

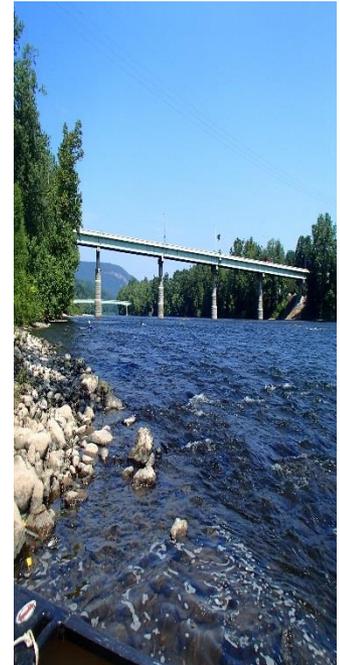
Delaware River Basin Commission

Advances in Implementation of Antidegradation Policies and Practices in Delaware River Basin Commission Special Protection Waters

*DRBC Science and Water Quality Management
Scenic Rivers Monitoring Program*

AWRA Mid-Atlantic Conference

*Robert Limbeck, Sr. Aquatic Biologist
September 16, 2016*



Special Protection Waters Reaches of the Delaware River



Special Protection Waters designated for entire non-tidal Delaware River

SPW rules cover $\approx 6,780$ of the 13,800 sq. mi. Delaware River Basin watershed area

DRBC/NPS Scenic Rivers Monitoring Program (SRMP)

~ 200 miles of Delaware River + most tributary watersheds

Special Protection Waters Objective: Antidegradation of Existing Water Quality

- *It is the policy of the Commission that there be no measurable change in existing water quality except towards natural conditions in waters considered by the Commission to have exceptionally high scenic, recreational, ecological, and/or water supply values.*

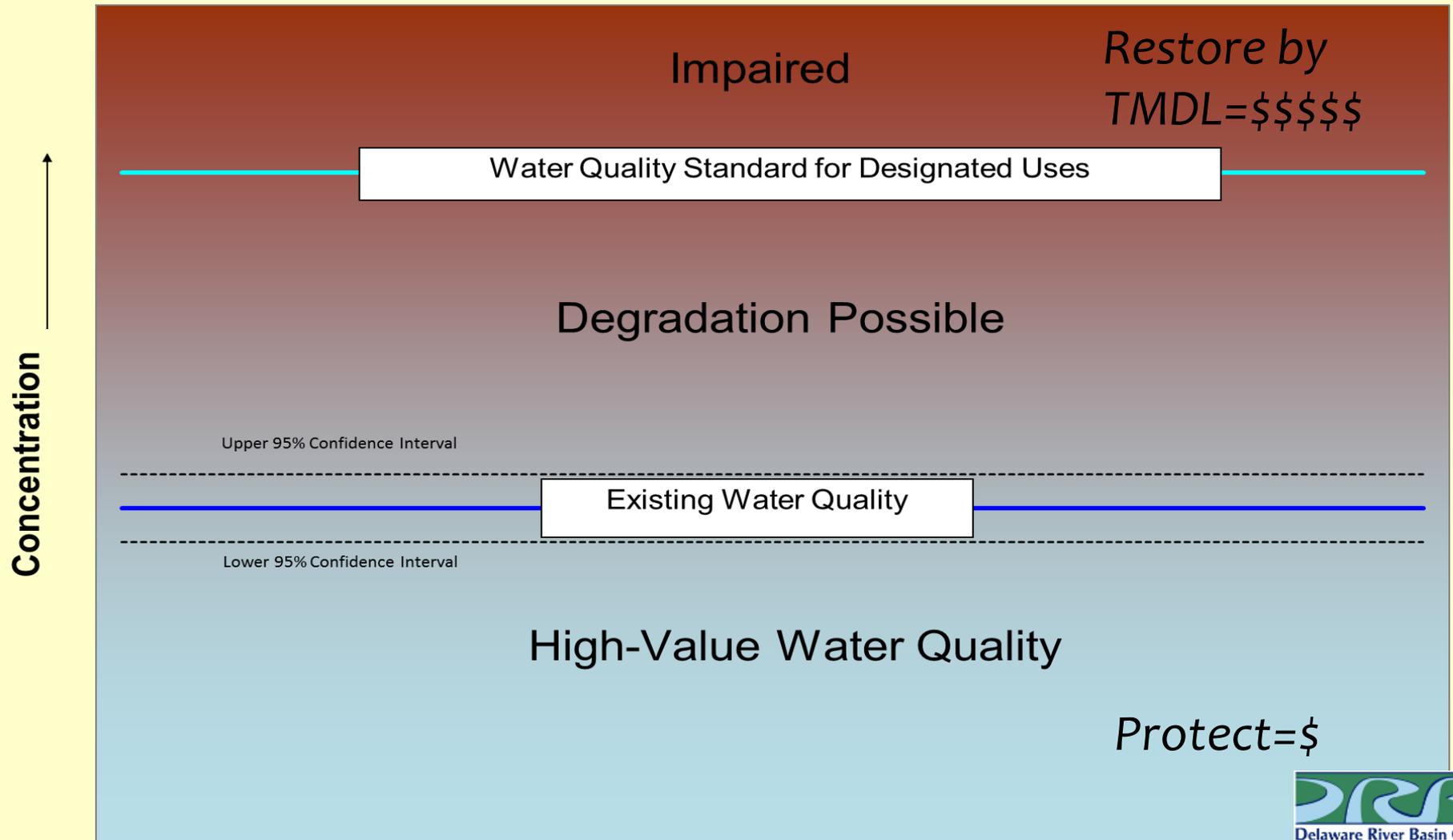
– Sec 3.10.3A.2.

