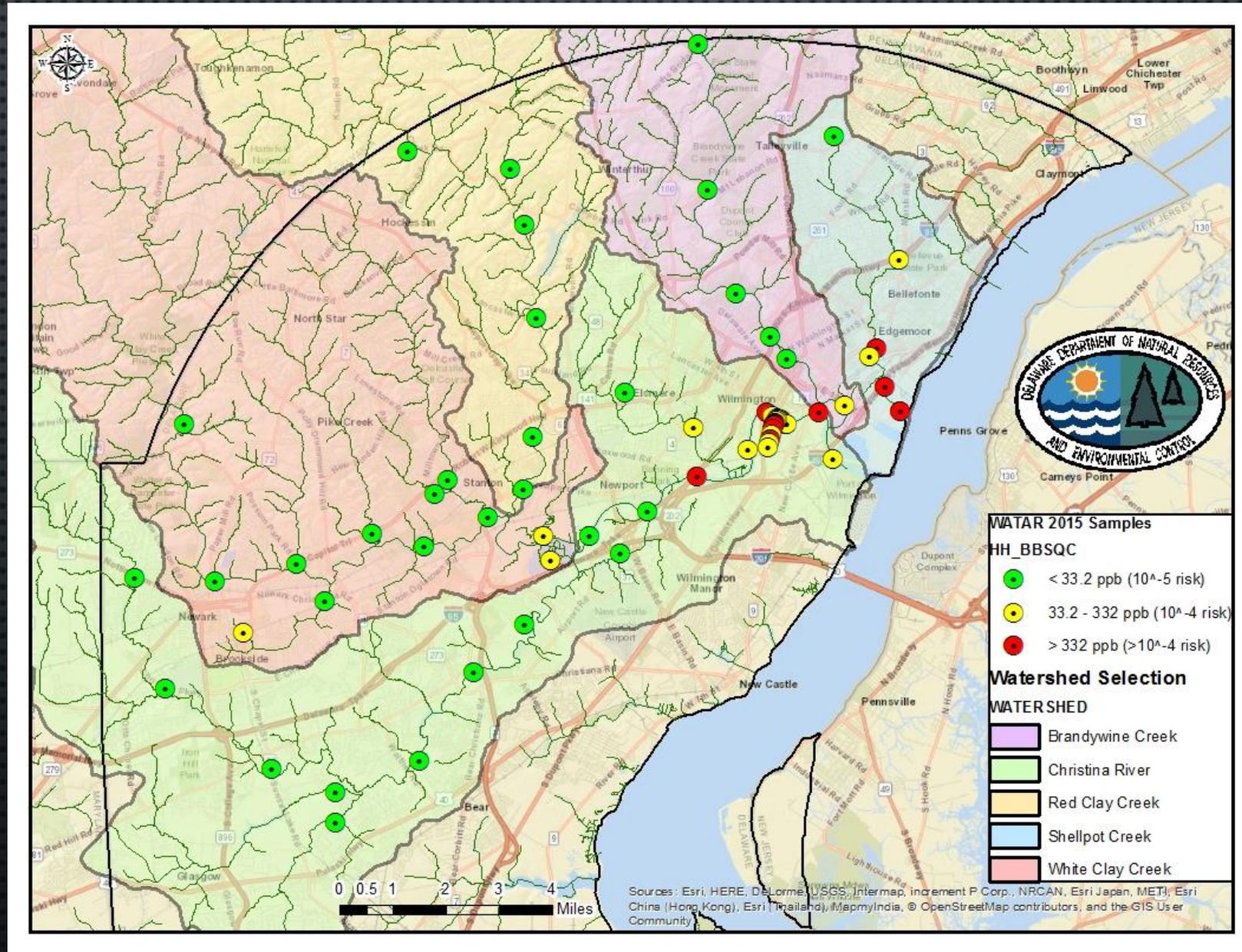
BASIN-WIDE PCB RISK TO BENTHIC AQUATIC LIFE



