

Status of Baseline Monitoring in the Delaware River Basin before Natural Gas Development

Monitoring Advisory Committee (MAC)
January 9, 2013



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DRBC Ambient Monitoring Framework for Natural Gas Development

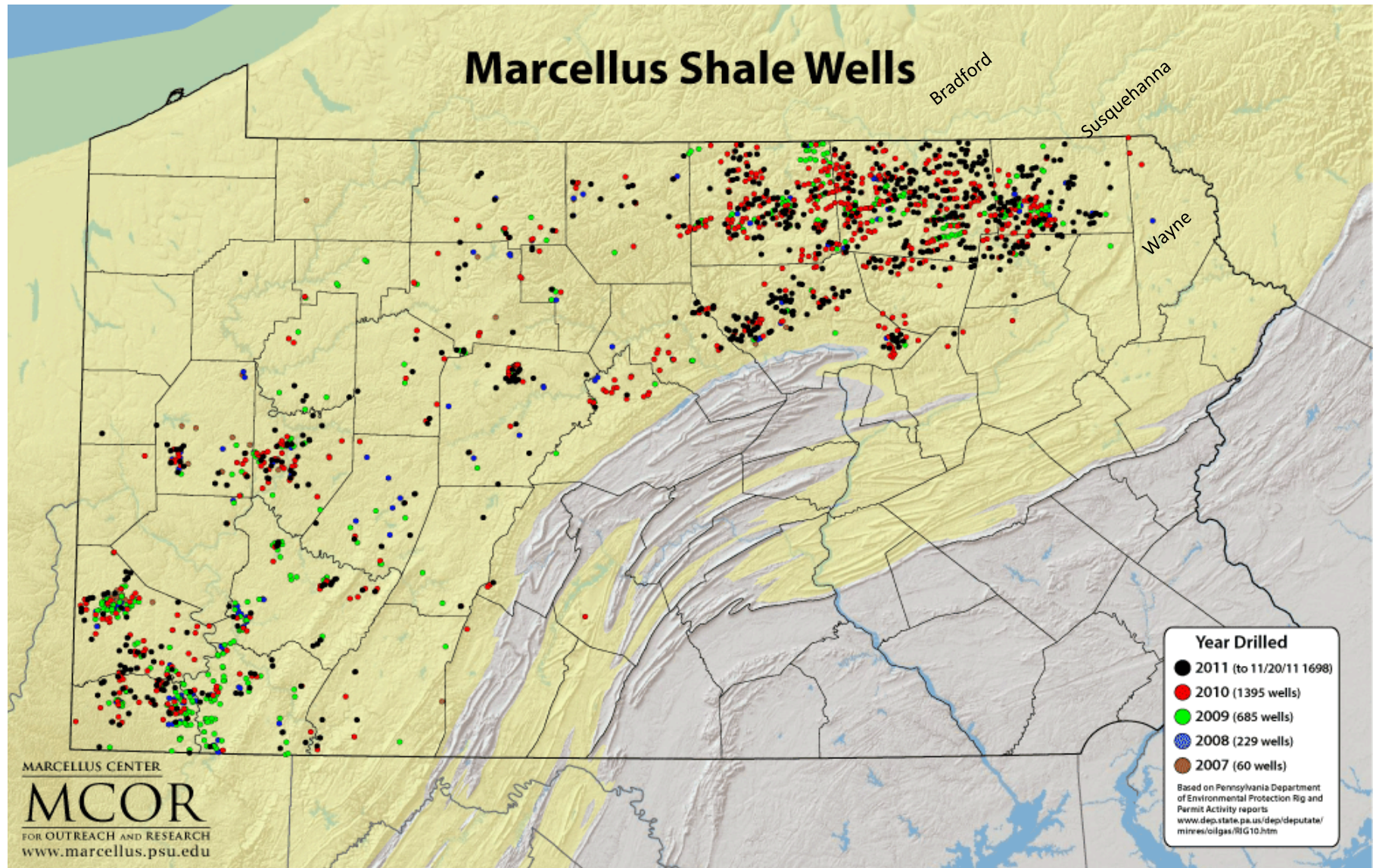
- Background
- DRBC Monitoring Activities
 1. HOBO Conductivity Loggers
 2. Reanalysis of archived samples
 3. Biological Monitoring
 4. Toxicity Testing
- Next steps
 1. USGS Gage upgrades (*applied*)
 2. NORMs (*applied*)
- Partnerships