Assess to confirm this

Define this

What is EWQ? Policy, Not Criteria

Comparison of Existing Water Quality versus Standards



SPW Program Advancements Since the Delaware Riverkeeper Petitions to DRBC and Initial Rulemaking

- First Assessment of Measurable Change was successfully completed
 - See Lower Delaware Measurable Change Assessment 2016
- Site-Specific Existing Water Quality is complete for 85 sites and growing
 - See Existing Water Quality Atlas of Delaware Basin SPW 2016
- Cumulative Watershed Assessment of Discharges with Models
 - Occurs during No Measurable Change Evaluation step of permitting
- Outreach is improving
 - Interactive Story Map service using ARC-MAP
 - Building R code, Shiny Apps, Dashboards to view water quality information
- USGS tools and studies have contributed greatly to SRMP success
- SRMP is integrated and complimentary with State monitoring
- U.S. EPA and NPS support have been critical to SRMP capabilities

Lower Delaware Measurable Change Assessment 2009-2011

2016



Lower Delaware River Special Protection Waters

ASSESSMENT OF MEASURABLE CHANGES TO EXISTING WATER QUALITY,
ROUND 1: BASELINE EWQ (2000-2004) VS. POST-EWQ (2009-2011)
DELAWARE RIVER BASIN COMMISSION, SCENIC RIVERS MONITORING PROGRAM



DRBC | West Trenton, NJ

DRBC Publication is Available

Released (pdf) July 2016

Executive Summary,

24 Chapters (one per site):

Within-site measurable changes

3 Appendices:

New ICP/BCP sites

Statistical Guide

Flow Estimation Methods



http://www.state.nj.us/drbc/home/newsroom/news/approved/20160808_LDSPW-EWQrpt.html