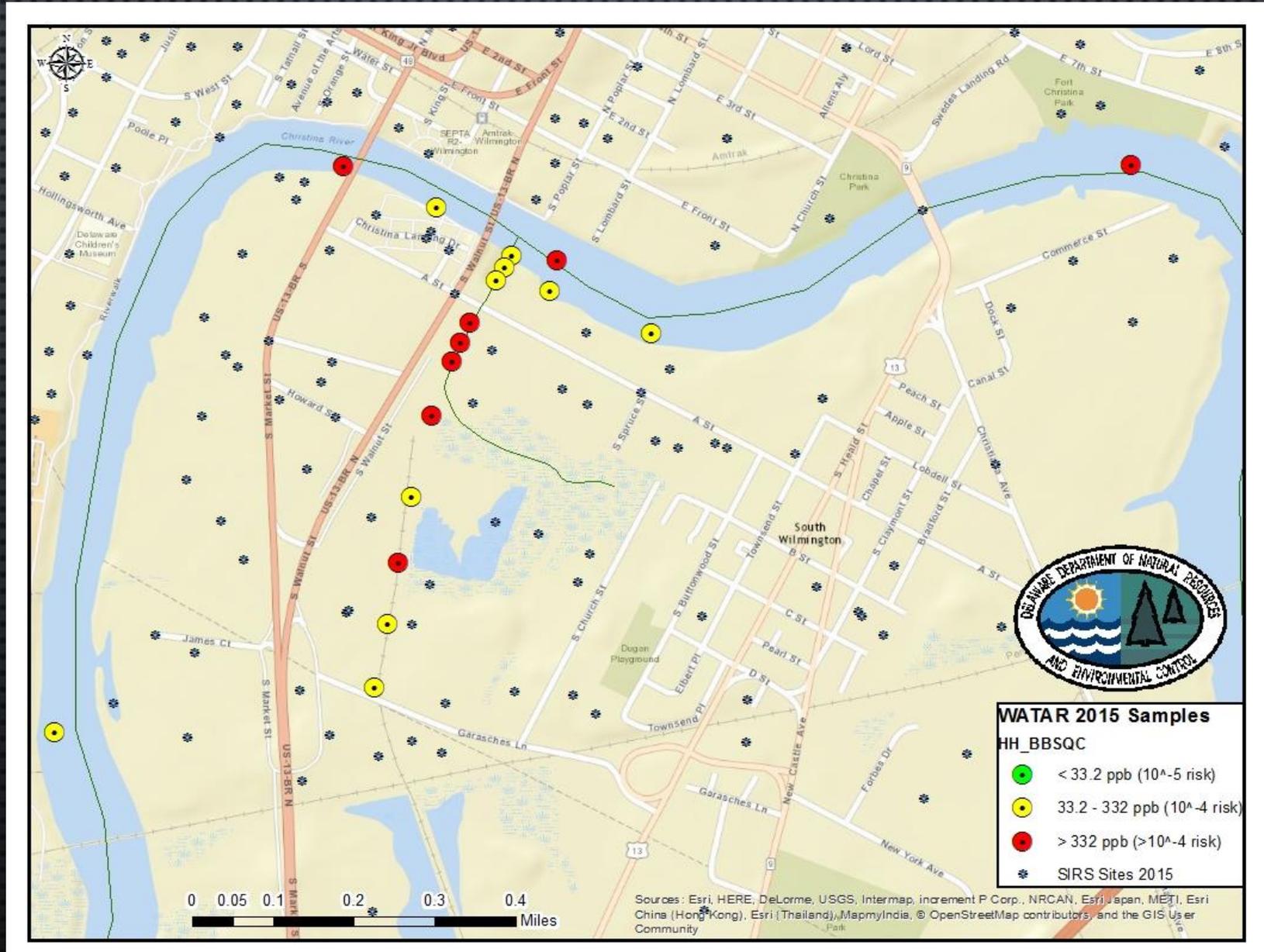
A ST. DITCH PCB RISK TO BENTHIC AQUATIC LIFE



