Chapter 7: 1554 ICP Delaware River at Bulls Island Foot Bridge, NJ/PA
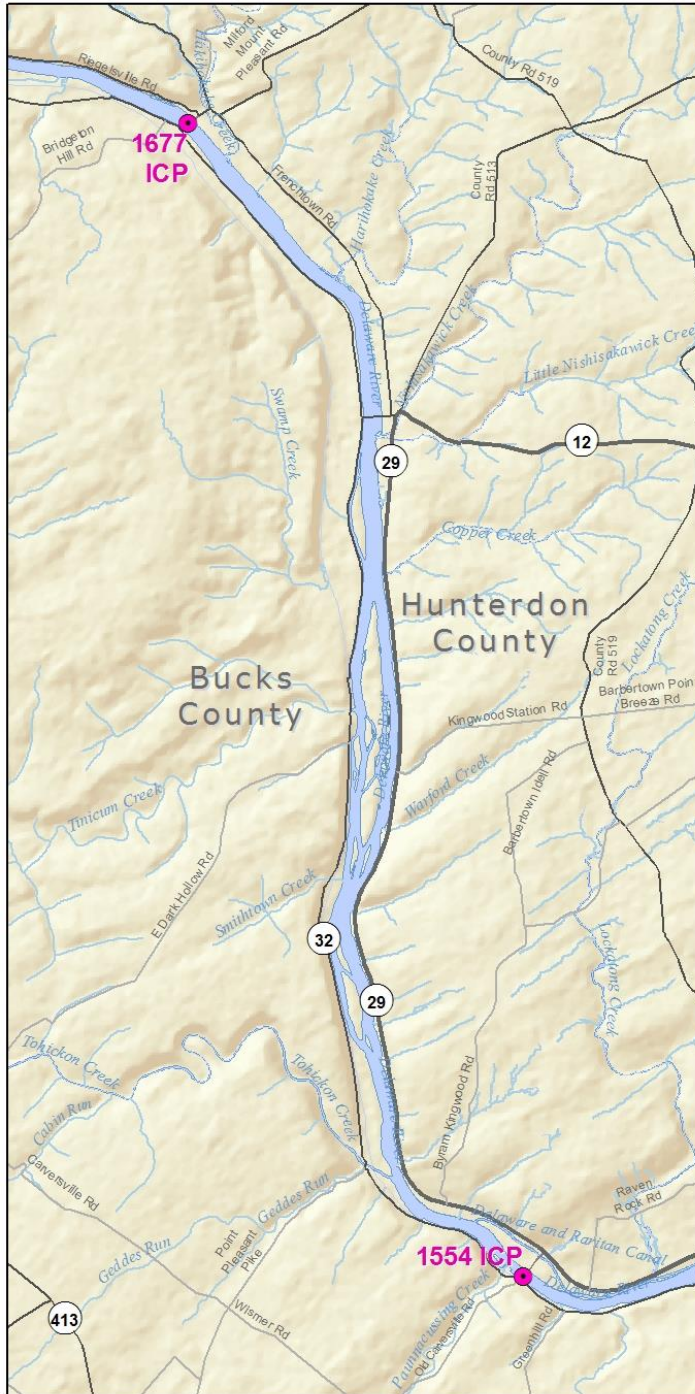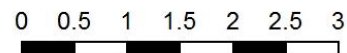

1554 ICP
Delaware River at Bull's Island Foot Bridge
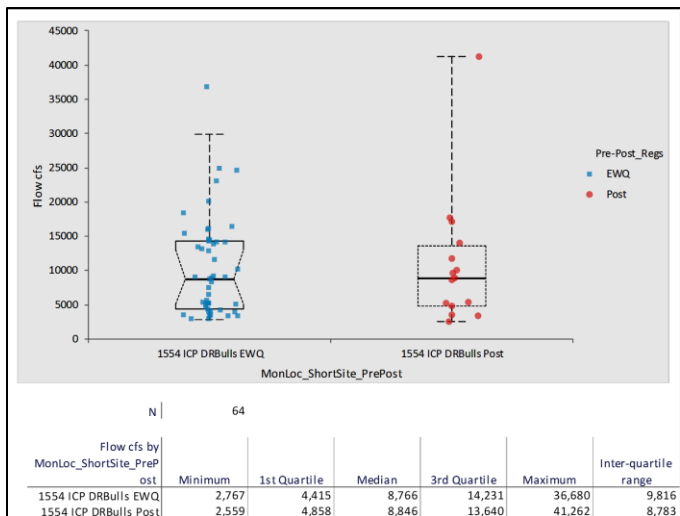
Sampling Location

County Boundary

0   0.5   1   1.5   2   2.5   3
Miles

N

Analysis of flow differences between the EWQ and post-EWQ monitoring periods:

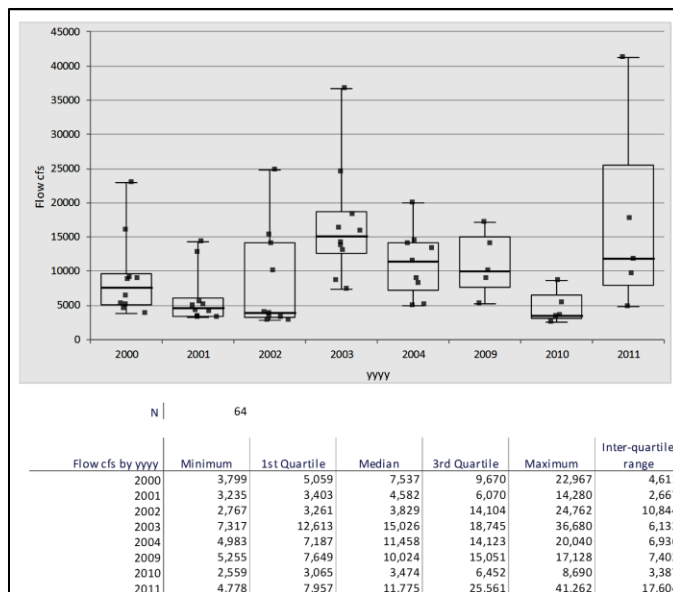| Flow cfs by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	2,767	4,415	8,766	14,231	36,680	9,816
1554 ICP DRBulls Post	2,559	4,858	8,846	13,640	41,262	8,783

N | 64

Flow was not different between the two periods at this location, though EWQ flow was normally distributed and well-represented for the May to September period and post-EWQ flow was less representative of above-normal conditions due to too few post-EWQ water quality samples.

Kruskal-Wallis test

Flow cfs by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	49	0.1	0.00
1554 ICP DRBulls Post	15	0.4	0.03

H statistic	0.00
X² approximation	0.00
DF	1
p-value	0.9684 [1]

H0: θ₁ = θ₂ = θ...
The median of the populations are all equal.
H1: θᵢ ≠ θⱼ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

Flow cfs by yyyy	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
2000	3,799	5,059	7,537	9,670	22,967	4,611
2001	3,235	3,403	4,582	6,070	14,280	2,667
2002	2,767	3,261	3,829	14,104	24,762	10,844
2003	7,317	12,613	15,026	18,745	36,680	6,132
2004	4,983	7,187	11,458	14,123	20,040	6,936
2009	5,255	7,649	10,024	15,051	17,128	7,402
2010	2,559	3,065	3,474	6,452	8,690	3,387
2011	4,778	7,957	11,775	25,561	41,262	17,604

N | 64

Annual flow statistics are plotted above. These are May to September flow measurements associated with the time of each water quality sample. Flow is estimated at this location using drainage area weighting based on the USGS continuous stream gage at Trenton, NJ. "Normal" flow is about 10,000 cfs at this location on the Delaware River.

Upstream ICP: Delaware River at Milford 1677 ICP
Downstream ICP: Del. River at Lambertville 1487 ICP

Tributary BCP Watersheds in Upstream Reach:

Paunnacussing Creek, PA – 1556 BCP
Tohickon Creek, PA – 1570 BCP
Tinicum Creek, PA – 1616 BCP
Nishisakawick Creek, NJ – 1641 BCP
Hakihokake Creek, NJ – 1672 BCP (new; EWQ def. in progress.)

All other tributaries to the upstream reach are less than 20 square miles drainage area, are not expected to have significant influence upon Delaware River water quality, and possess no wastewater discharges.