Lower Delaware (LDEL) Sites

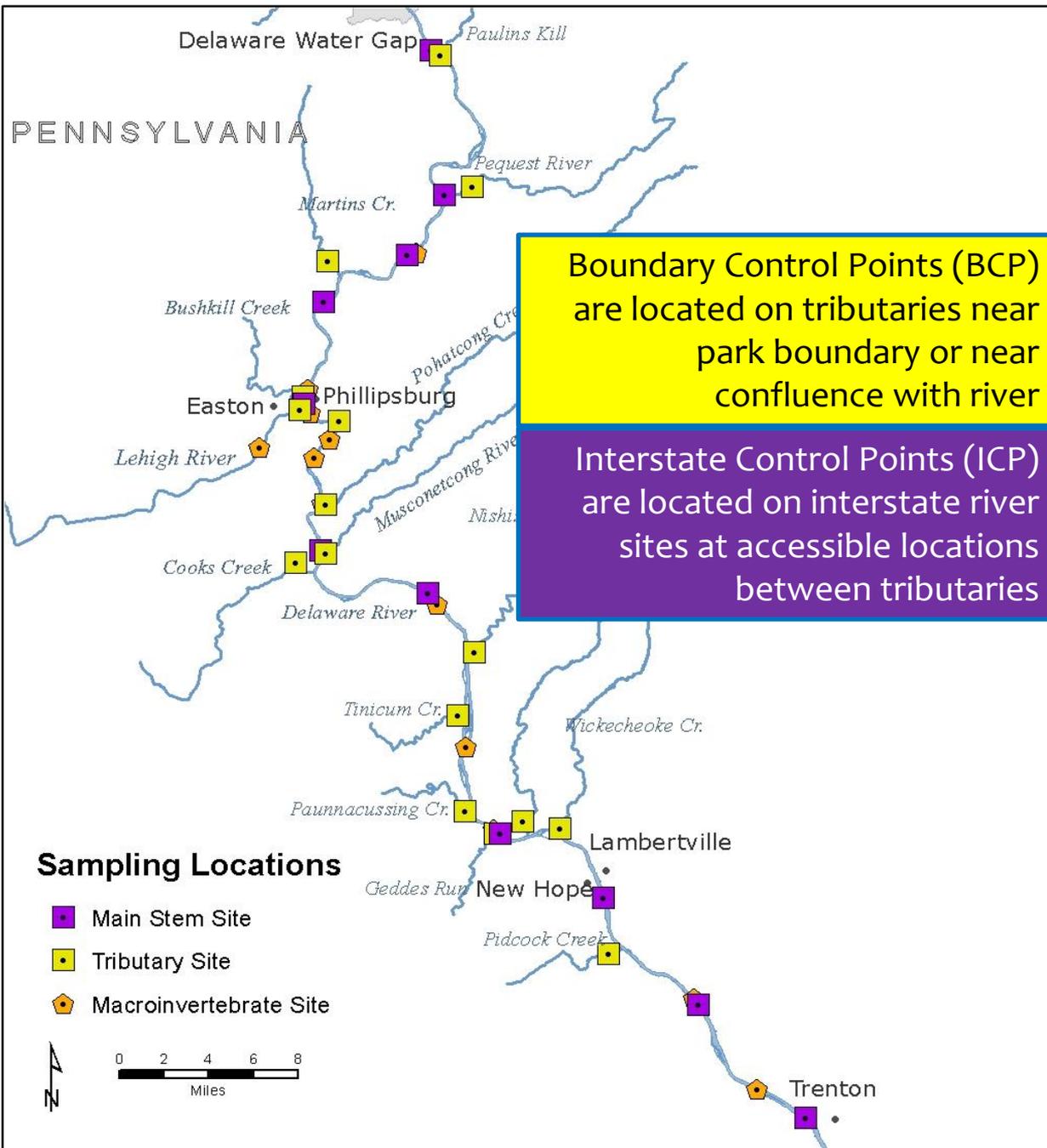
EWQ established 2000-2004 (n=40-50)

SPW Rules passed 2008

Designated as Significant Resource Waters

Assessment 1:
2009-2011

Assessment 2 planned
2019-2021



DRBC Measurable Change Assessment Process: Primary Question=Has Degradation Occurred?

Quantitative plots and statistical tests were used in combination for assessment of within-site changes to each of 20 parameters between the EWQ and post-EWQ time periods

1. Scatter Plot of Concentration vs. Stream Flow (cfs), EWQ vs. Post-EWQ
2. Scatter Plot of Annual Concentration, 2000-2011
3. Box Plot Comparison of EWQ vs. Post-EWQ Concentrations
4. Cumulative Distribution Function (CDF) Comparison of EWQ vs. Post-EWQ
5. Kruskal-Wallis Statistical Test of Difference between EWQ and Post-EWQ