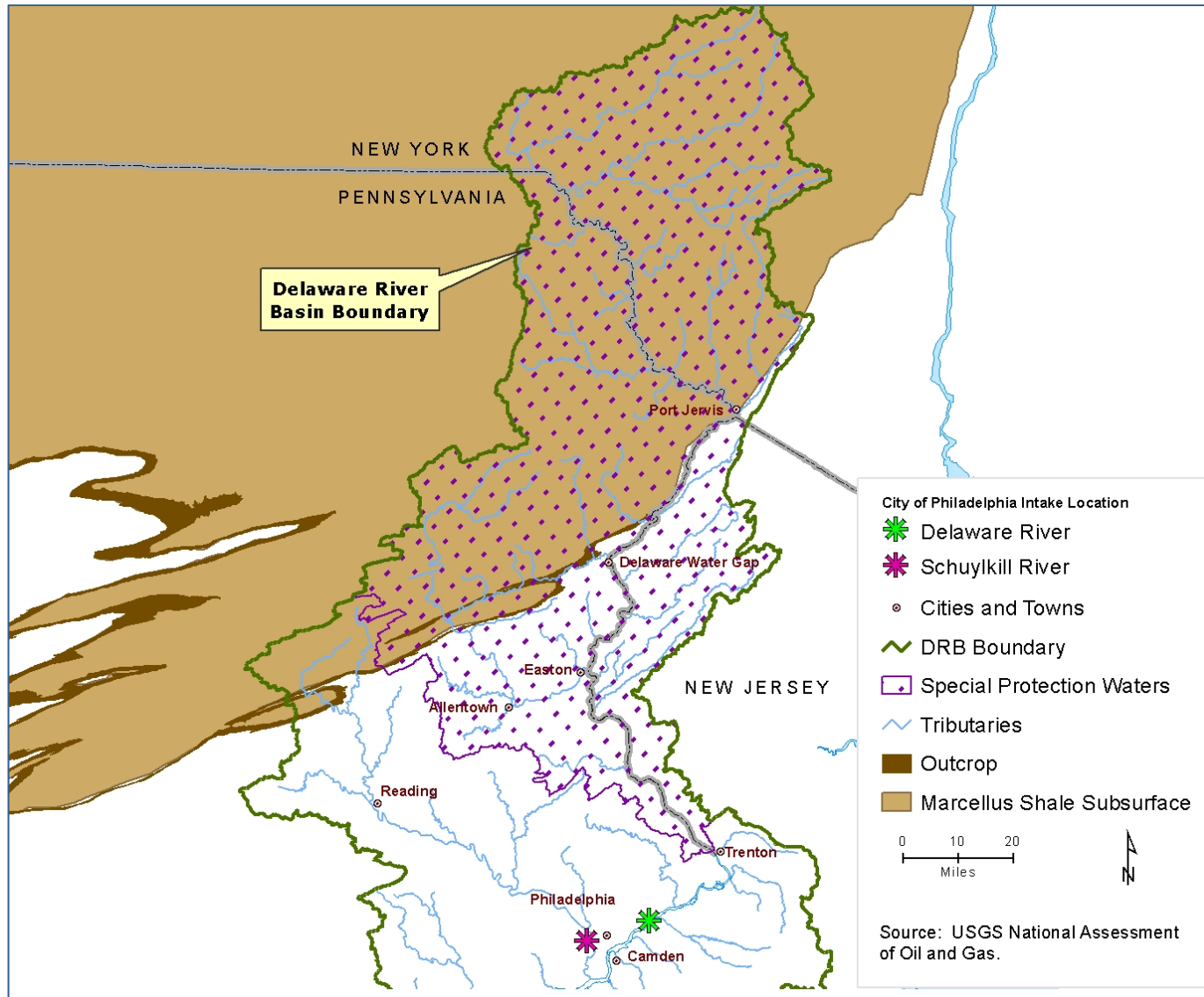
Background

- In May 2010 Commissioners postponed approval of shale gas development, called for new regulations.
- ***Narrow window of opportunity*** to establish pre-drilling conditions.
- Marcellus shale underlies basin's Special Protection Waters area, requiring No Measurable Change to existing water quality.
- Aqueous wastes from hydraulic fracturing dramatically different than WWTP effluent or non-point runoff.

Drilling Activity from 2007- Nov 2011



Marcellus Shale and Special Protection Waters



36% (4,937 mi²) of the Delaware Basin is underlain by the Marcellus Shale

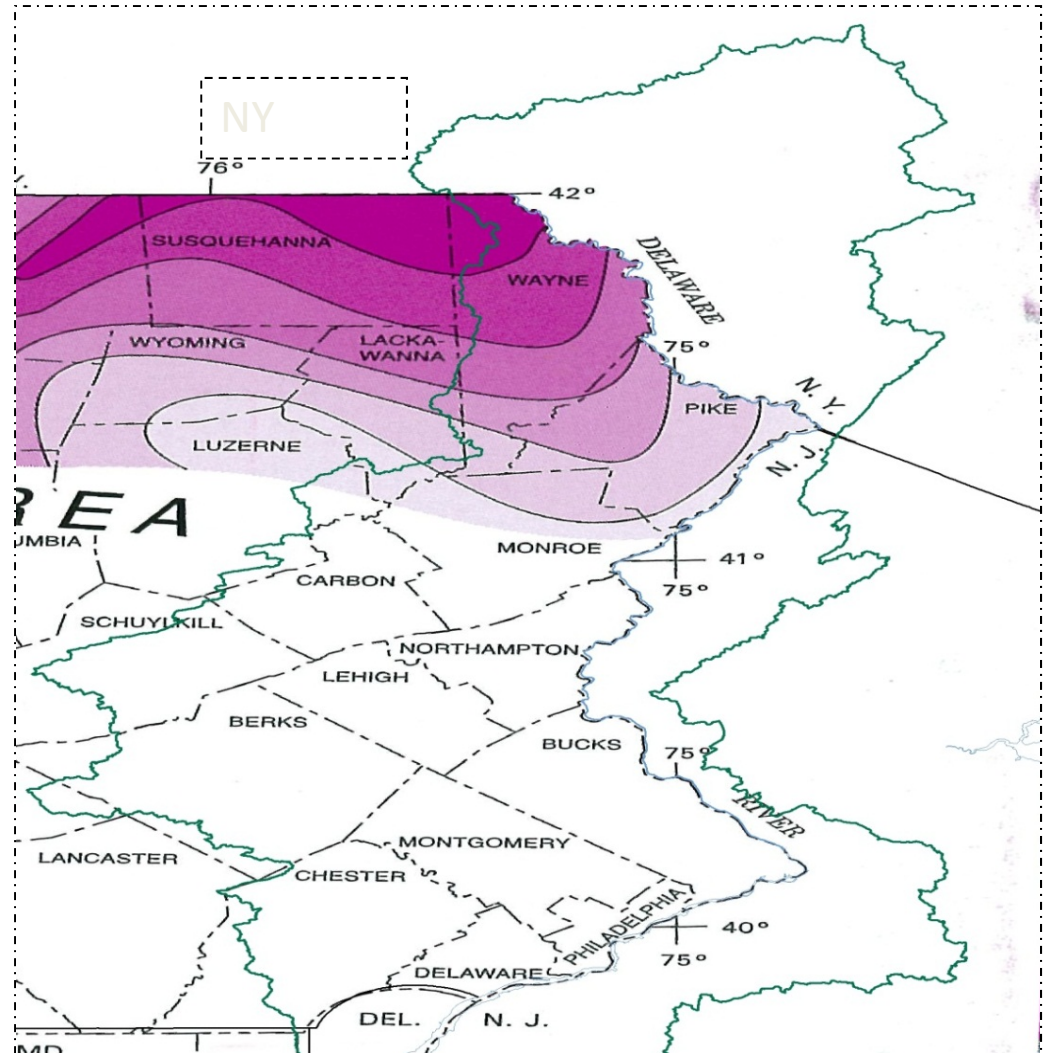
Areas with the Greatest Shale Gas Potential

Darker pink indicates greater percentage of organic shale and greater gas shale potential.

Organic carbon data from 19 samples in New York averaged 4.3%.

In east-central Pennsylvania, organic carbon ranged from 3 to 6% (Millic, 2006).

Source: Eastern Gas Shale Evaluation Project 1977-80 as modified by the Piotroski and Harper 1979.