BASIN-WIDE PCB RISK TO HUMAN HEALTH: SEDIMENT TO FISH



A ST. DITCH PCB RISK TO HUMAN HEALTH: SEDIMENT TO FISH



SJR/TAR DITCH ASSESSMENT APPROACH

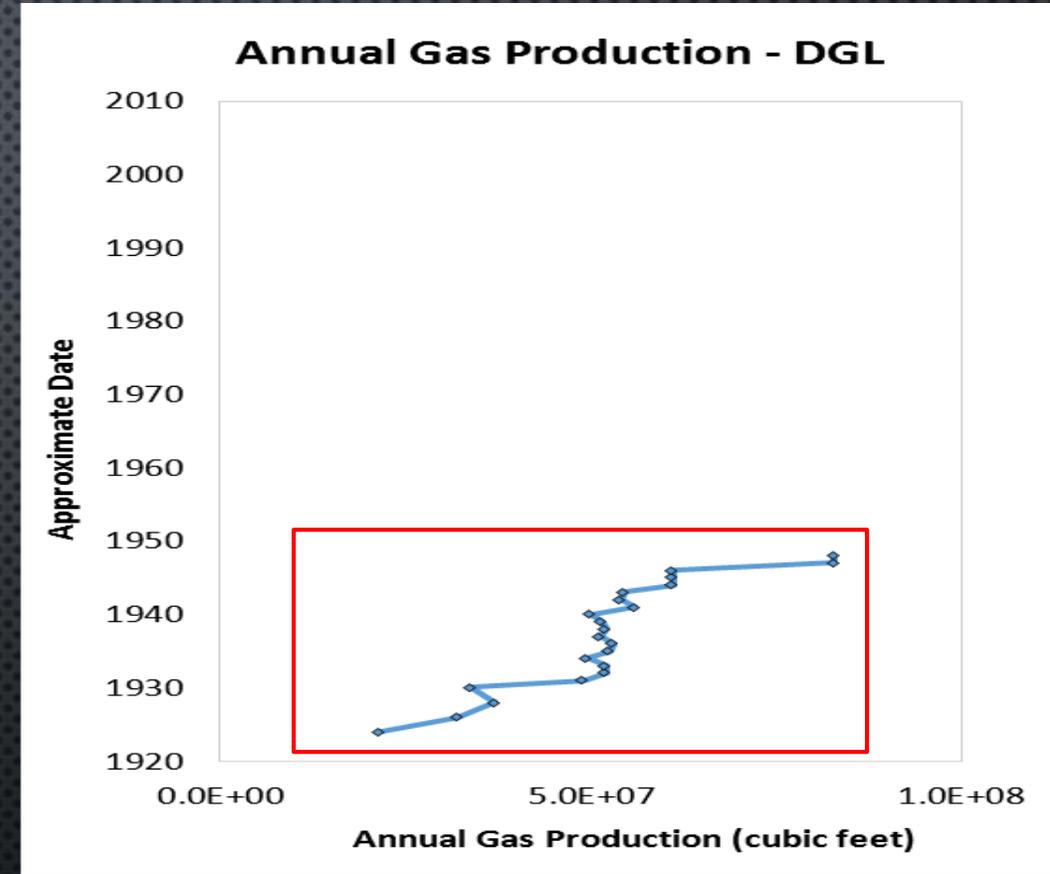
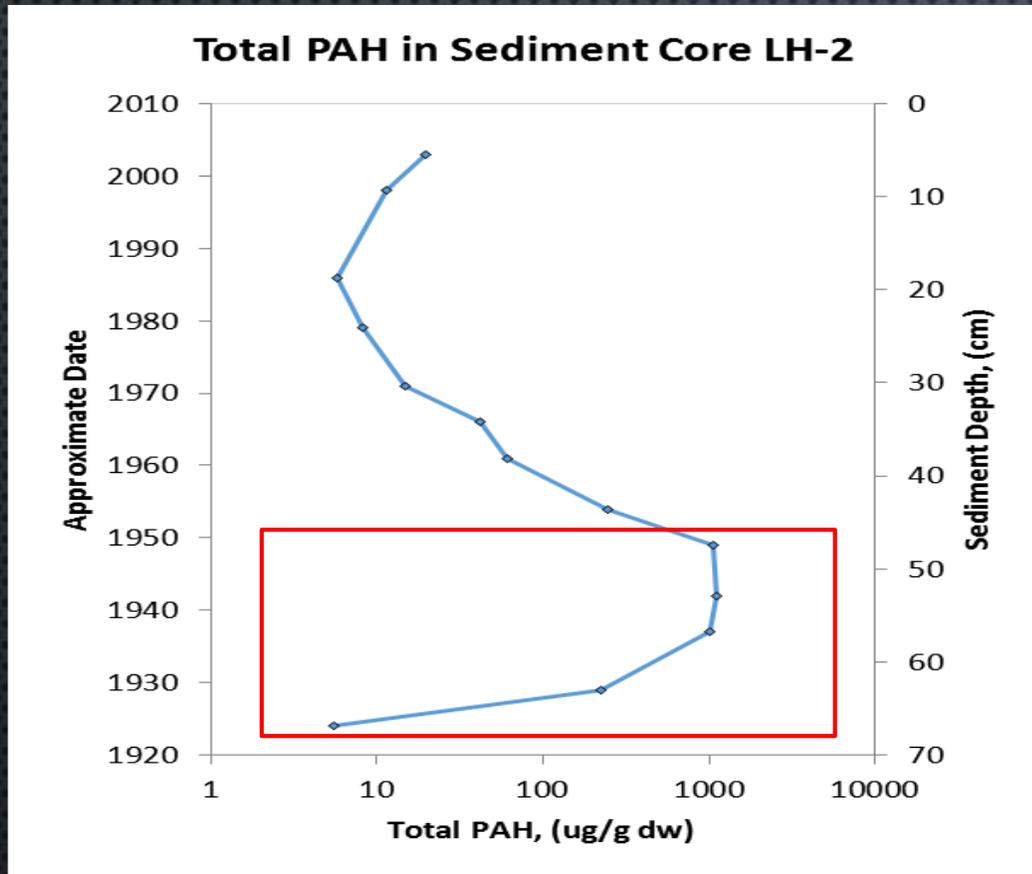
- **Watershed Scale:** surface water, surface sediment, and fish tissue samples collected throughout the watershed in 2013
- **Spatial Targeting:** focused on 0.75 mi., 10 acre reach between Court St and Rt 13, plus the Tar Ditch drainage. Specialized testing used to characterize distribution, bioavailability, bioaccumulation and toxicity in 2015/2016
- **Temporal Trends:** considered through radiodated sediment cores
- **Integration:** Multiple lines of evidence used to characterize impact, source(s), and restoration potential