Summary Matrix of Measurable Changes: 440 Within-Site Comparisons at a Glance

Good News:
88% of water quality tests showed no degradation

Site Color Key		Dark Blue → Interstate Control Point (ICP)										Dark Red → Pennsylvania Tributary Boundary Control Point (BCP)					Dark Green → New Jersey Tributary Boundary Control Point (BCP)								
Parameter	Site →	Del. River at Trenton	Del. River at Washngtn Crossing	Pidcock Creek, PA	Delaware River at Lambrtvile	Wicke-cheoke Creek, NJ	Lockatong Creek, NJ	Delaware River at Bulls Island	Pauna-cussing Creek, PA	Tohickon Creek, PA	Tinicum Creek, PA	Nishi-sakawick Creek, NJ	Del. River at Milford	Cooks Creek, PA	Musco-netcong River, NJ	Del. River at Rieglsvll	Pohat-cong Creek, NJ	Lehigh River, PA	Del. River at Easton	Bushkill Creek, PA	Martins Creek, PA	Pequest River, NJ	Del. River at Belvidere	Paulins Kill River, NJ	Del. River at Portland
	Site Number →	1343 ICP	1418 ICP	1463 BCP	1487 ICP	1525 BCP	1540 BCP	1554 ICP	1556 BCP	1570 BCP	1616 BCP	1641 BCP	1677 ICP	1737 BCP	1746 BCP	1748 ICP	1774 BCP	1837 BCP	1838 ICP	1841 BCP	1907 BCP	1978 BCP	1978 ICP	2070 BCP	2074 ICP
Field	Dissolved Oxygen (DO) mg/l										~														
	Dissolved Oxygen Saturation %										~														
	pH, units																								
	Water Temperature, degrees C																								
Nutrients	Ammonia Nitrogen as N, Total mg/l																								
	Nitrate + Nitrite as N, Total mg/l																**								
	Nitrogen as N, Total (TN) mg/l																**								
	Nitrogen, Kjeldahl, Total (TKN) mg/l																								
	Orthophosphate as P, Total mg/l																								
	Phosphorus as P, Total (TP) mg/l																								
Bacteria	Enterococcus colonies/100 ml	~			~																				
	Escherichia coli colonies/100 ml	**	**	**	**	**	**			**	**	**													
	Fecal coliform colonies/100 ml																								
Conventionals	Alkalinity as CaCO3, Total mg/l																								
	Hardness as CaCO3, Total mg/l											~													
	Chloride, Total mg/l			**		**	**	**	**	**	**	**	**	**	**	**	**	**	**	~	**	**	**	**	**
	Specific Conductance µmho/cm			**		**	**	~	**	**	**	**	**	**	**	~	**	**	~	~	~	**	~		
	Total Dissolved Solids (TDS) mg/l																								
	Total Suspended Solids (TSS) mg/l																								
Turbidity NTU																									
KEY		= No indication of measurable change to EWQ								** = Indication of measurable water quality change toward more degraded status					~ = Weak indication of measurable water quality change toward more degraded status										

Lower Delaware Assessment Findings: Measurable Changes 2000-2011

88% of tests revealed no evidence of water quality degradation; many revealed water quality improvement.