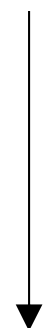


From Pennsylvania Geology Vol 38 No.1 Spring 2008

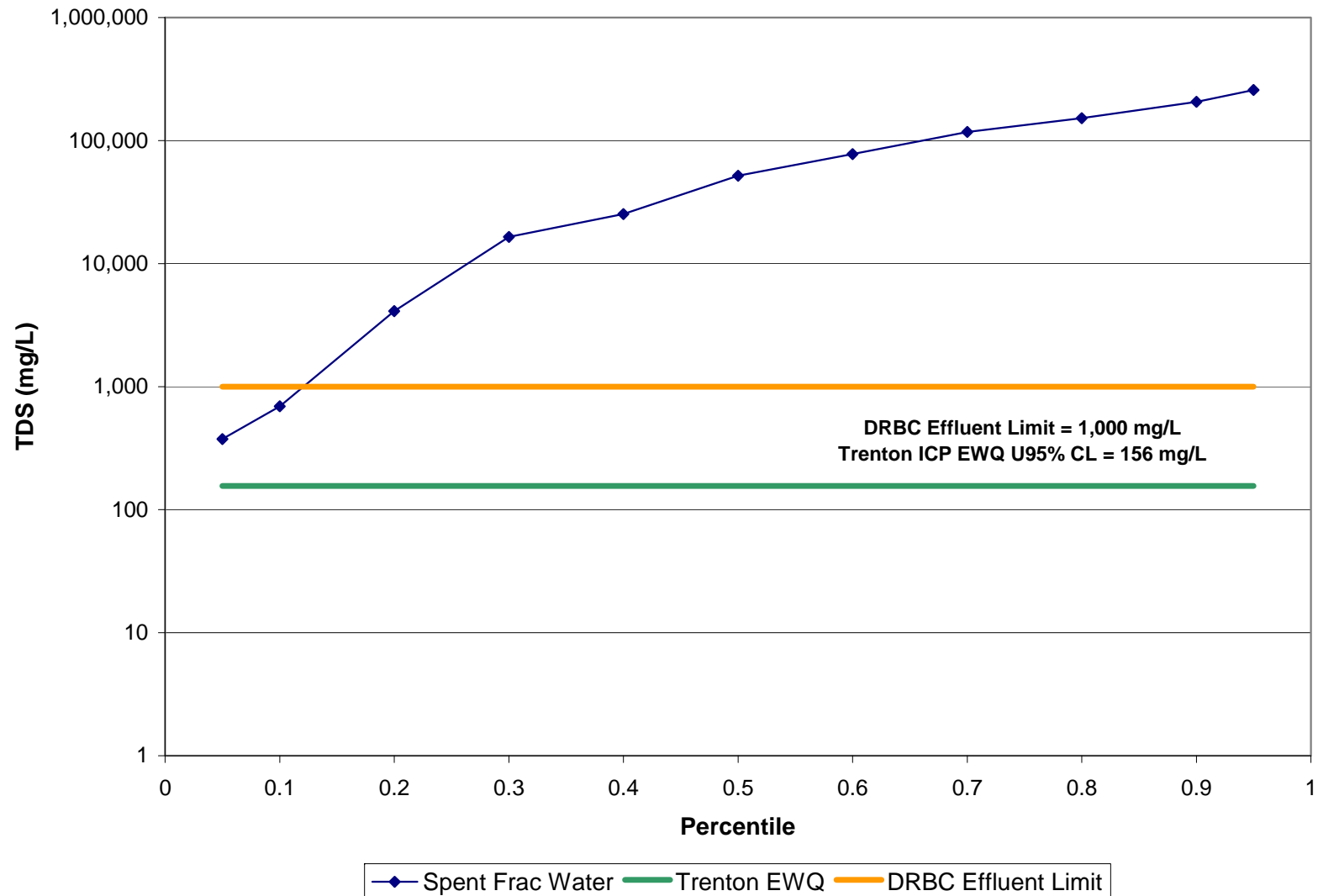
***“Sampling and Analysis of Water Streams Associated with the
Development of Marcellus Shale Gas”***
prepared for Marcellus Shale Coalition, December 2009



Parameter Group	Results (mg/L)
Total Dissolved Solids mg/L 10 SM18 2540 C	81,627.02
Chloride mg/L 1 MCAWW 300.0A	49,472.68
Hardness, as CaCO3 mg/L 5 SM20 2340C	24,787.62
Sodium-DISS ug/L 5000 SW846 6010B	21,710.21
Sodium ug/L 5000 SW846 6010B	20,197.76
Calcium-DISS ug/L 5000 SW846 6010B	6,949.16
Chemical Oxygen Demand (COD) mg/L 10 MCAWW 410.4	6,686.42
Calcium ug/L 5000 SW846 6010B	6,518.05
Strontium-DISS ug/L 50 SW846 6010B	1,510.51
Strontium ug/L 50 SW846 6010B	1,433.30
Barium-DISS ug/L 200 SW846 6010B	1,156.48
Barium ug/L 200 SW846 6010B	1,149.11
Magnesium-DISS ug/L 5000 SW846 6010B	586.62
Biochemical Oxygen Demand mg/L 2 SM18 5210 B	553.74
Magnesium ug/L 5000 SW846 6010B	548.72
Bromide mg/L 1 MCAWW 300.0A	507.77
Potassium-DISS ug/L 5000 SW846 6010B	483.34
Potassium ug/L 5000 SW846 6010B	461.04
Total Suspended Solids mg/L 4 SM20 2540D	338.70
Dissolved Organic Carbon mg/L -- SM20 5310B	316.98
TOC mg/L 1 SM20 5310B	297.40
Acidity mg/L 5 SM20 2310B (4a)	250.66
Total Alkalinity mg/L 5 SM18 2320 B	131.50
Sulfate mg/L 1 MCAWW 300.0A	104.56



Aqueous Waste TDS Percentiles (log scale)