Chapter 7: 1554 ICP
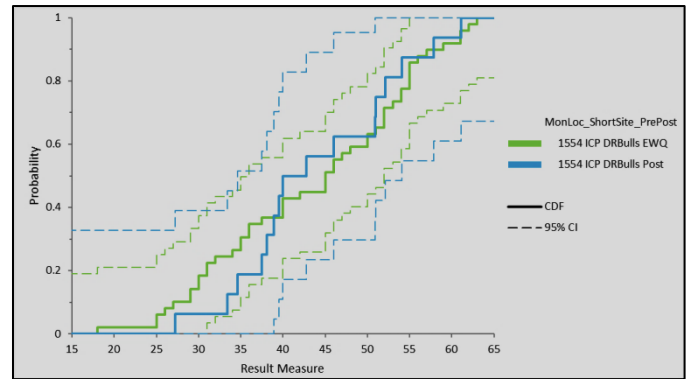Delaware River at Bulls Island Foot Bridge, NJ/PA
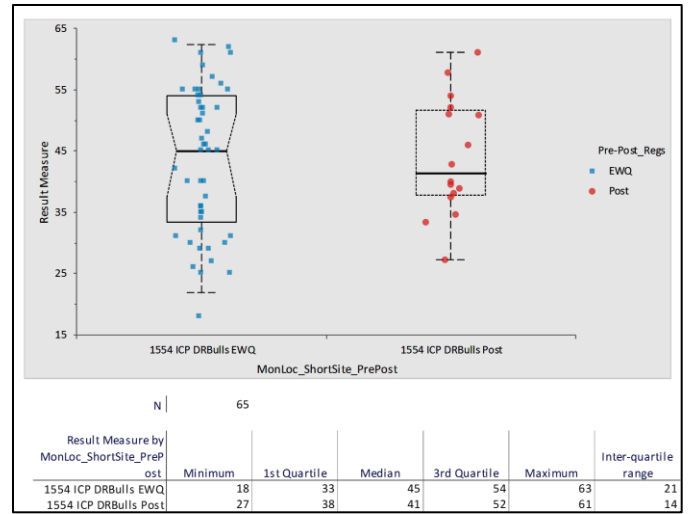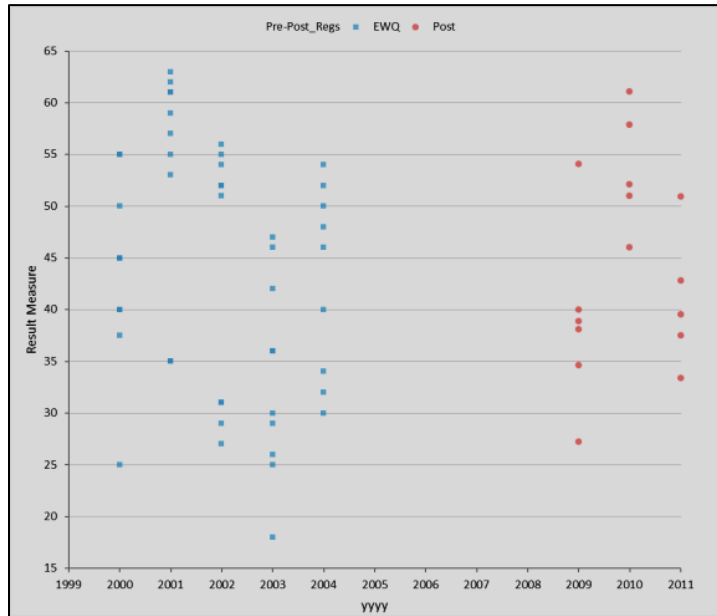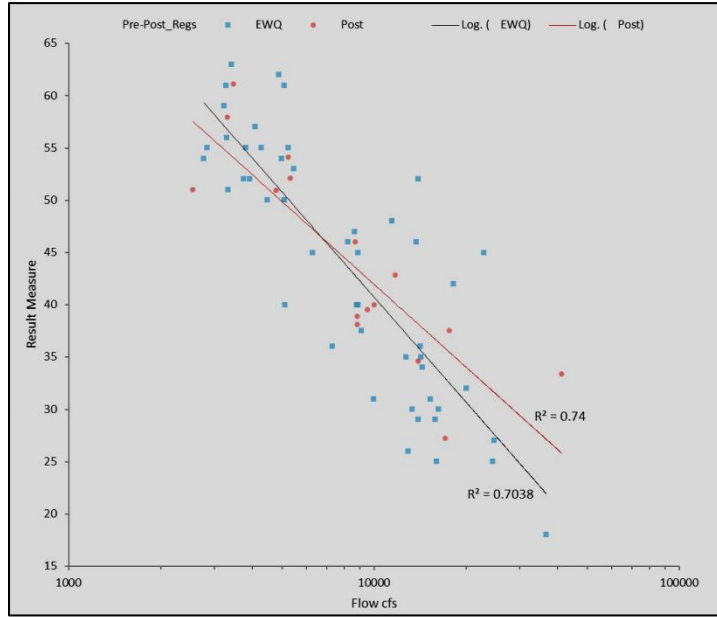
Alkalinity as CaCO3, Total mg/l

Existing Water Quality (Table 2T):

Median 45 mg/l
Lower 95% Confidence Interval 38 mg/l
Upper 95% Confidence Interval 51 mg/l
Defined in regulations as a flow-related parameter

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
N						65
1554 ICP DRBulls EWQ	18	33	45	54	63	21
1554 ICP DRBulls Post	27	38	41	52	61	14

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	49	0.2	0.01
1554 ICP DRBulls Post	16	0.8	0.05

H statistic	0.00
X² approximation	0.00
DF	1
p-value	0.9575 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is indicated. Alkalinity did not measurably change between the EWQ and post-EWQ periods. Alkalinity is inversely related to flow. Post-EWQ median alkalinity fell within the EWQ 95% confidence intervals. The overall distributions were closely matched.

Chapter 7: 1554 ICP
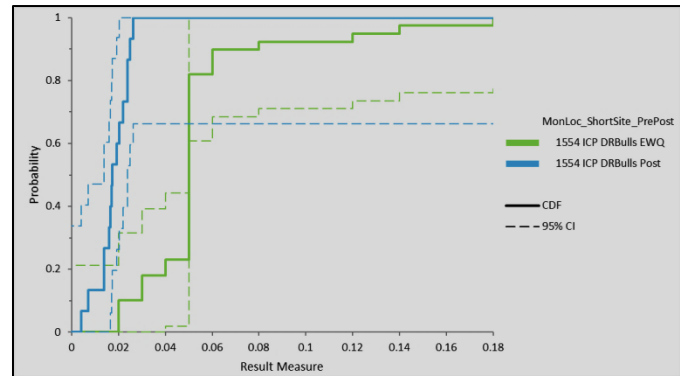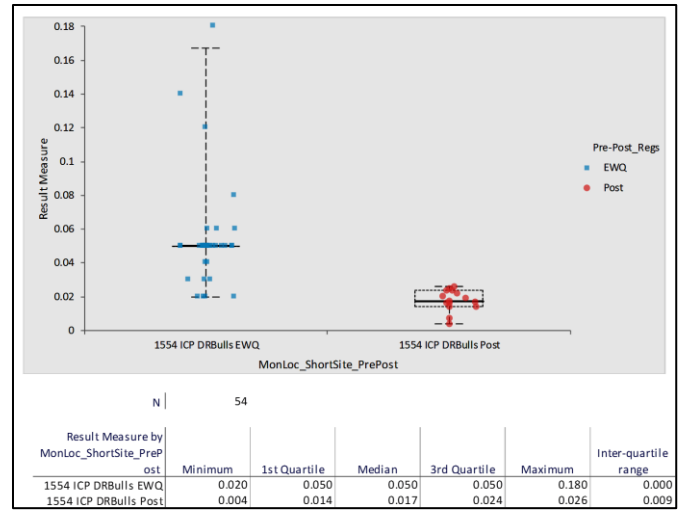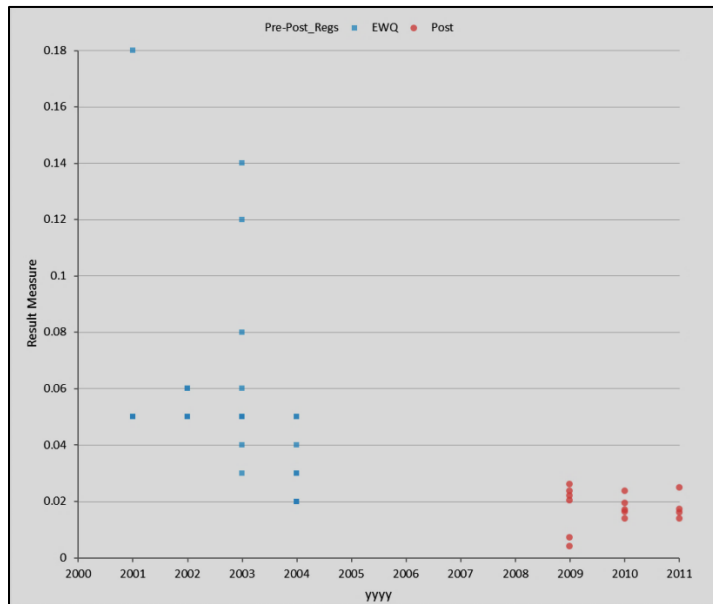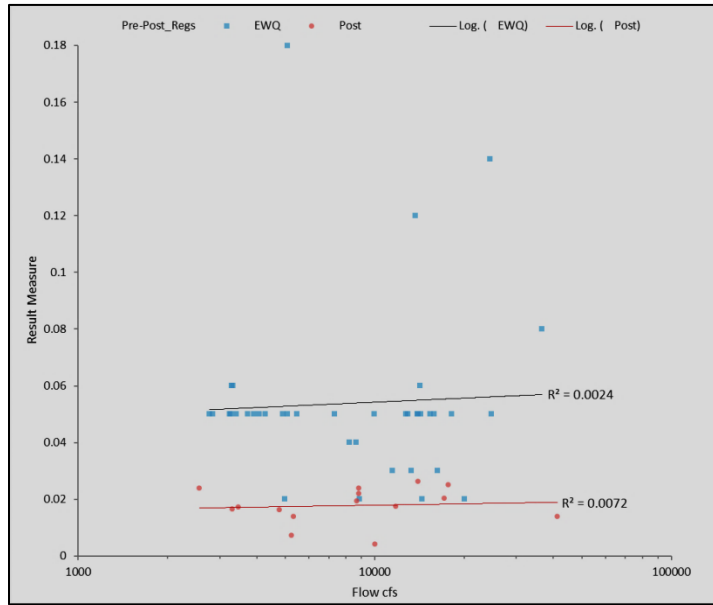Delaware River at Bulls Island Foot Bridge, NJ/PA

Ammonia Nitrogen as N, Total mg/l

Existing Water Quality (Table 2T):

Median <0.05 mg/l
Lower 95% Confidence Interval <0.05 mg/l
Upper 95% Confidence Interval <0.05 mg/l

N				54		
Result Measure by MonLoc_ShortSite_PreP ost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	0.020	0.050	0.050	0.050	0.180	0.000
1554 ICP DRBulls Post	0.004	0.014	0.017	0.024	0.026	0.009

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PreP ost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	39	1848.5	47.40
1554 ICP DRBulls Post	15	4806.2	320.41

H statistic	29.16
X² approximation	29.16
DF	1
p-value	<0.0001 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

No independent data were available to validate results. The post-EWQ detection limit (0.004-0.006 mg/l) was much lower than during the EWQ period (0.05 mg/l 2002-2003; 0.02 mg/l in 2004). EWQ data included 27/39 undetected results, interfering with calculation of the median. Under 2009-2011 lower detection levels there was one undetected result. Thus the result found by DRBC may not be a real change in ambient river concentrations, but simply that we now have defined the real concentrations below the EWQ 0.05 mg/l. No post-EWQ results were above 0.026 mg/l, where 18% (7/39) of EWQ results were above 0.05 mg/l. This implies a water quality improvement.

No water quality degradation is indicated. Ammonia concentrations apparently declined significantly. However, detection level differences and potential laboratory artifacts introduced uncertainty to conclusions.