SOURCE REVEALED IN DEEP CORE



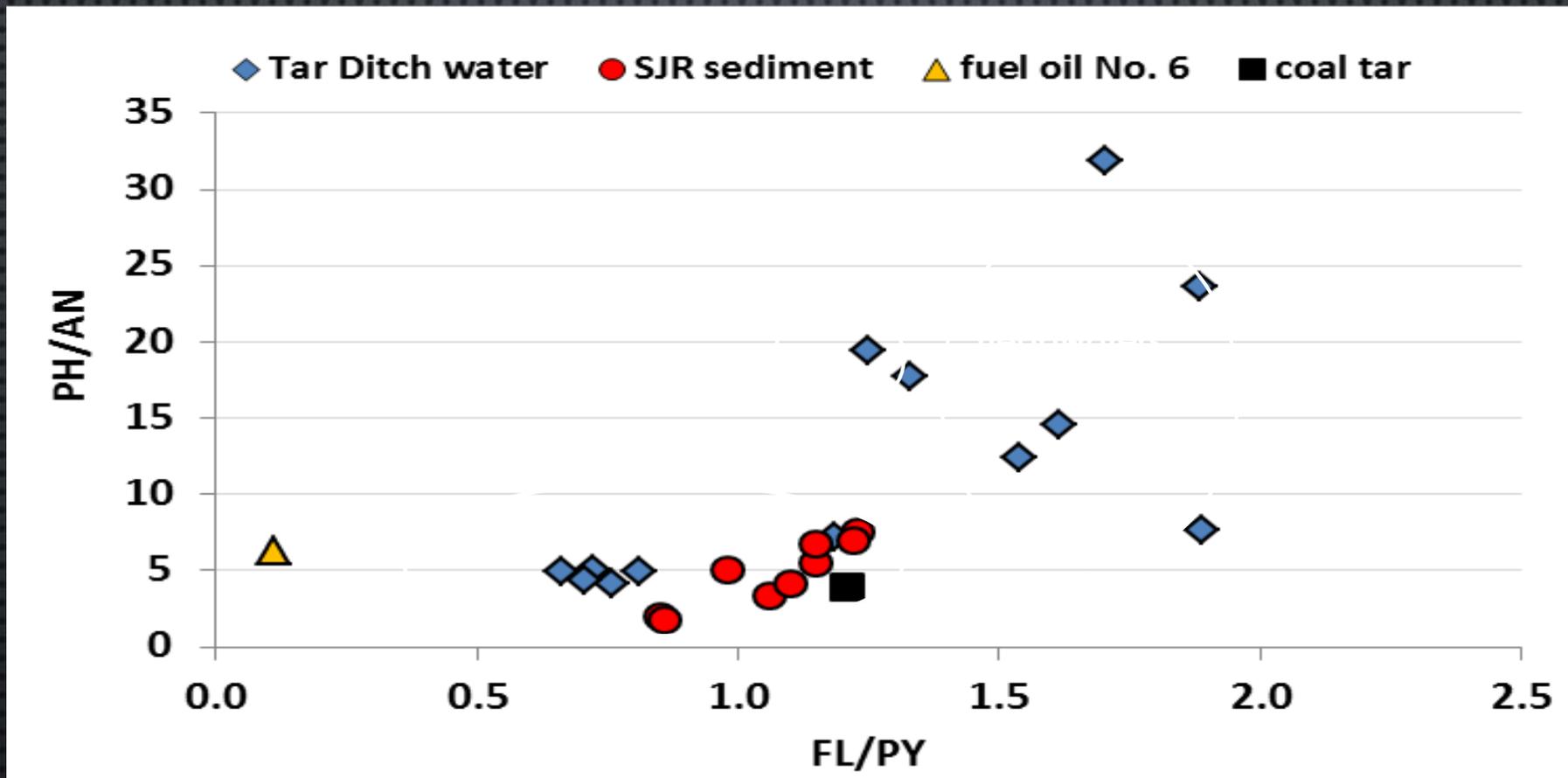
- UD and ANSP collected deep sediment cores from the SJR just upstream of Tar Ditch in 2003.
- Slices radiodated to determine depth-age relationship & sedimentation rate.
- Slices also analyzed for contaminants, including PAHs, to determine “pollution history”.
- Downcore PAH profile compared to gas production log of the DGL MGP.