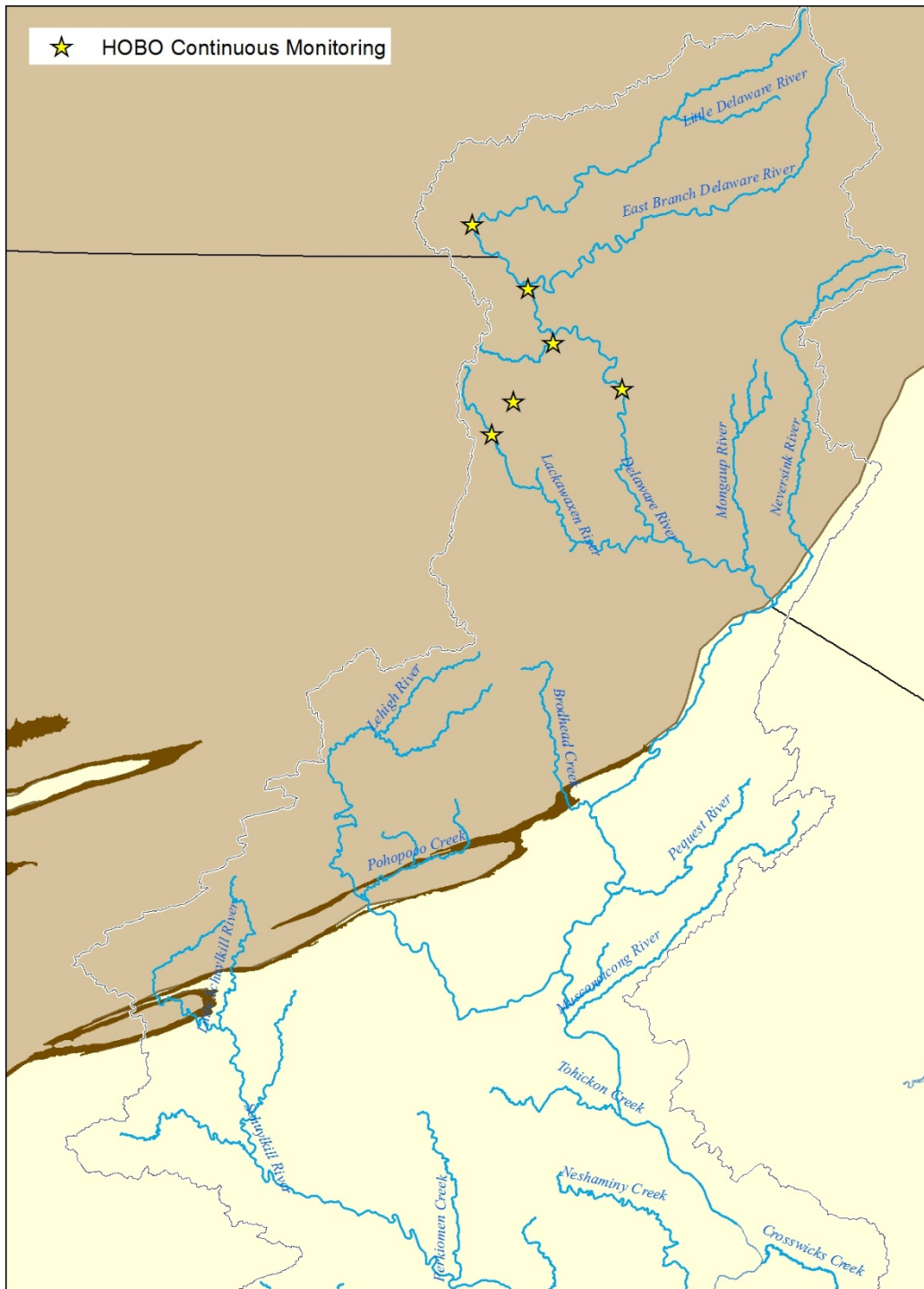
HOBO-U24 Conductivity / Temperature Logger



HOBO-U24 Deployment



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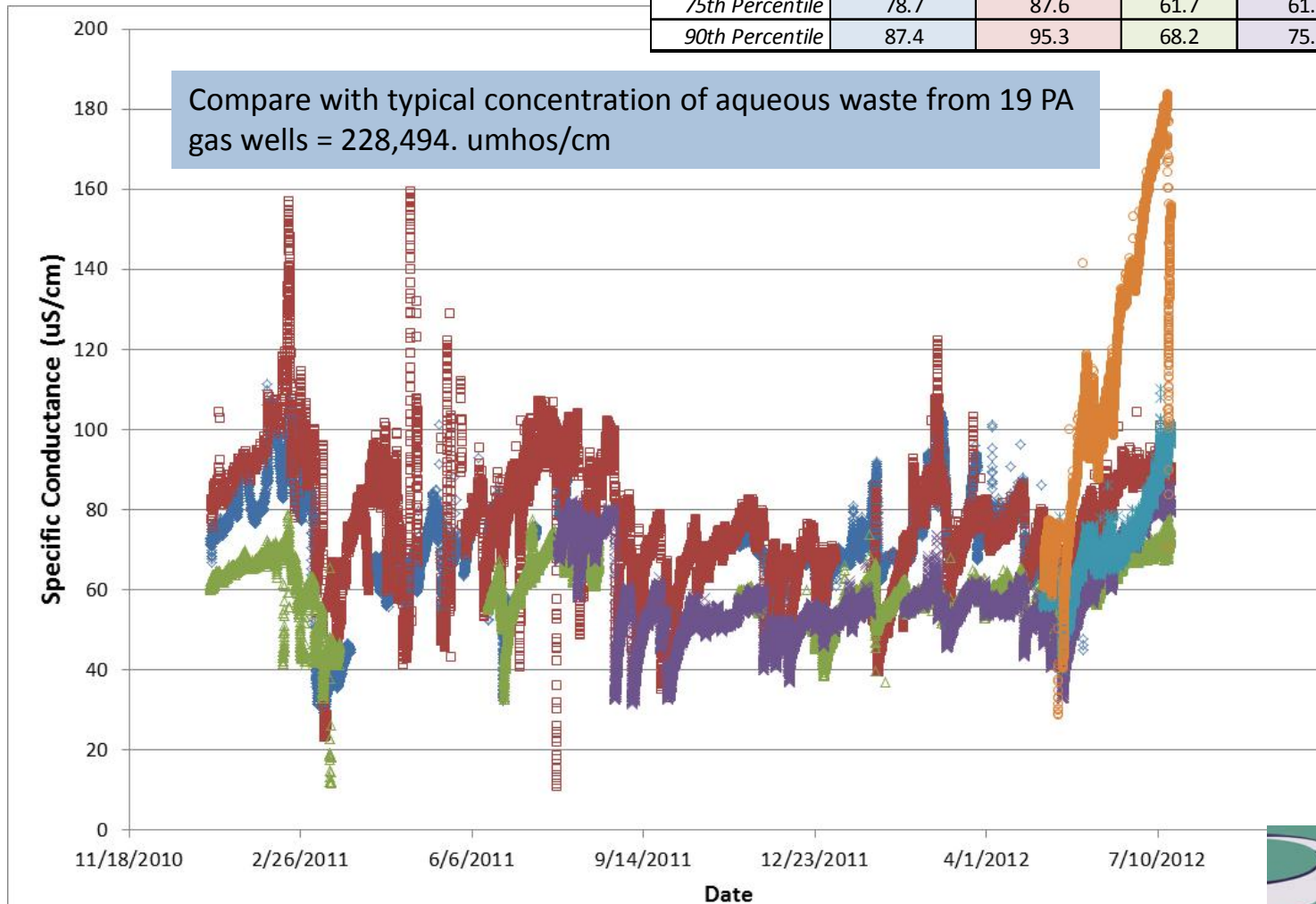


Deployment of HOBO SpecCond/Temp

For establishing
background
specific
conductivity
including road salt
runoff

Specific Conductance Baseline

	Delaware River at Callicoon	West Branch Lackawaxen	Equinunk Creek	Middle Branch Dyberry Creek	Shehawken Creek	Oquaga Creek
10th Percentile	55.2	57.2	50.5	47.1	57.2	72.2
25th Percentile	64.5	67.5	55.2	51.9	62.7	93.2
Median	70.1	76.8	58.2	55.7	70.0	111.1
75th Percentile	78.7	87.6	61.7	61.2	75.7	142.9
90th Percentile	87.4	95.3	68.2	75.3	88.5	169.3



- ◇ Delaware River at Callicoon
- West Branch Lackawaxen
- △ Equinunk Creek
- × Middle Branch Dyberry Creek
- ✱ Shehawken Creek
- Oquaga Creek



Reanalysis of Archived Samples



funded by Haas Foundation Grant and
National Park Service

- Approx. 700 archived samples from Delaware River and tributary control points collected in 2009 and 2010.
- Upper, Middle, and Lower Delaware archived samples were analyzed for selected parameters identified in flowback samples.
- Approximately 500 samples taken by the Scenic Rivers Monitoring Program in 2011 were also analyzed for flowback parameters.
- Three years of data to represent pre-drilling baseline chemical conditions.