Chapter 7: 1554 ICP
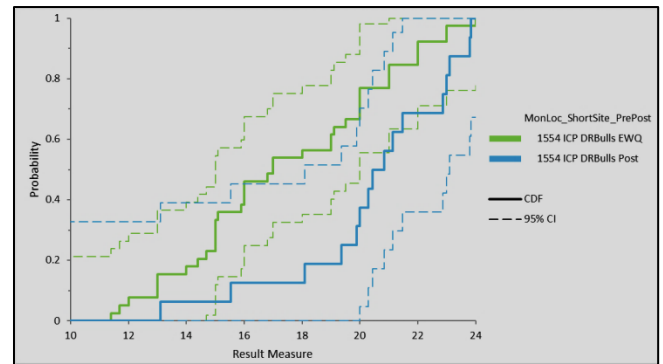Delaware River at Bulls Island Foot Bridge, NJ/PA
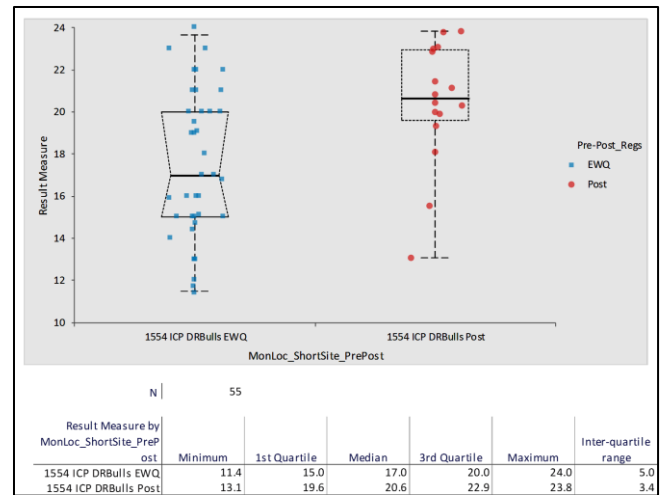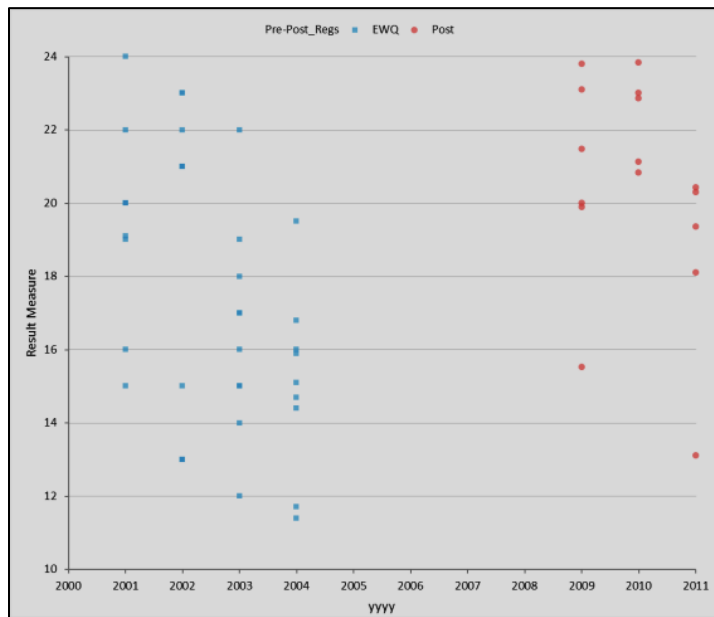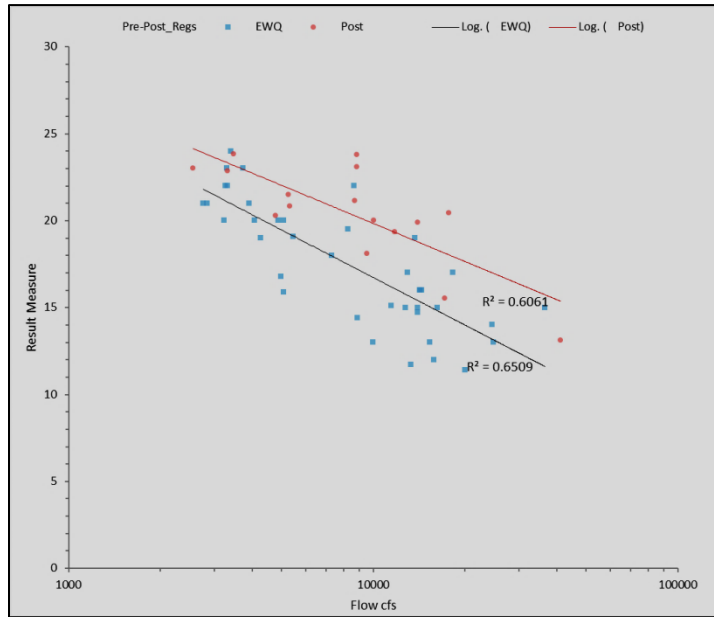
Chloride, Total mg/l

Existing Water Quality (Table 2T):

Median 17 mg/l
Lower 95% Confidence Interval 15 mg/l
Upper 95% Confidence Interval 20 mg/l
Defined in regulations as a flow-related parameter

Result Measure by MonLoc_ShortSite_PrePost	N					55

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	11.4	15.0	17.0	20.0	24.0	5.0
1554 ICP DRBulls Post	13.1	19.6	20.6	22.9	23.8	3.4

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	39	592.4	15.19
1554 ICP DRBulls Post	16	1444.0	90.25

H statistic	7.95
X² approximation	7.95
DF	1
p-value	0.0048 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

Evidence indicates water quality degradation. Chloride concentrations increased by about 3.6 mg/l (21%) between the two periods. Too few post-EWQ samples introduced some uncertainty in the conclusion, yet the difference still was significant. Post-EWQ median concentration was above the EWQ upper 95% confidence interval. Both sets are strongly related to flow. This is the furthest downstream Delaware River location where the increase in chloride concentrations was significant and above the upper Existing Water Quality target. Of course, more frequent sampling at Trenton, Washington Crossing and Lambertville might have produced a measurable difference downstream of this location, where smaller increases were measured.

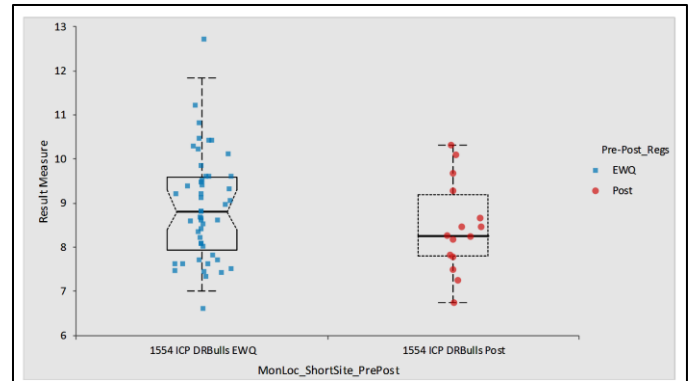Chapter 7: 1554 ICP
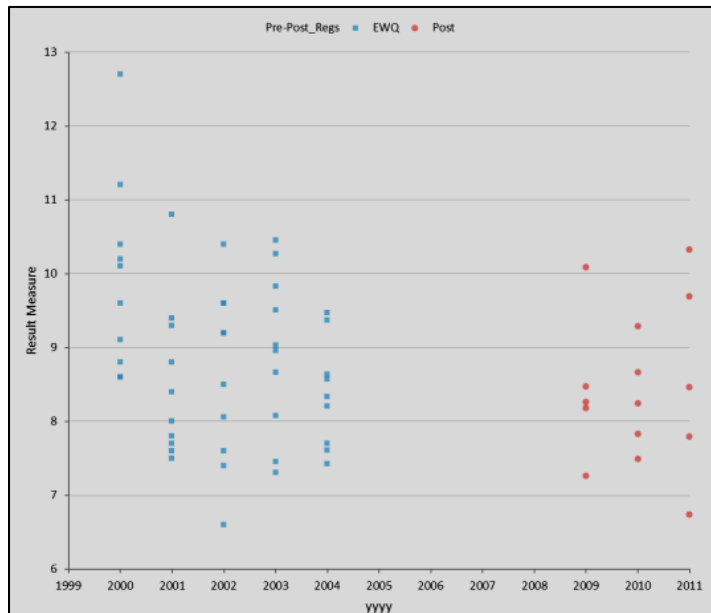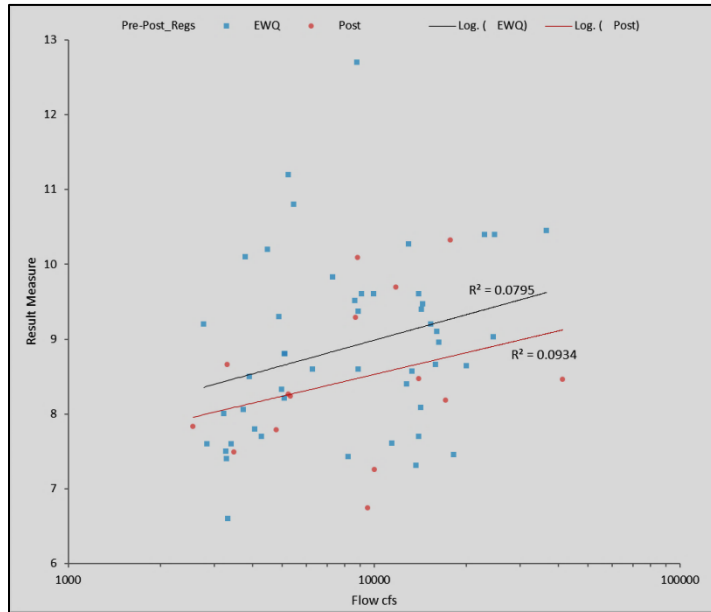Delaware River at Bulls Island Foot Bridge, NJ/PA