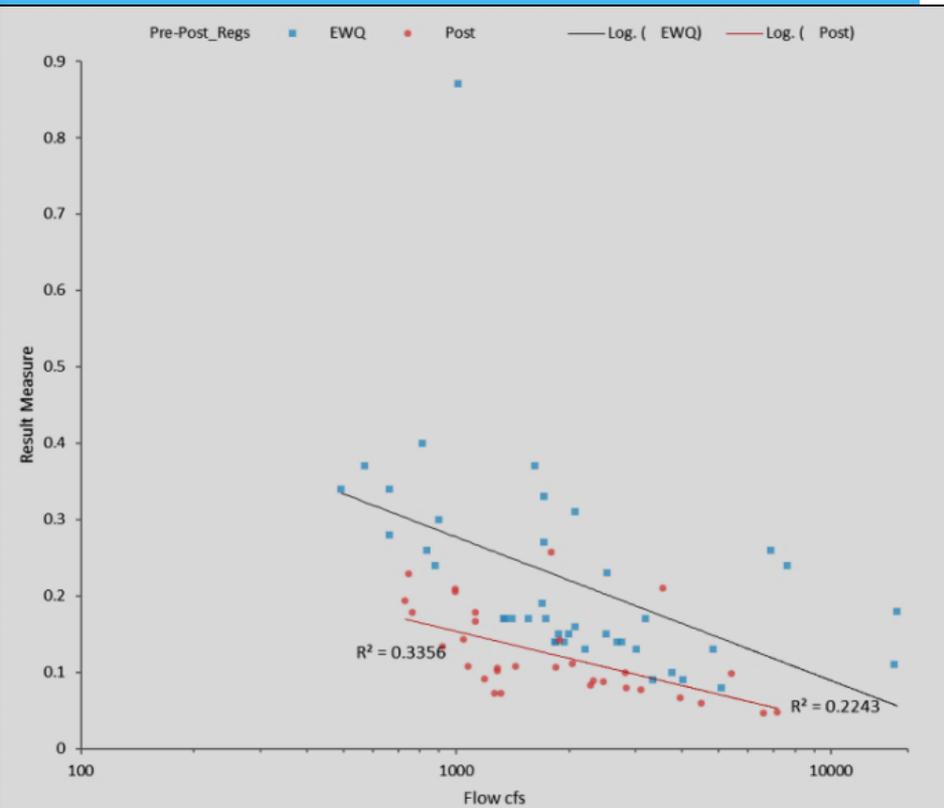
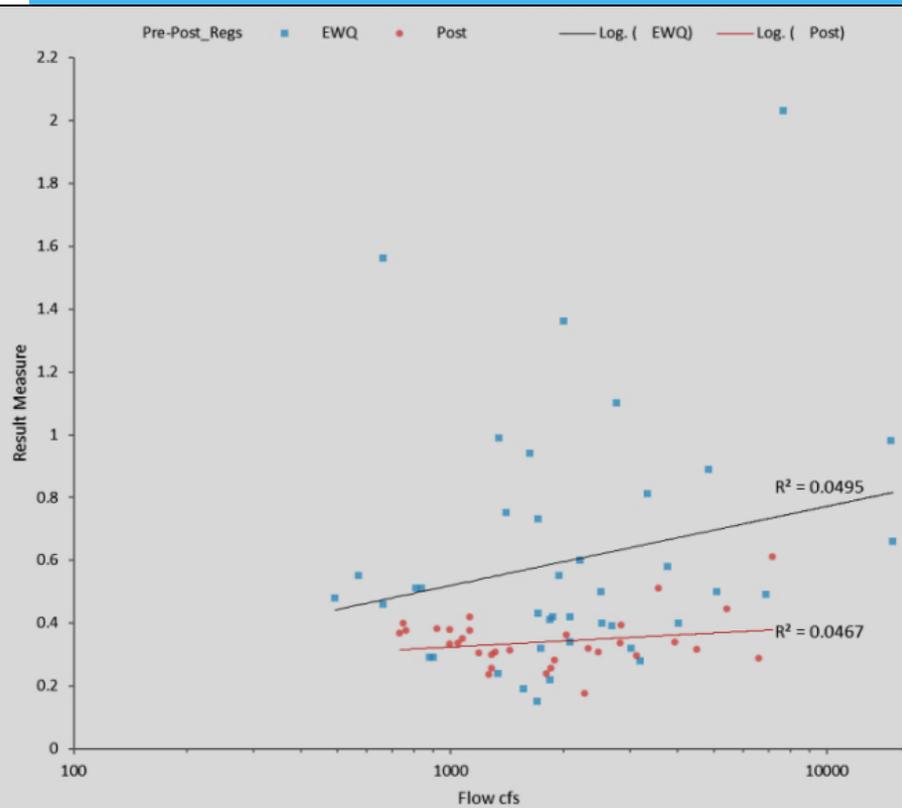
Nutrients improved at many sites since 2000. Only Pohatcong Creek increased.

Chlorides and Specific Conductance increased at almost all locations (winter road salting is most likely cause). Further continuous monitoring underway; we want to work with co-regulators on issue.

E. Coli concentrations increased from Frenchtown southward.
Enterococcus is too variable an indicator for measurable change assessment.