Analytical Parameters

Analyses conducted by Academy of Natural Sciences of Philadelphia and Smithsonian Institution

<u>Parameters</u>	<u>Method</u>
Filtration of Sample	Vacuum filtration
Na, Mg, Ca, K	Ion Chromatograph
Barium, Strontium	ICP-OES
Chloride	Titration
Bromide	Flow Injection
Sulfate	Flow Injection or turbidimetric
Total Alkalinity	Titration
Total Hardness	Titration
TDS	Evaporation, gravimetric

Total 2009-2010 Archived Samples

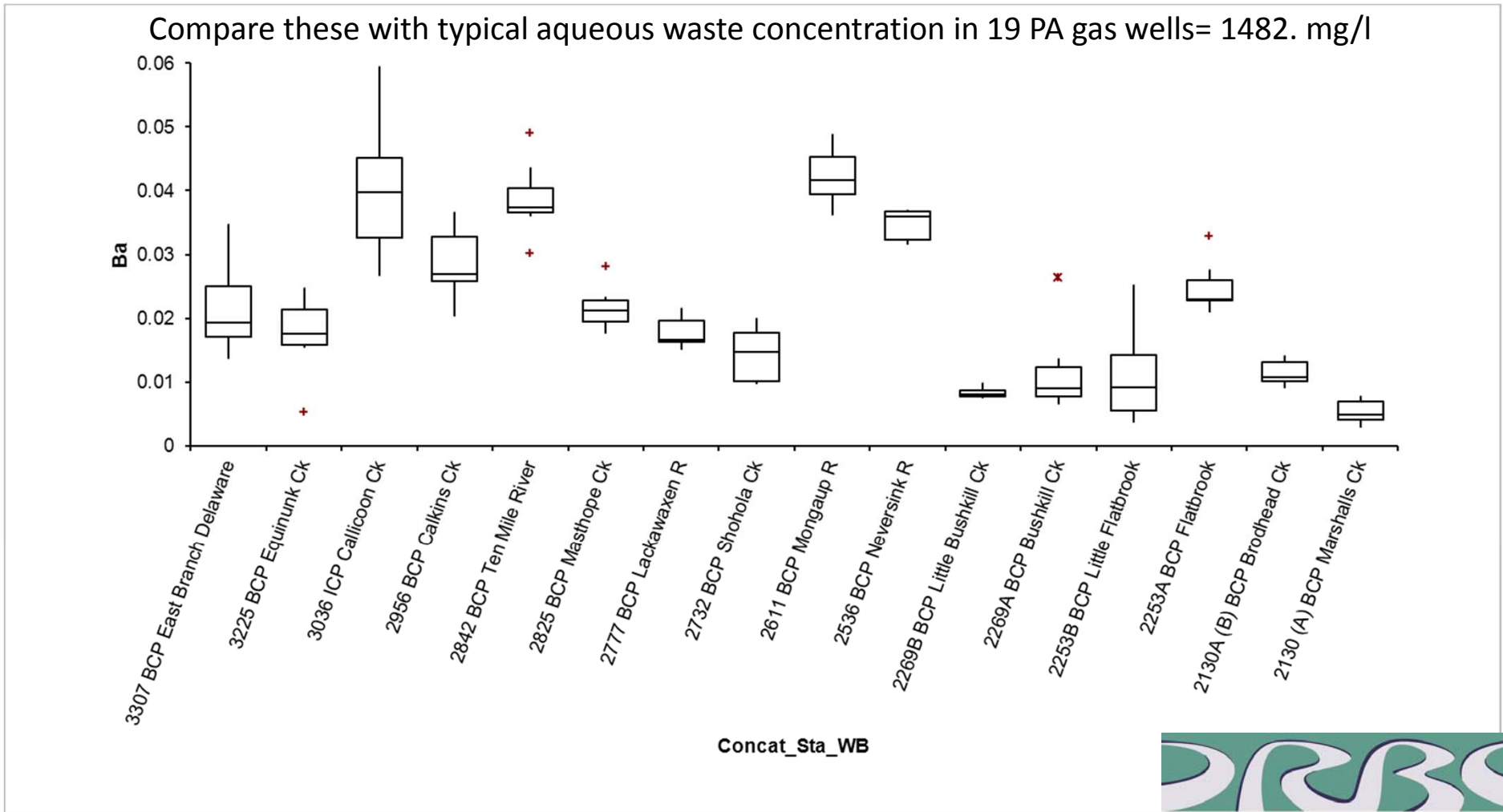
	<u>BCP</u>	<u>ICP</u>		<i>Subtotals</i>
<u>Upper</u>	149	135		284
<u>Middle</u>	95	94		189
<u>Lower</u>	145	99		244
<i>Subtotals</i>	389	328		
Total	717			