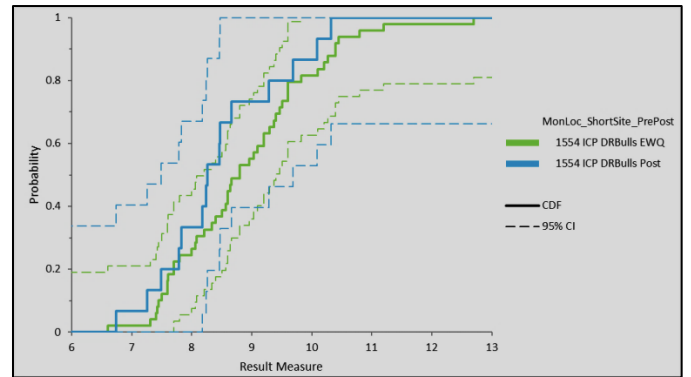Dissolved Oxygen (DO) mg/l

Existing Water Quality (Table 2T):

Median 8.80 mg/l
Lower 95% Confidence Interval 8.40 mg/l
Upper 95% Confidence Interval 9.30 mg/l

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	6.60	7.93	8.80	9.60	12.70	1.67
1554 ICP DRBulls Post	6.74	7.80	8.26	9.19	10.32	1.39

N | 64

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	49	124.2	2.53
1554 ICP DRBulls Post	15	405.6	27.04

H statistic	1.53
X^2 approximation	1.53
DF	1
p-value	0.2163 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. No measurable DO change took place between the EWQ and Post-EWQ periods. Post-EWQ dissolved oxygen concentrations fell below the EWQ lower 95% confidence interval, but overall the data distributions were not significantly different. There were too few measurements taken in the post-EWQ period. Bi-weekly instead of monthly sampling is recommended to improve statistical comparisons. DO concentration was unrelated to flow in both data sets.

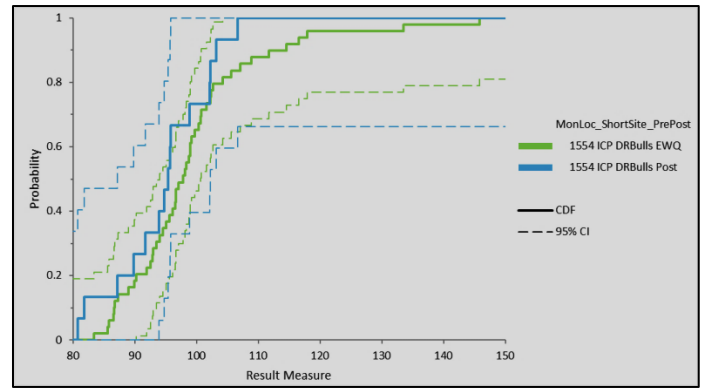Chapter 7: 1554 ICP
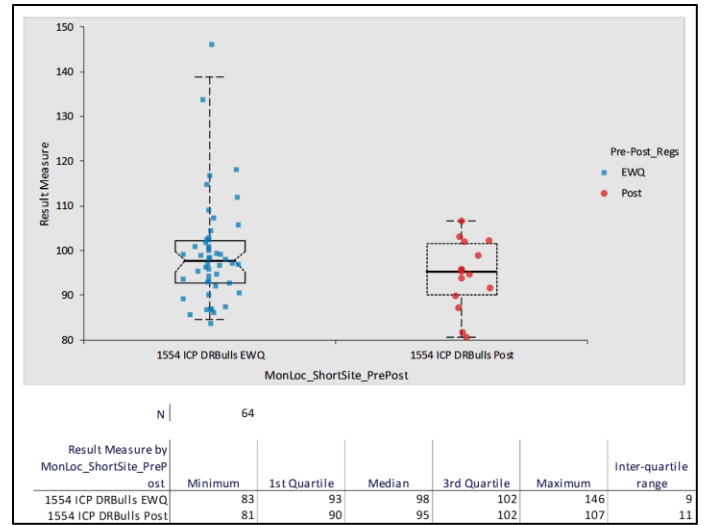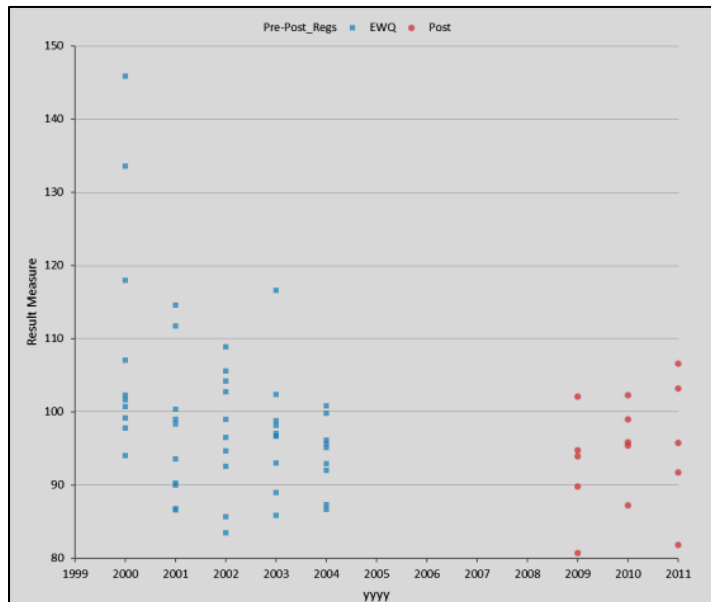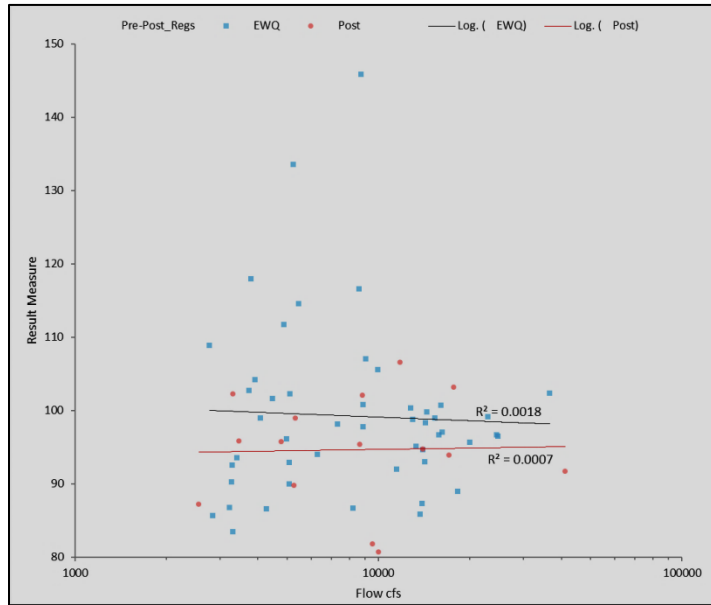Delaware River at Bulls Island Foot Bridge, NJ/PA

Dissolved Oxygen Saturation %

Existing Water Quality (Table 2T):

Median 98%
Lower 95% Confidence Interval 95%
Upper 95% Confidence Interval 100%

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	83	93	98	102	146	9
1554 ICP DRBulls Post	81	90	95	102	107	11

N | 64

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	49	113.3	2.31
1554 ICP DRBulls Post	15	370.0	24.67

H statistic	1.39
X² approximation	1.39
DF	1
p-value	0.2377 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. Dissolved Oxygen Saturation did not measurably change between the EWQ and post-EWQ periods. Post-EWQ median DO saturation was within the EWQ 95% confidence intervals.   Dissolved Oxygen Saturation is unrelated to flow.

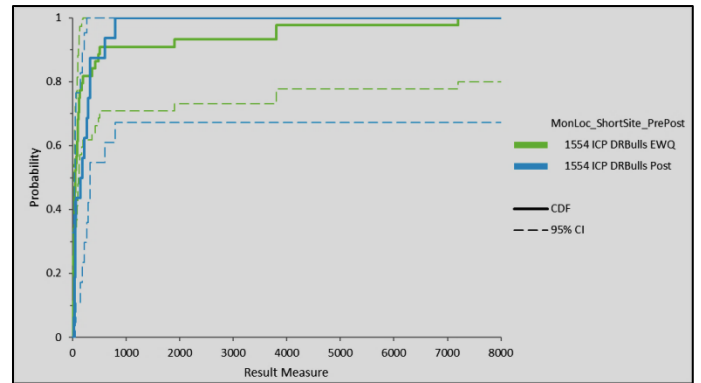Chapter 7: 1554 ICP
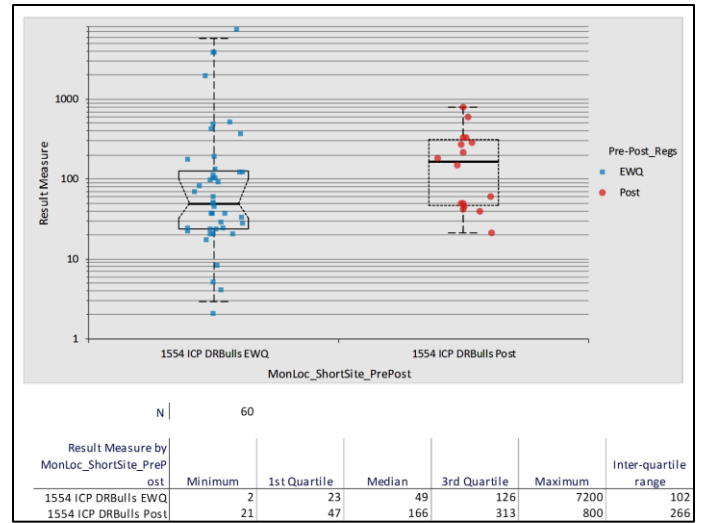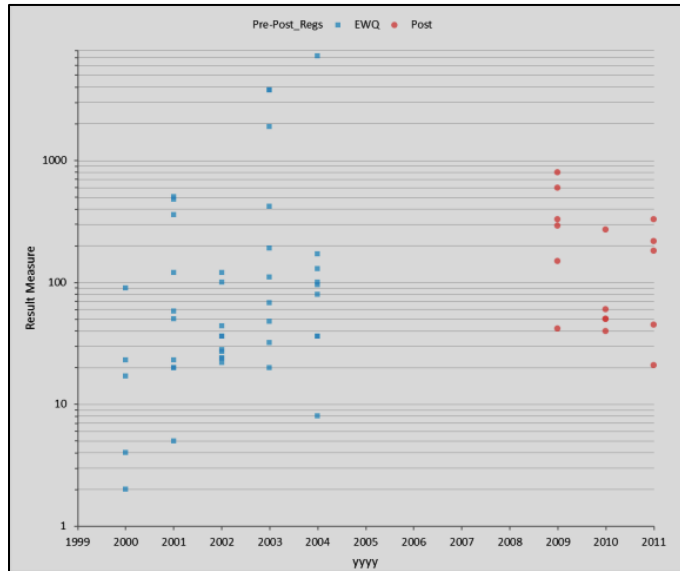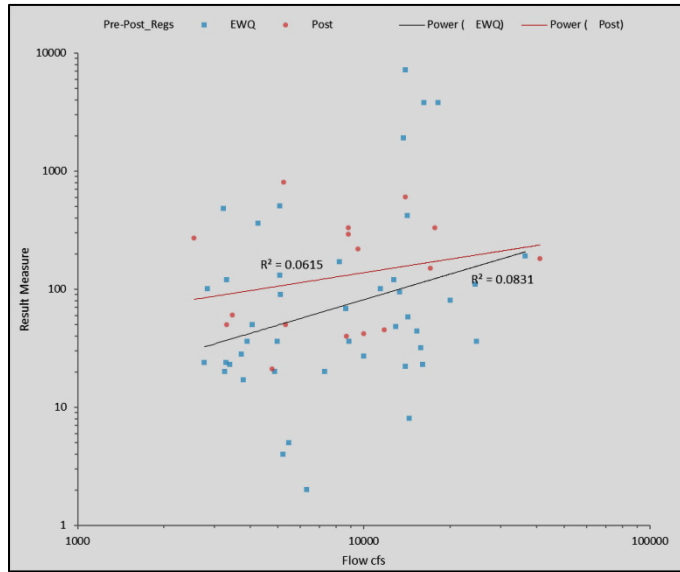Delaware River at Bulls Island Foot Bridge, NJ/PA