CHRONOLOGY MATCHES



- DGL operated 1859 – 1948. Tar Ditch went “underground” 1927 – 1934.
- Rapid increase in PAH in St Jones sediments mid-1920s followed by decline ~1950 tracks gas production at DGL.
- Max Total PAH ~1,000 ppm at a depth of 50 – 60 cm (1.5 - 2 ft)

AND MORE ... SOURCE RATIOS



- Diagnostic PAH source ratios calculated & compared between SJR sediments, Tar Ditch samples, coal tar and No. 6 fuel oil.
- Clusters evident. Seds & lower TD stations have coal tar signature.

INTEGRATION/SUMMARY OF FINDINGS

- PAH impacts in SJR confirmed in area between Court St and Rt 13.
- Impact in surface sediments & water column primarily due to legacy contamination in deeper sediments that diffuse upward. Deep sediments are “hot”.
- Original source was DGL plant and transport pathway was Tar Ditch.
- Watershed sources have been evaluated & are largely controlled. Still a few coal tar hotspots in Tar Ditch drainage area that deserve a second look.
- The SJR between Court St and Rt 13 should be considered for sediment remediation.

PART 3

THE NEXT 5 YEARS . . .

NEXT 5 YEAR PLAN (2017-2021)

- Prepare Work Plan for next 5 years, to include:
 - *Chesapeake Bay drainage monitoring*
 - *Revisit AOCs identified in first 5 years to pinpoint sources*
 - *Choose long-term surveillance stations to support trend assessment*
 - *Consider adding several emerging contaminants to mix*
- Complete interpretive data report(s) for 2013-2016 efforts
- Continue to implement Delaware Estuary PCB TMDL
 - *Coordinate on PMPs (point sources and MS4s)*
 - *Monitor loads at head of tide to document progress*

NEXT 5 YEAR PLAN (2017-2021)

- By the end of 2017, re-evaluate existing 303(d) listed segments for possible delisting, monitored natural recovery (MNR), or TMDL
- Evaluate/advance various sediment cleanups:
 - *Amtrak Former Fueling Facility In-situ Sediment Stabilization (ISS)*
 - *A Street Ditch/Walnut Street Shoal*
 - *Saint Jones River, Court Street to Route 13*
 - *Red Lion Creek adjacent to Standard Chlorine Delaware*
 - *Shellpot Creek*
- Increase effort on Delaware Sediment Guidance development

NEXT 5 YEAR PLAN (2017-2021)

- Explore/Expand Collaboration
 - *Delaware Environmental Institute (DENIN) – EPSCOR*
 - *Delaware National Estuarine Research Reserve (DNERR)*
- Explore new funding opportunities
 - *Incorporate select WATAR projects into Water Pollution Control revolving loan program (e.g., NVF-Yorklyn first example)*
 - *Clean Water for Delaware's Future; Task Force on Flooding & Water Quality*
 - *William Penn Foundation*
 - *Christina Conservancy*
- Executive Order 41 – Prepare for Sea Level Rise

NEXT 5 YEAR PLAN (2017-2021)

- Develop Delaware specific bioaccumulation metrics (BAF/BSAF)
- Publish findings. Examples:
 - *Mirror Lake*
 - *Black carbon measurements in water column & sediment and role in partitioning*
 - *Simultaneous measurements in surface water, sediment and fish (therefore, BAFs & BSAFs). Unique dataset regionally and nationally.*
- Refine database and usage
- Learn/Adapt/Grow/Provide Meaningful Insight

CONTACT INFORMATION

[HTTP://WWW.DNREC.DELAWARE.GOV/DWHS/SIRB/PAGES/WATAR.ASPX](http://www.dnrec.delaware.gov/dwhs/sirb/pages/watar.aspx)

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