Locations of Archived Samples



Preliminary Results from 2009/2010 Archived SRMP Samples

Dissolved Barium mg/l

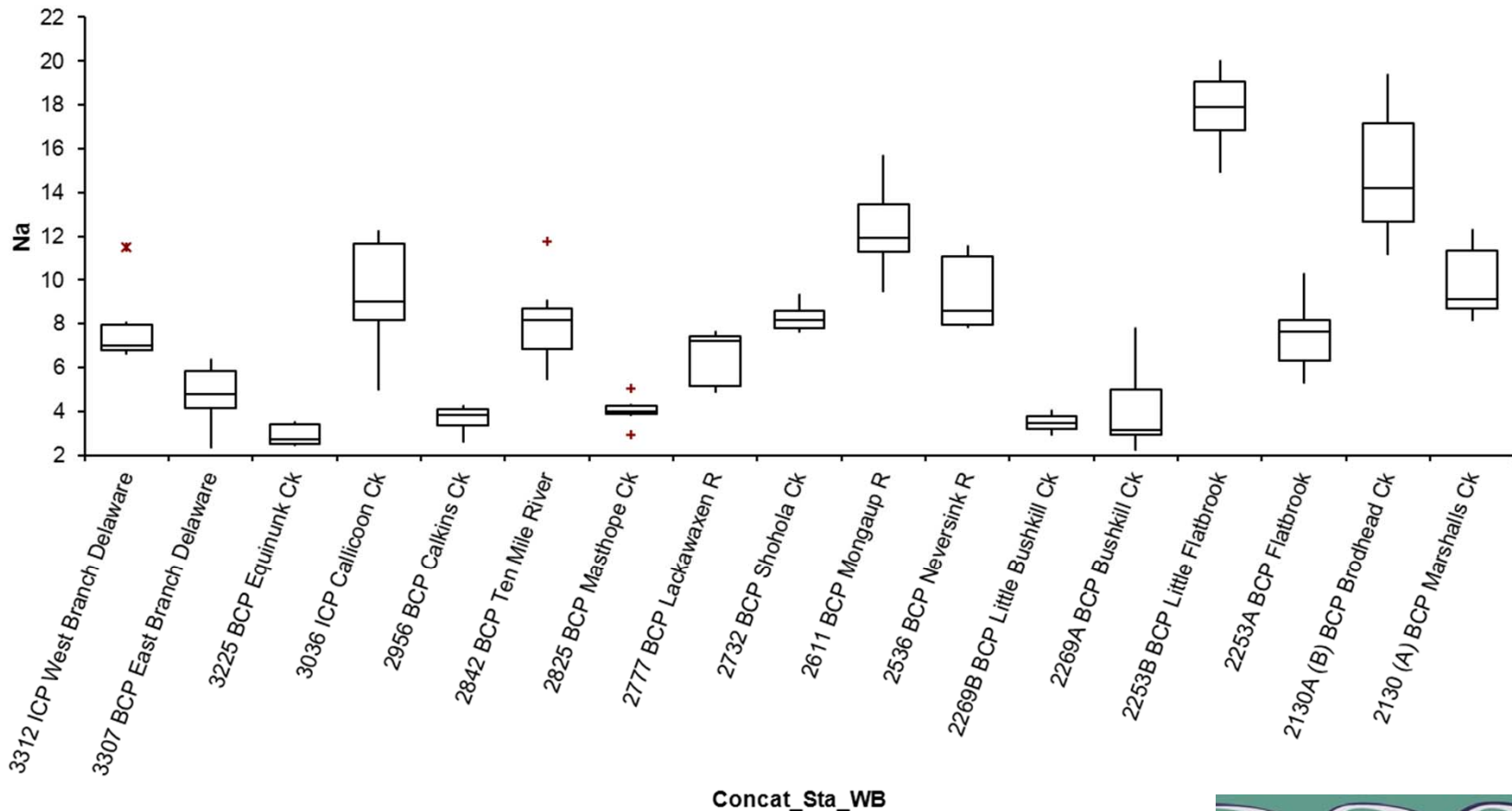


SRMP = DRBC/NPS Scenic Rivers Monitoring Program

Preliminary Results from 2009/2010 Archived SRMP Samples

Dissolved Sodium mg/l

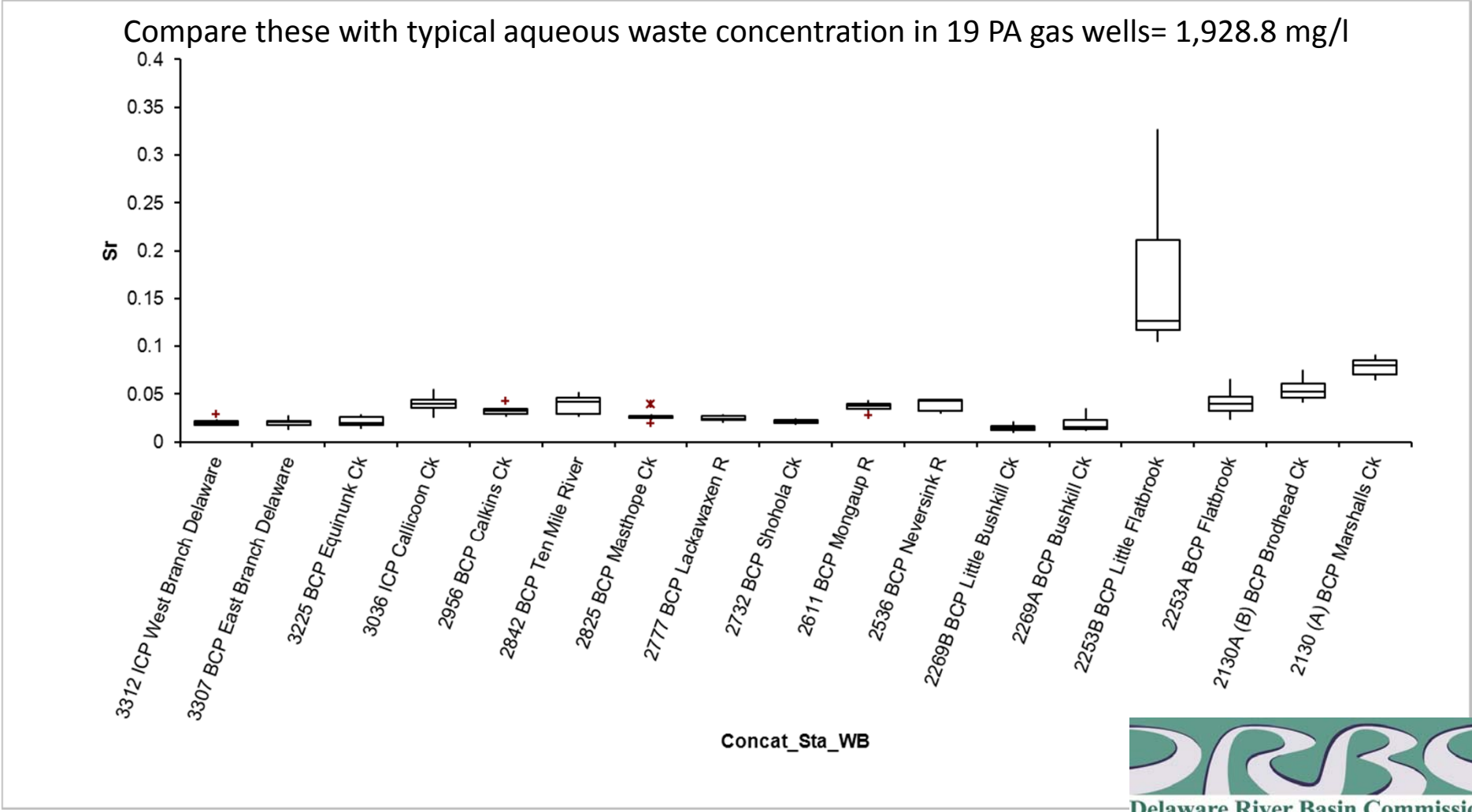
Compare these with typical aqueous waste concentration in 19 PA gas wells= 27,674. mg/l