Enterococcus colonies/100 ml

Existing Water Quality (Table 2T):

Median 49/100 ml
Lower 95% Confidence Interval 32/100 ml
Upper 95% Confidence Interval 100/100 ml

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	2	23	49	126	7200	102
1554 ICP DRBulls Post	21	47	166	313	800	266

N = 60

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	44	300.6	6.83
1554 ICP DRBulls Post	16	826.6	51.66

H statistic	3.70
X² approximation	3.70
DF	1
p-value	0.0545 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. Enterococci did not measurably change between the EWQ and Post-EWQ periods, though the median for the post-EWQ period was higher than the upper 95% confidence interval established in the rules. There were too few measurements taken in the post-EWQ period. Bi-weekly instead of monthly sampling is recommended to improve statistical comparisons. Enterococcus concentrations are unrelated to flow in both data sets. Note that concentrations and flows are plotted on a logarithmic scale.

Chapter 7: 1554 ICP
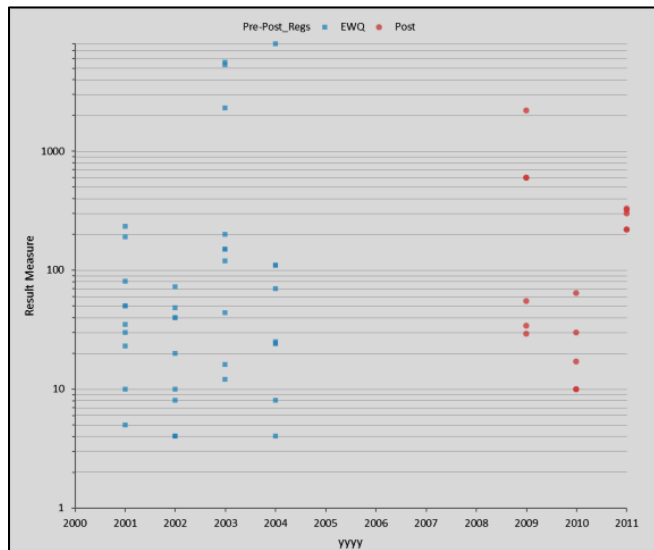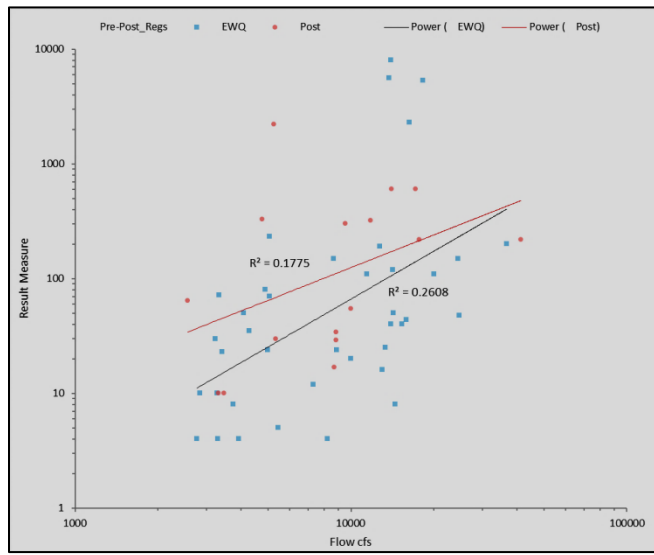Delaware River at Bulls Island Foot Bridge, NJ/PA

Escherichia coli colonies/100 ml

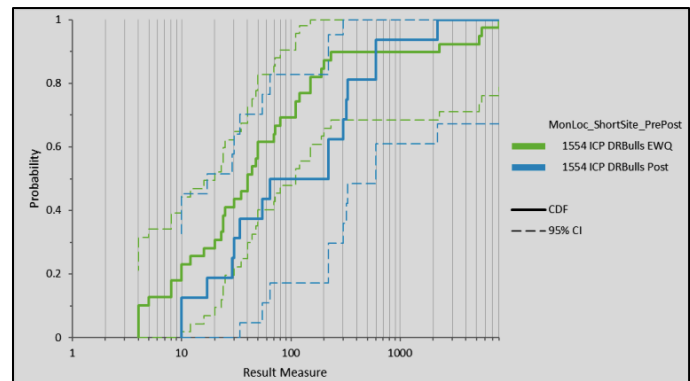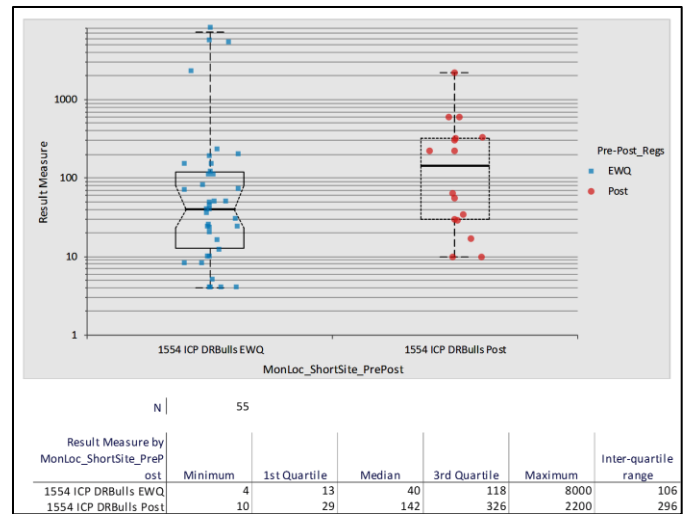Existing Water Quality (Table 2T):

Median 40/100 ml
Lower 95% Confidence Interval 23/100 ml
Upper 95% Confidence Interval 80/100 ml

Result Measure by MonLoc_ShortSite_PreP ost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
N	55					
1554 ICP DRBulls EWQ	4	13	40	118	8000	106
1554 ICP DRBulls Post	10	29	142	326	2200	296

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PreP ost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	39	210.0	5.38
1554 ICP DRBulls Post	16	511.9	31.99
H statistic	2.82		
X^2 approximation	2.82		
DF	1		
p-value	0.0934 [1]		

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

Slight evidence of water quality degradation is evident. E. coli concentrations did not measurably change between the EWQ and Post-EWQ periods, though post-EWQ median E. coli fell above the EWQ upper 95% confidence interval.

E. coli results are extremely variable, as are the other bacteria parameters, especially since too few samples were taken in the post-EWQ period (n=16). E. coli concentrations are weakly related to flow in both data sets. Note that concentrations and flow are plotted on a logarithmic scale. No independent data from other agencies were available at this site to validate DRBC's conclusion.