DRBC/NPS data compare well with USGS and State data.
30+ samples provide best resolution to detect measurable change.
Detection limits now low enough to measure conc. in high quality streams.

Water Quality Improvement Examples

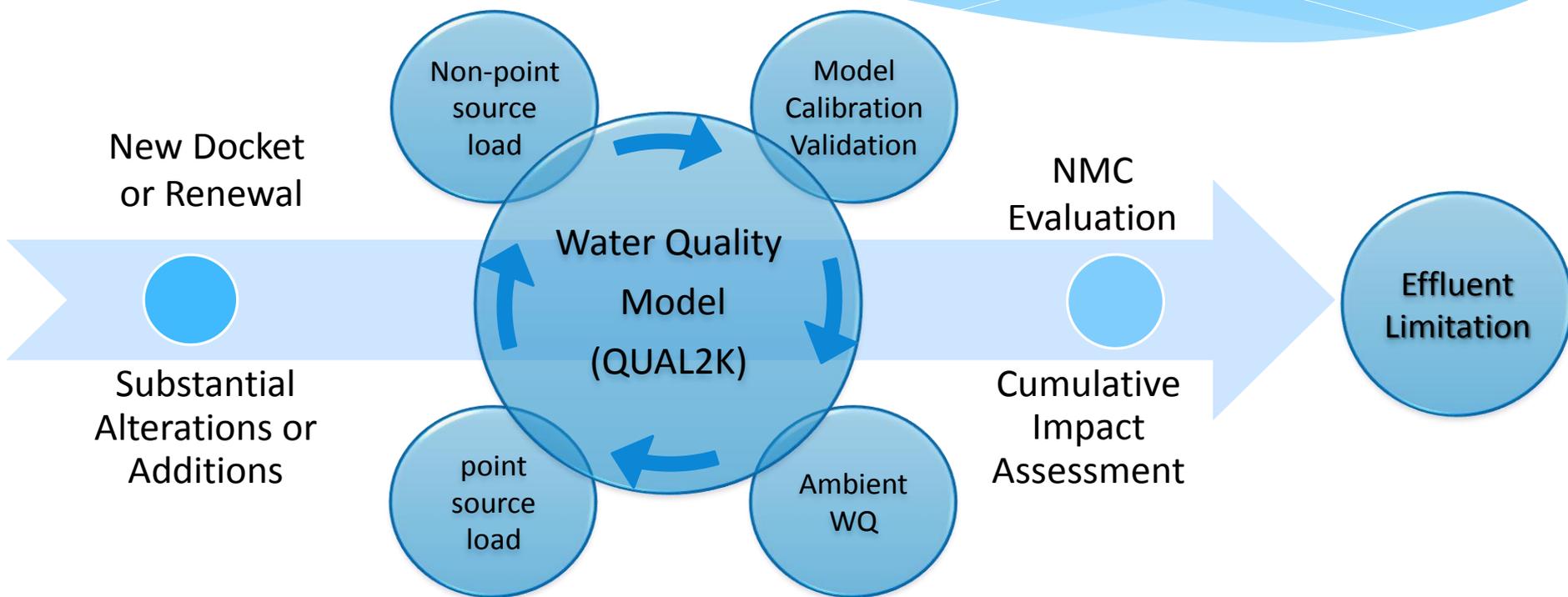


Lehigh River: Kjeldahl Nitrogen

Lehigh River: Total Phosphorus

SPW management actions may have contributed to Lehigh River nutrient reductions through numerous project review dockets. Concentrations are still high, but results may be early indication of SPW effectiveness. Improvements were statistically significant.

No Measurable Change Evaluation for Docket holders



To date, of >150 SPW dockets, 33 had NMC evaluations for wastewater permits. Of these, 21 have resulted in effluent limitations maintain EWQ. (Namsu Suk, personal communication 9/12/16).