SRMP = DRBC/NPS Scenic Rivers Monitoring Program

Preliminary Results from 2009/2010 Archived SRMP Samples

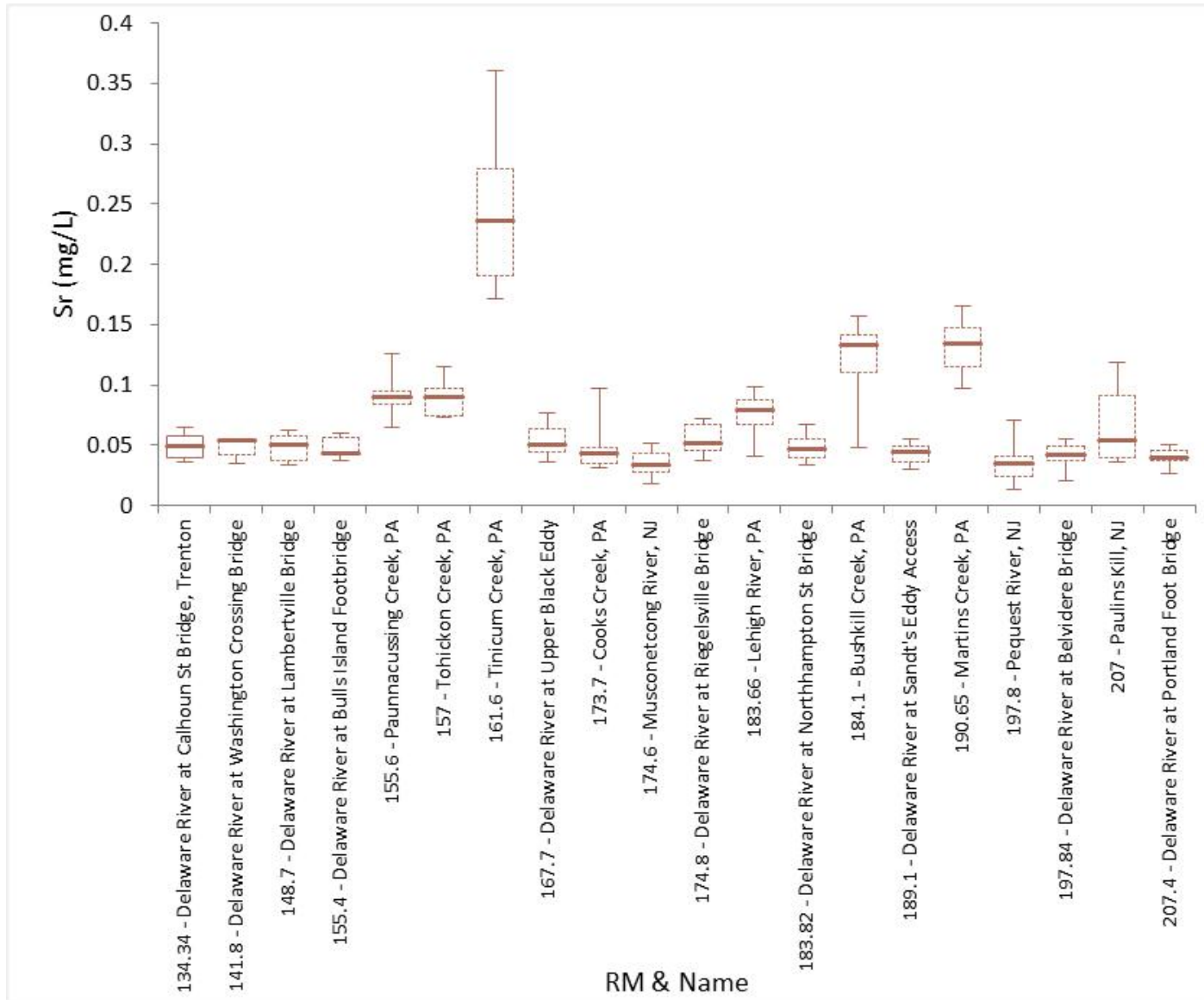
Dissolved Strontium mg/l



SRMP = DRBC/NPS Scenic Rivers Monitoring Program



Preliminary Results from 2009/2010 Archived Lower Delaware Samples Dissolved Strontium mg/l



Summer 2011 Biomonitoring



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Ambient Biomonitoring – 2011

funded by Haas Foundation Grant



□ Steps

1. Identified existing baseline sites (NYSDEC, PADEP, USGS, EPA).
2. Targeted new sites in 28 HUC-12 watersheds PA/NY.
3. Stations selected to complement the locations of other state and federal quantitative monitoring sites sampled since about 2000.
4. Used state-specific monitoring protocols.
5. April: 35 sites sampled in PA using PADEP methods.
6. July/August: 68 sites sampled in NY using NYSDEC methods.
7. N= 5 to 7 for each of 28 targeted watersheds.