Chapter 7: 1554 ICP
Delaware River at Bulls Island Foot Bridge, NJ/PA
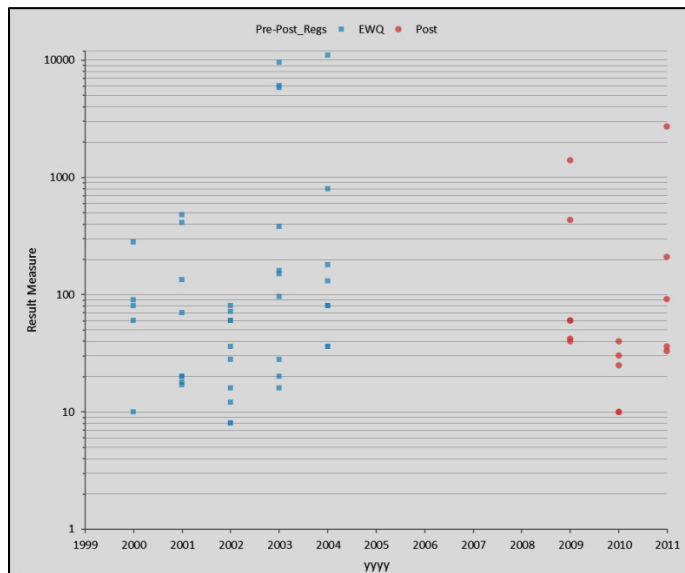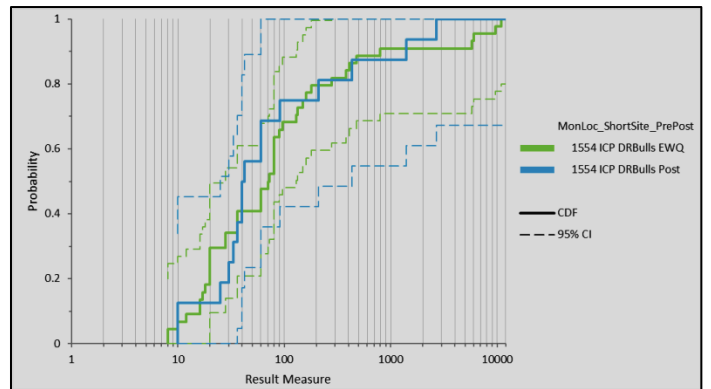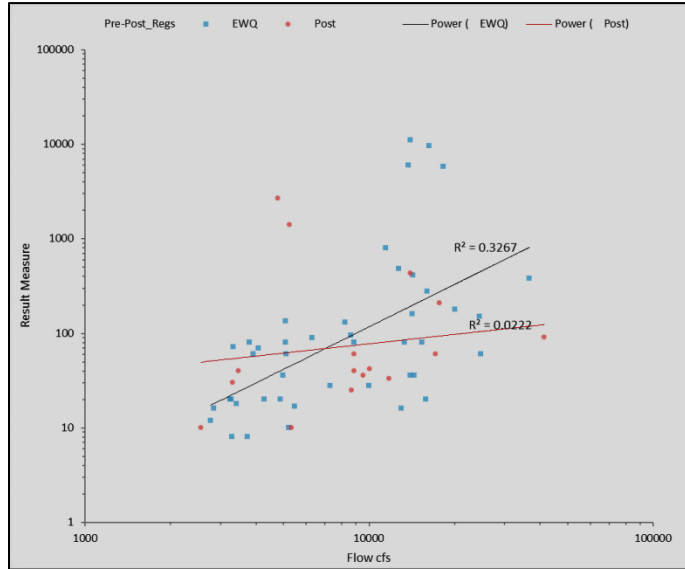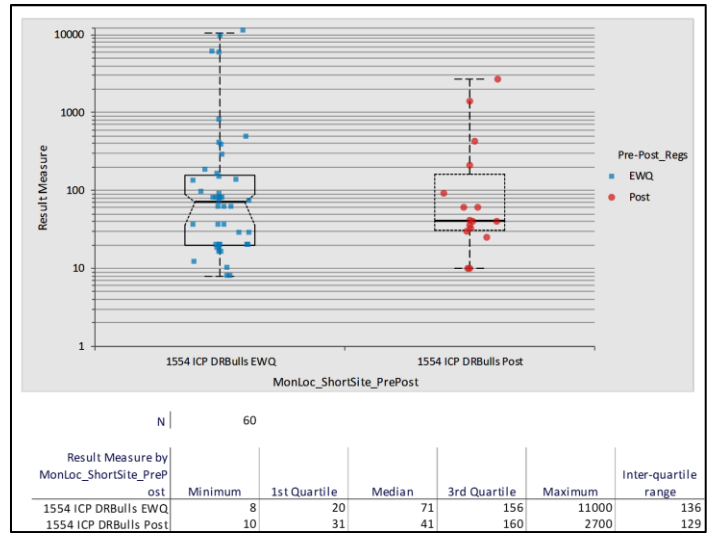
Fecal coliform colonies/100 ml

Existing Water Quality (Table 2T):

Median 71/100 ml
Lower 95% Confidence Interval 36/100 ml
Upper 95% Confidence Interval 90/100 ml
Defined in regulations as a flow-related parameter

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	8	20	71	156	11000	136
1554 ICP DRBulls Post	10	31	41	160	2700	129

N: 60

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	44	3.6	0.08
1554 ICP DRBulls Post	16	9.8	0.61

H statistic	0.04
X² approximation	0.04
DF	1
p-value	0.8343 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. Fecal coliform concentrations did not measurably change between the EWQ and post-EWQ periods. EWQ fecal coliform concentrations are positively but weakly related to flow, but post-EWQ data are unrelated to flow, probably because of too few post-EWQ samples (n=16). Post-EWQ median concentrations fell within the EWQ 95% confidence intervals. Note that both concentrations and flows are presented on a logarithmic scale.

Chapter 7: 1554 ICP
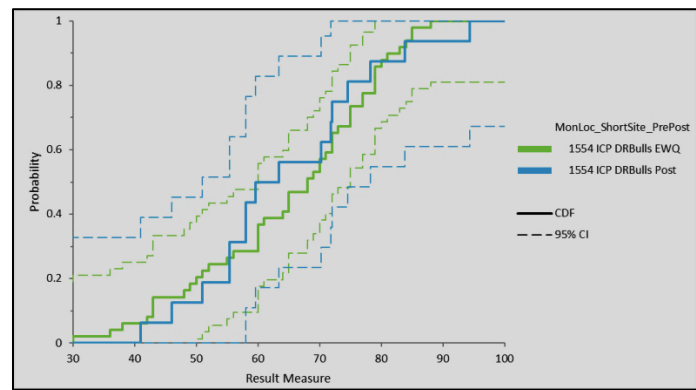Delaware River at Bulls Island Foot Bridge, NJ/PA
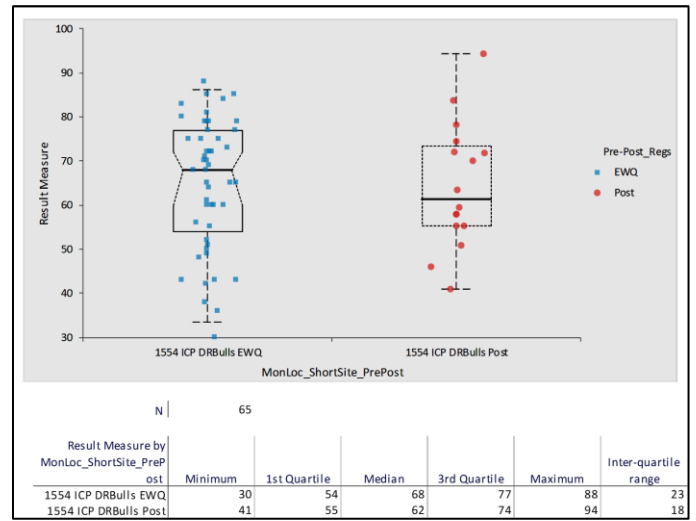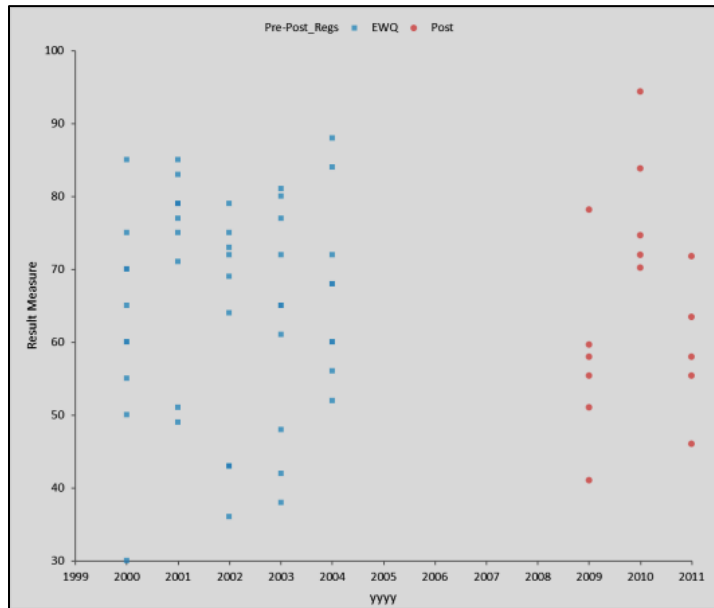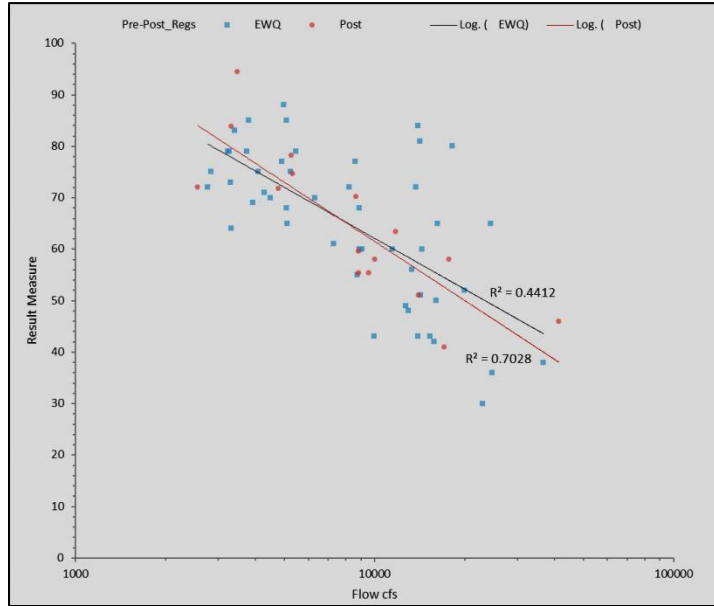
Hardness as CaCO3, Total mg/l

Existing Water Quality (Table 2T):

Median 68 mg/l
Lower 95% Confidence Interval 60 mg/l
Upper 95% Confidence Interval 72 mg/l
Defined in regulations as a flow-related parameter

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
N		65				
1554 ICP DRBulls EWQ	30	54	68	77	88	23
1554 ICP DRBulls Post	41	55	62	74	94	18

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	49	20.9	0.43
1554 ICP DRBulls Post	16	64.0	4.00

H statistic	0.24
X² approximation	0.24
DF	1
p-value	0.6258[1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is indicated. Hardness did not measurably change between the EWQ and post-EWQ periods. Hardness is inversely related to flow. Post-EWQ median hardness fell within the EWQ 95% confidence intervals.