TABLE 2I. Definition of Existing Water Quality: Easton ICP

Delaware River at Northampton Street Bridge, Easton-Phillipsburg, PA/NJ, River Mile 183.82

Parameter (Y)	Definition of Existing Water Quality			
	Median	Lower 95%CI	Upper 95%CI	Flow Relationships Site specific regression equation.
Ammonia NH3-N (mg/l) *	<.05	<.05	<0.05	
Chloride (mg/l)	16	14	17	$Y = -0.00022184 Q + 16.751$
Chlorophyll a (mg/m ³)	1.45	1.07	2.14	
Dissolved Oxygen (mg/l) mid-day*	8.10	7.90	8.58	
Dissolved Oxygen Saturation (%)	95%	92%	96%	
E. coli (colonies/100 ml)	31	24	64	$Y = \text{antilog}(0.00004425 Q + 1.273)$
Enterococcus (colonies/100 ml)	145	80	250	
Fecal coliform (colonies/100 ml) *	100	64	130	
Nitrate NO3-N (mg/l) *	0.85	0.70	0.90	
Orthophosphate (mg/l)	0.02	0.01	0.02	
pH	7.55	7.41	7.70	
Specific Conductance (umhos/cm)	142	127	155	$Y = -0.0024666 Q + 158.76$
Total Dissolved Solids (mg/l)	110	103	120	
Total Kjeldahl Nitrogen (mg/l)	0.35	0.26	0.46	
Total Nitrogen (mg/l) *	1.19	1.01	1.35	
Total Phosphorus (mg/l) *	0.05	0.04	0.06	
Total Suspended Solids (mg/l) *	4.0	3.0	5.0	$Y = 0.00177536 Q - 4.8027$
Turbidity (NTU)	2.6	1.8	4.0	$Y = \text{antilog}(0.00003836 Q + 0.1845)$
Alkalinity (mg/l)	34	30	39	$Y = -0.00073929 Q + 39.867$
Hardness (mg/l)	48	45	52	

Existing Water Quality Definitions are contained in our Water Quality Regulations and in the new EWQ Atlas

Two Key Aspects of No Measurable Change Evaluations

1. Implementation to preserve NMC
 - Establishes wasteload allocations among sources to maintain EWQ utilizing WQ models where possible
 - Sets effluent limitations in a docket and/or permit
 - Not a TMDL
 - Manages water quality before exceedances occur
2. Assessment of NMC
 - Set multi-year instream monitoring program

Designed to preserve existing high water quality

Water Quality Models



Neversink River Watershed (NY)

Brodhead Creek Watershed (PA)

Lehigh River Watershed (PA)