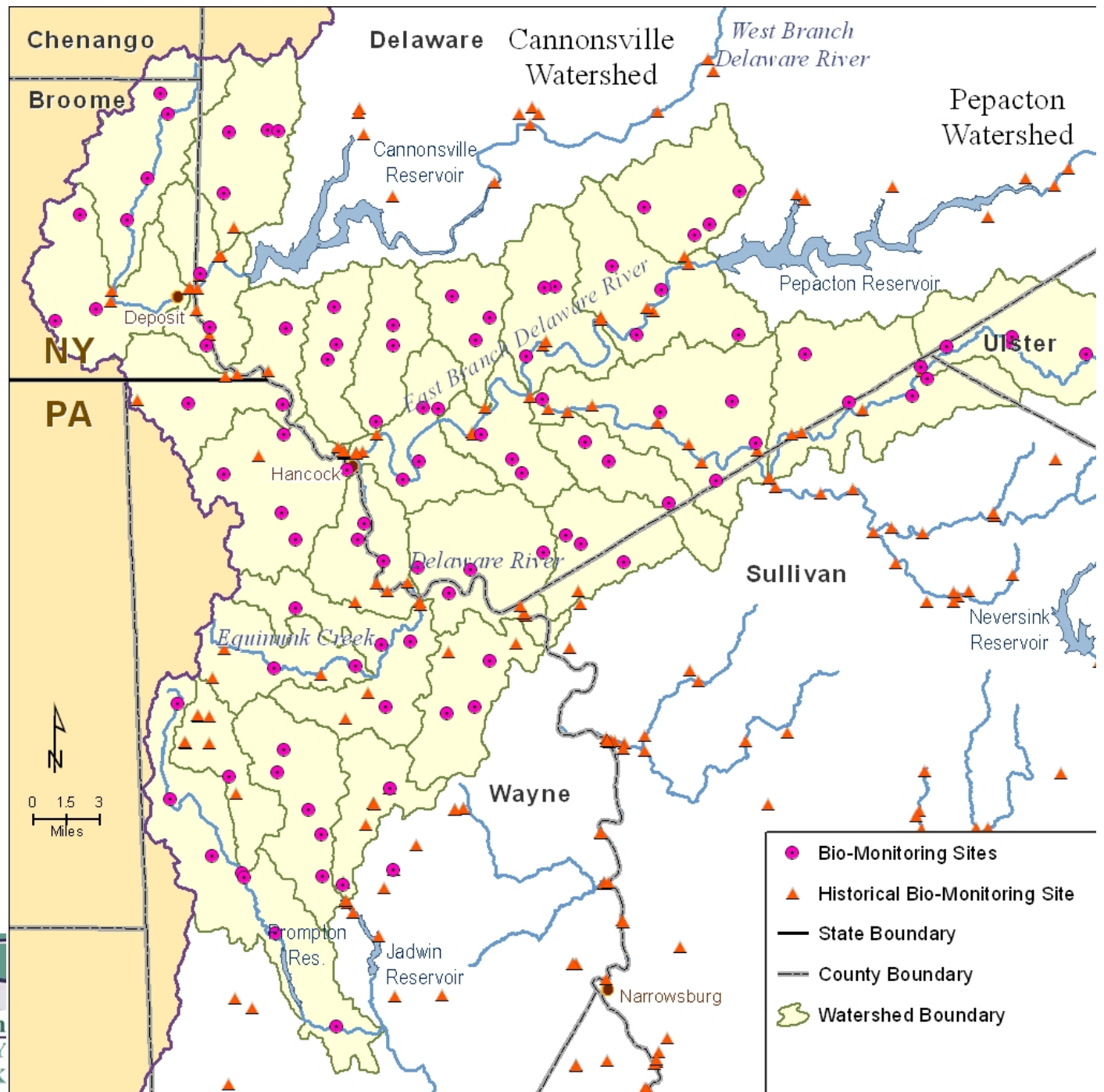
Ambient Biomonitoring - 2011

□ Steps (cont.)

8. Analysis: lab methods match state protocols; shooting for consistency with state programs / methods / index periods / data comparability.
 9. Stations covered a range of stream types from small headwater streams to larger main stem streams and rivers within each HUC12.
- DRBC also plans an annual ambient monitoring survey (total of 150 sites with 75 sampled per year) to assess biological and habitat changes in the region.

2011
Spring / Summer
Biomonitoring Sites

Wayne, Delaware,
Broome, Sullivan,
and Ulster County
Sub-Watersheds



DRBC/Stroud Mayfly Toxicity Testing

- ❑ The headwaters of the Delaware River Basin are typically soft (hardness - 21 mg/l) with low ionic strength (Spec. Conductivity - 68). These water quality characteristics may influence the effects of pollutants.
- ❑ To evaluate the use of alternative toxicity test species and the impact of these waters on the response of traditional toxicity test species, the Commission is working with the Stroud Water Research Center



Centropilum triangulifer
Photo from: www.discoverlife.org

DRBC/Stroud Mayfly Toxicity Testing



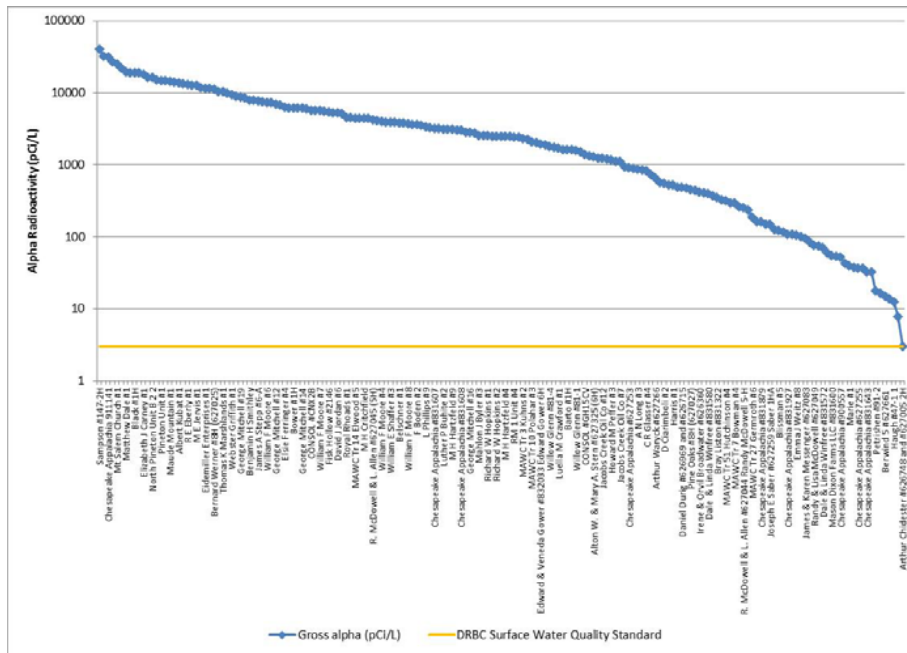
- Project tasks (2012) include:
 - Collecting pre-drilling alteration surface water samples in upper basin tributaries;
 - Collecting representative samples of natural gas drilling flowback/production water;
 - Sample analysis for physical-chemical parameters;
 - Toxicity testing using modified whole effluent toxicity test methods (*Pimephales promelas*, *Ceriodaphnia dubia*, and *Pseudokirchneriella subcapitata*)
 - Toxicity testing using alternative test procedures using native mayflies (*Centroptilum triangulifer*, *Procloeon rivulare* and *Pseudocloeon frondale*)

Possible Next Steps

- Some additional pre-gas expansion possibly including more HOBOS sites, follow up biological monitoring, and continued analysis of gas-related parameters in existing monitoring programs;
- With commencement of gas development, implement monitoring requirements in draft regulations;
 - Site specific;
 - Regional monitoring;
- Improved infrastructure including telemetry;
- Continued close coordination with partner organizations.

NORMs and TE-NORMs (preliminary grant application)

Comparison of February 2011 NY Times gross alpha water levels to DRBC surface water quality criteria.



- 1-year quarterly monitoring
- 33 BCPs and ICPs in Upper and Middle Delaware;
- Gross alpha & gross beta
- Radium -226 + Radium-228
- 30 follow-up samples in reserve for additional characterization at selected sites



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Upgrade Select USGS Monitors with Specific Conductance (*preliminary grant application*)

- Specific Conductance very responsive to hydraulic fracturing aqueous waste streams;
- Conductance is an easier upgrade than full DO and pH;
- Existing communication infrastructure + *Water Alert* = Early Warning Network;
- Seeking funding to upgrade ~13 gages;
- Capital plus 3-years O&M;
 - If production commences, transition to other O&M funding;
 - If not, decommission conductance;
- Partnering with USGS.



Partnerships



- DRBC
- U.S. Geological Survey
- National Park Service
- PADEP
- NYSDEC
- Stroud Water Research Center
- Dickinson University
- Delaware Riverkeeper Network
- Academy of Natural Sciences
- Smithsonian Institution
- U.S. EPA; Haas Foundation (funders)
- QC Laboratories Inc.; Axis Labs; EcoAnalysts Inc. (lab support)



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Questions?



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