Chapter 7: 1554 ICP
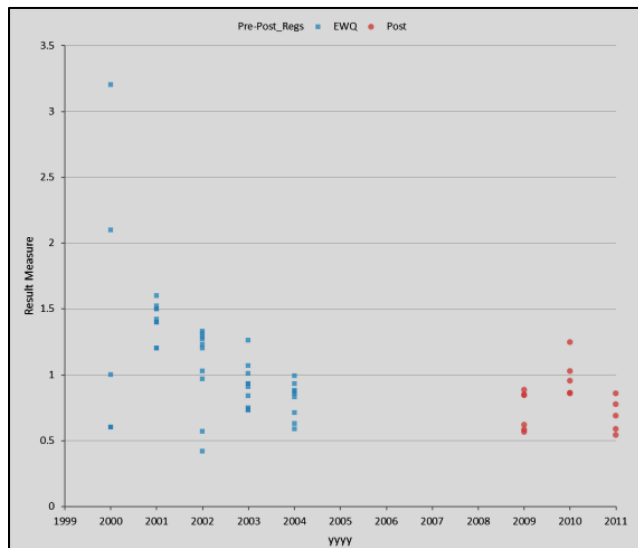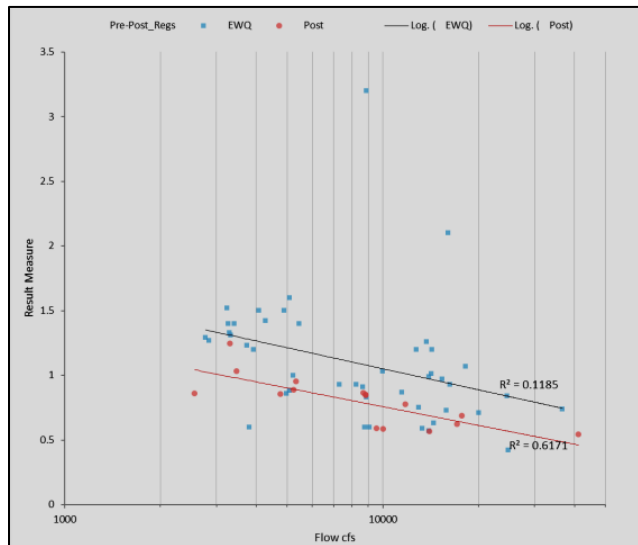Delaware River at Bulls Island Foot Bridge, NJ/PA

Nitrate + Nitrite as N, Total mg/l

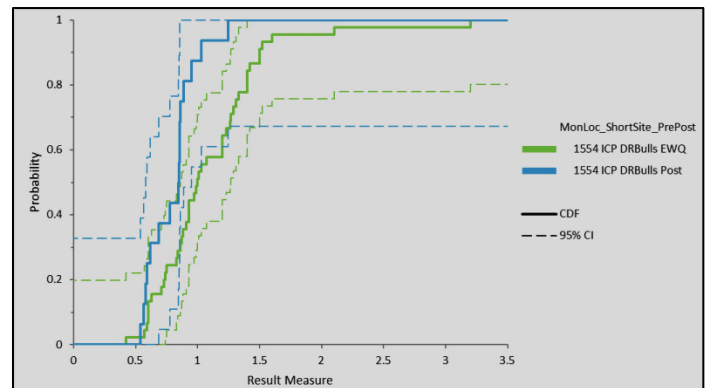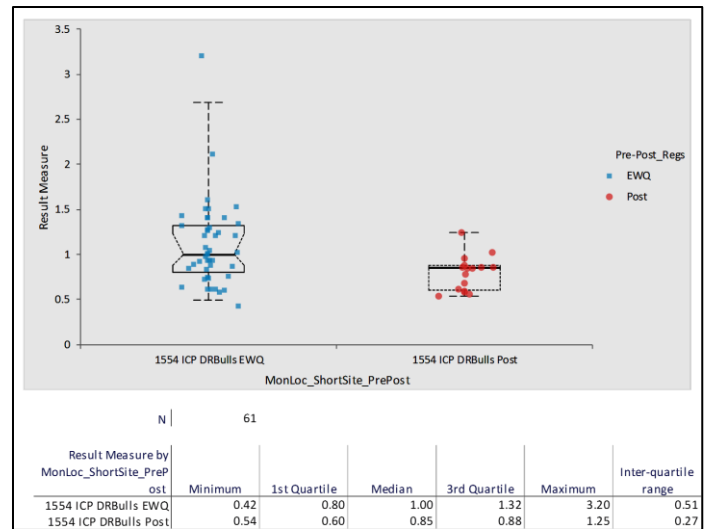Existing Water Quality (Table 2T as Nitrate):

Median 1.00 mg/l
Lower 95% Confidence Interval 0.88 mg/l
Upper 95% Confidence Interval 1.23 mg/l

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	0.42	0.80	1.00	1.32	3.20	0.51
1554 ICP DRBulls Post	0.54	0.60	0.85	0.88	1.25	0.27

N | 61

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	45	672.8	14.95
1554 ICP DRBulls Post	16	1892.3	118.27

H statistic	8.14
X² approximation	8.14
DF	1
p-value	0.0043 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

No water quality degradation is indicated. Nitrate concentrations apparently declined between the EWQ and post-EWQ periods. On the annual plot there is a declining trend in concentration within the EWQ period that appears to stabilize in the post-EWQ period. 2002-2004 EWQ nitrates appear to match well with post-EWQ nitrate + nitrite.

The data may be affected by laboratory artifacts that produce uncertainty in conclusions. Nitrate + Nitrite concentrations are assumed equivalent for comparison with EWQ nitrate concentrations, since EWQ nitrite concentrations were never detected. Note that flow is plotted on a logarithmic scale. Independent data were not available for validation of the apparent decline. Post-EWQ median concentrations fell just below the EWQ lower 95% confidence interval. There were no undetected results in either data set.

Chapter 7: 1554 ICP
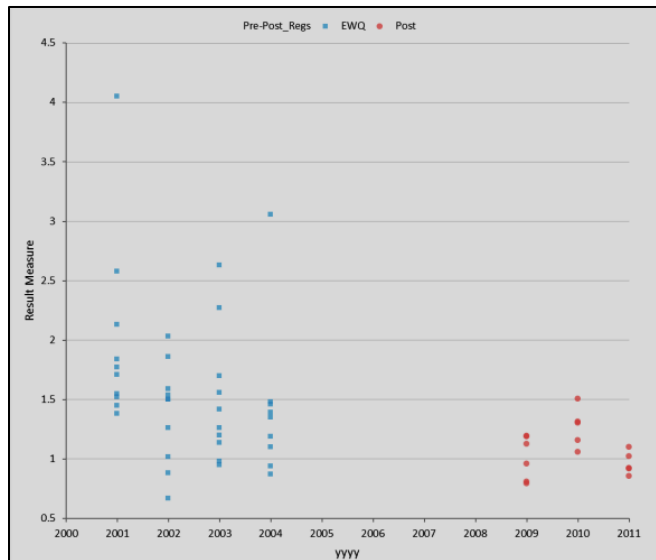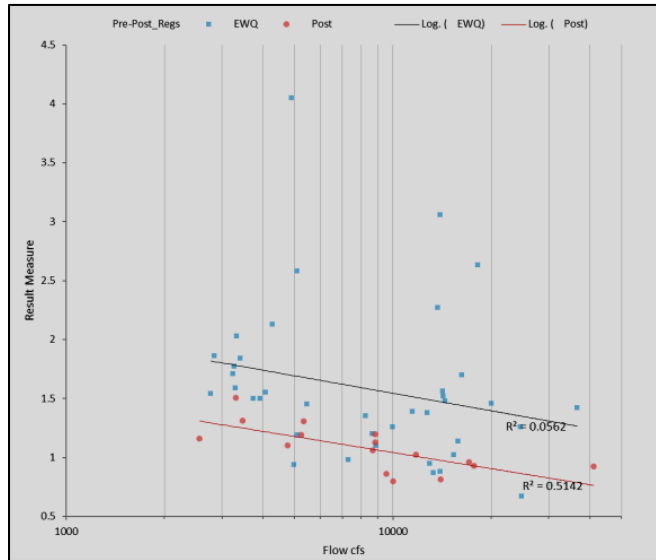Delaware River at Bulls Island Foot Bridge, NJ/PA

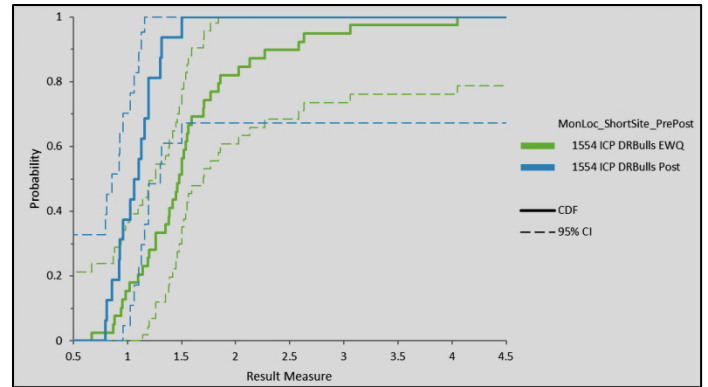Nitrogen as N, Total (TN) mg/l
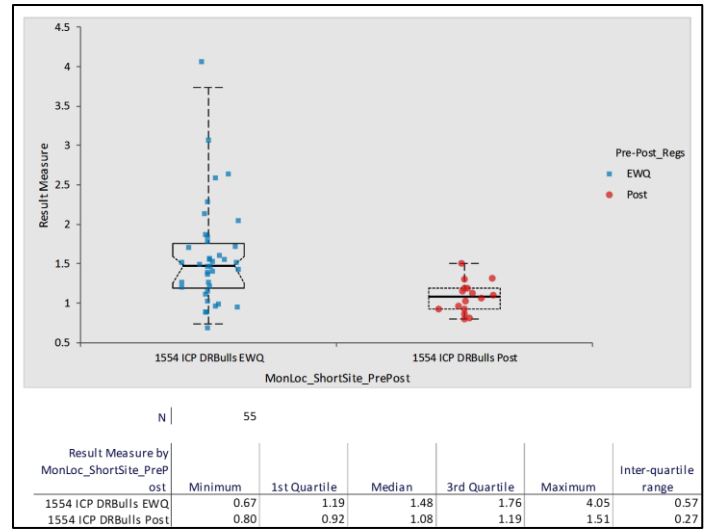
Existing Water Quality (Table 2T):

Median 1.48 mg/l
Lower 95% Confidence Interval 1.26 mg/l
Upper 95% Confidence Interval 1.59 mg/l

N	55				

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	0.67	1.19	1.48	1.76	4.05	0.57
1554 ICP DRBulls Post	0.80	0.92	1.08	1.19	1.51	0.27

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	39	935.4	23.98
1554 ICP DRBulls Post	16	2280.1	142.50

H statistic	12.53
X^2 approximation	12.53
DF	1
p-value	0.0004 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

No water quality degradation is evident. Total Nitrogen concentrations apparently declined between the EWQ and post-EWQ periods. However, potential laboratory artifacts produced uncertainty in conclusions.