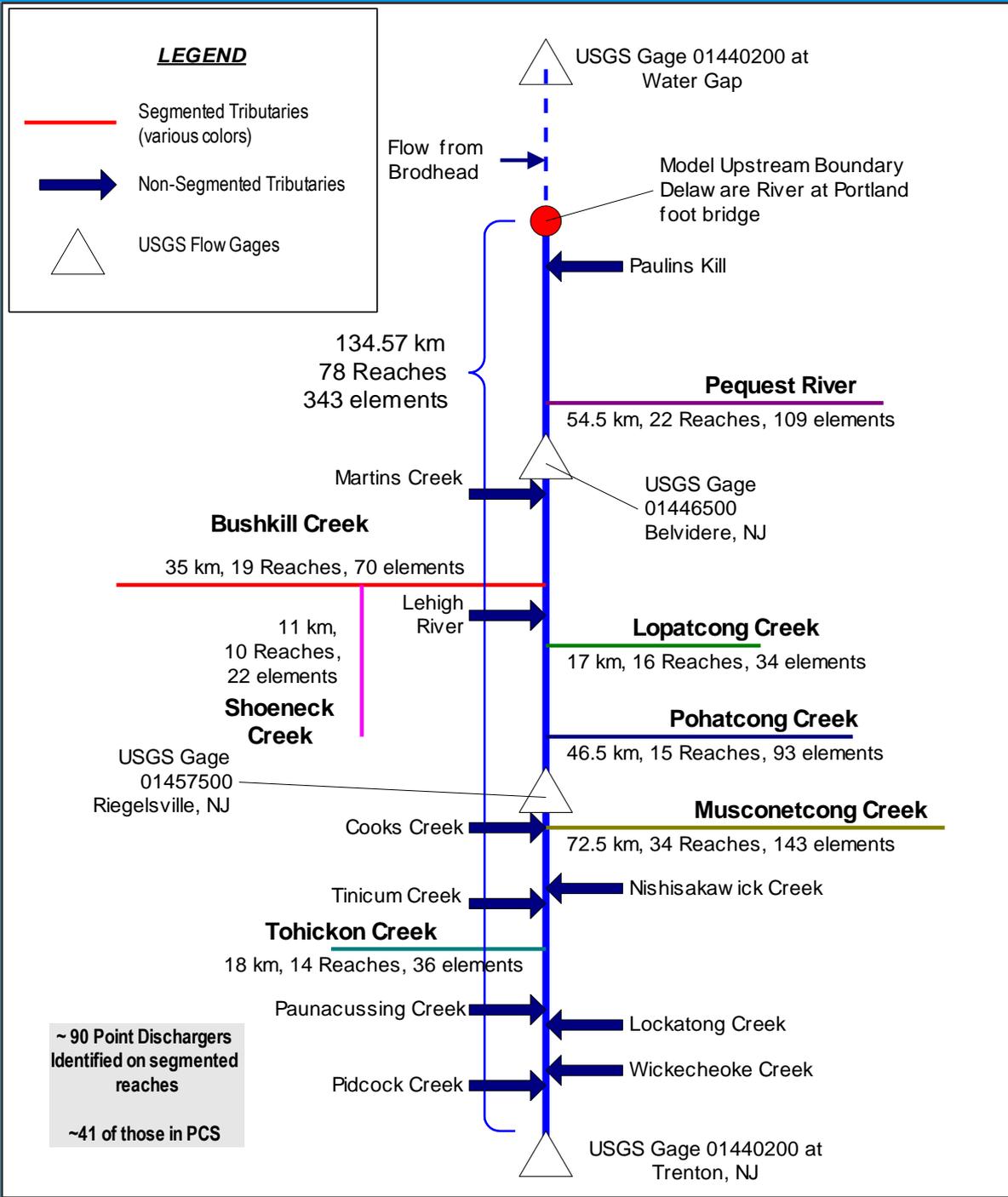
Lower Delaware River (PA/NJ)

Multiple BCPs/ICPs

Lower Delaware QUAL2K Model

*Received a grant from
National Park Service
to monitor point
discharges for this
model*

Steady state model at harmonic mean
flow; also use dynamic models to
identify sources of variability



Existing Water Quality Atlas of the Delaware River Special Protection Waters

Delaware River Basin Commission

Existing Water Quality Atlas of the Delaware River Special Protection Waters



DRBC Special Protection Waters Program

May 2016



Maps, Watershed Population, Land Use & Flow Statistics, and Site-Specific Existing Water Quality Tables from West Branch Delaware River to Trenton

85 River Reaches & Watersheds → 88 by 2018
Upper Delaware: 11 ICP's, 19 BCP tribs.
Middle Delaware: 7 ICP's, 20 BCP tribs.
Lower Delaware: 10 ICP's, 18 BCP tribs.
(28 DR sites & 57 tributary watersheds)

Best existing scientific knowledge of water quality, flow and characteristics of the Delaware River and its tributaries.

Planned Annual Updates and Additions including discharge inventory, new sites and parameters, updated population and land use, improved flow estimation.

Atlas Preparation: Many Sources, Many Thanks

Extensively Used Information Sources:

National Water Quality Data Portal

- Site Specific EWQ includes 1999-2015 USGS, PA, NY, NJ water quality data + SRMP

3 USGS/NPS Studies:

- Delaware Water Gap 2002-2004: Ward Hickman and Jeff Fisher
- Upper Delaware 2005-2007: Jason Siemion and Pete Murdoch
- Upper Delaware 2012-2015: Lisa Senior

USGS Gages at or near Control Point Locations

USGS Stream Stats v.2 and v.3 (PA application primarily used)

USGS Delaware River Basin BaSE Model (Marla Stuckey)

U.S. Census, 2000 and 2010 Block Data

National Land Cover Data Sets 2001, 2011

Contacts

**We are available to meet about more detailed discussion of these products.
There are many more slides and details: see me for more or request a
presentation tailored to your organization!**

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