TN is unrelated to flow in the EWQ period, but strongly related to flow in the post-EWQ period. The flow relationship may be false because of insufficient post-EWQ samples (n=16) which were not fully representative of flow conditions in the post-EWQ period. The EWQ data overall are far more variable than the post-EWQ data. DRBC results could not be independently validated. Post-EWQ median TN concentrations fell below the EWQ lower 95% confidence interval.

Chapter 7: 1554 ICP
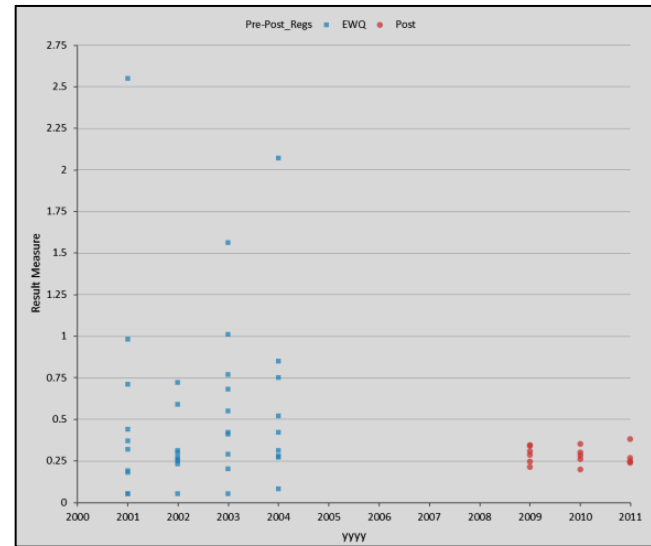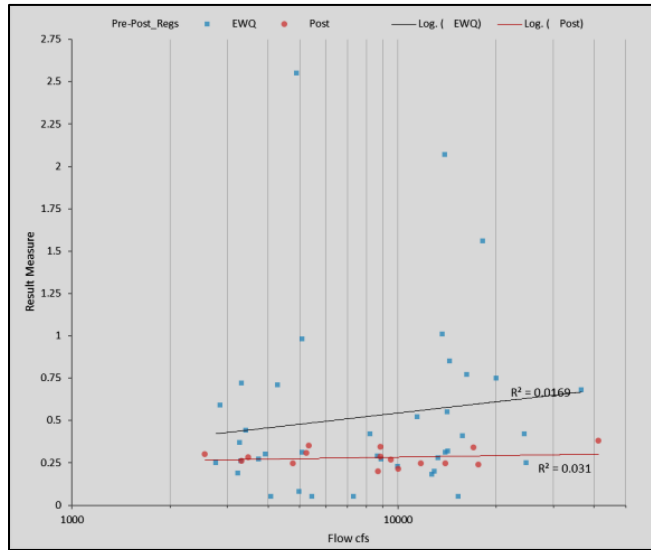Delaware River at Bulls Island Foot Bridge, NJ/PA

Nitrogen, Kjeldahl as N, Total (TKN) mg/l
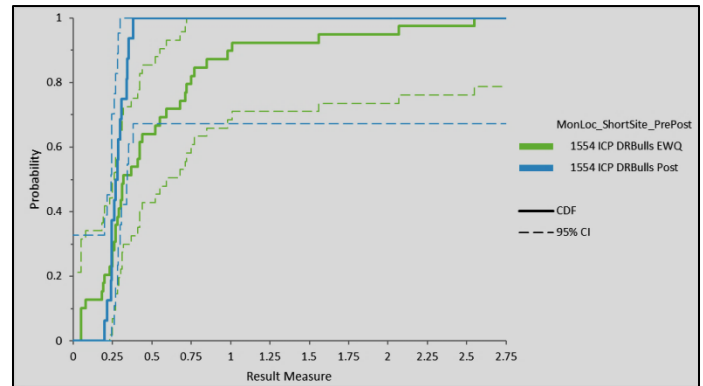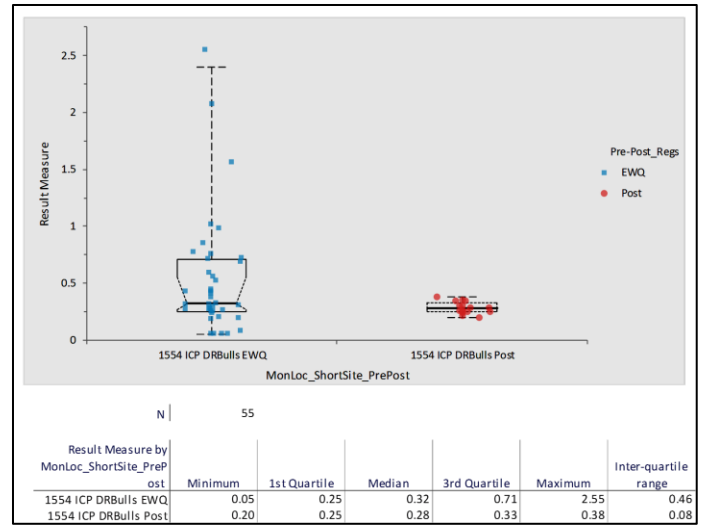
Existing Water Quality (Table 2T):

Median 0.32 mg/l
Lower 95% Confidence Interval 0.27 mg/l
Upper 95% Confidence Interval 0.55 mg/l

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	0.05	0.25	0.32	0.71	2.55	0.46
1554 ICP DRBulls Post	0.20	0.25	0.28	0.33	0.38	0.08

N | 55

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	39	226.6	5.81
1554 ICP DRBulls Post	16	552.3	34.52

H statistic	3.04
X² approximation	3.04
DF	1
p-value	0.0814 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. No measurable change occurred in TKN concentrations between the EWQ and post-EWQ periods. TKN concentration is unrelated to flow in both data sets. Post-EWQ TKN was far less variable than EWQ TKN.

Post-EWQ median TKN fell within the EWQ 95% confidence intervals. Though there was no statistical difference between EWQ and post-EWQ TKN, concentrations fell and were much more stable. This may be a laboratory artifact rather than a real trend. However, unlike nitrate + nitrite and other parameters, the TKN data sets should be directly comparable since there are no discrepancies in detection limits. The main differences were that post-EWQ TKN samples were less numerous and not as fully representative of flow conditions.

Chapter 7: 1554 ICP
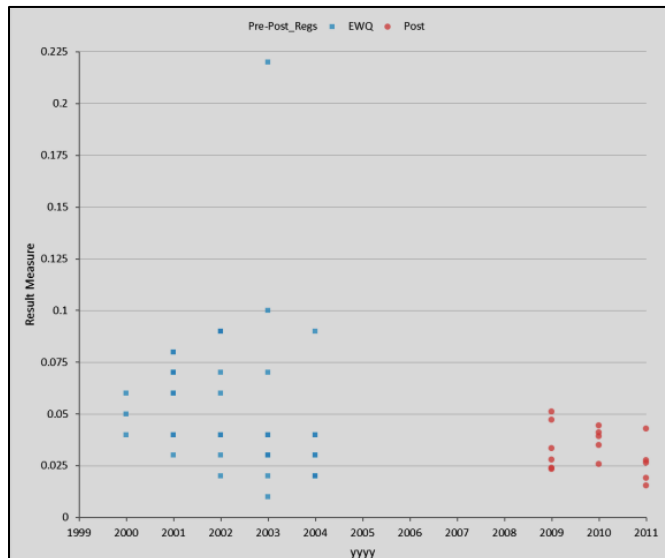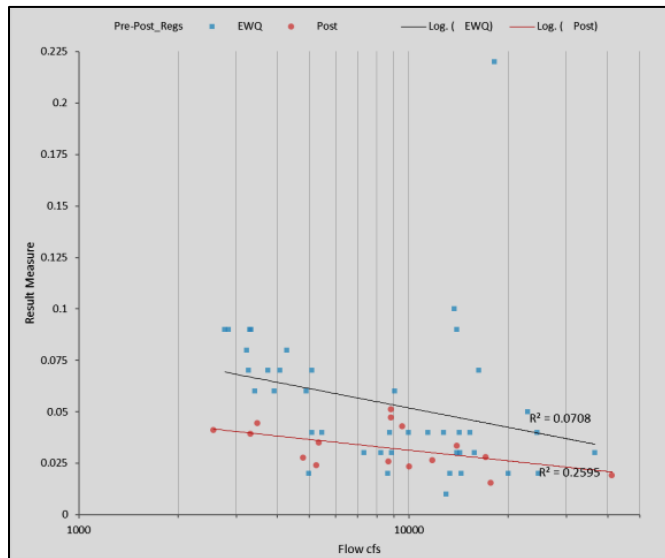Delaware River at Bulls Island Foot Bridge, NJ/PA

Orthophosphate as P, Total mg/l (OP)
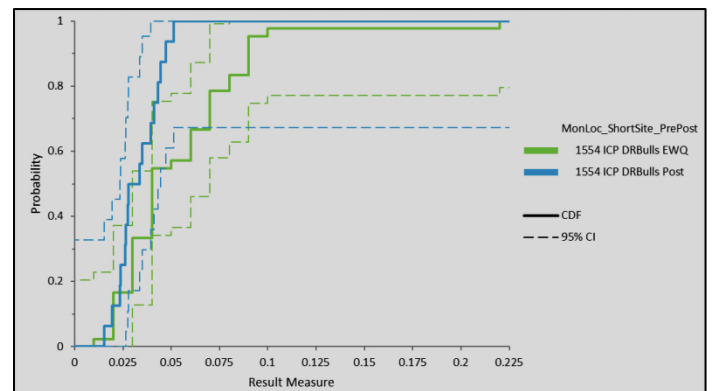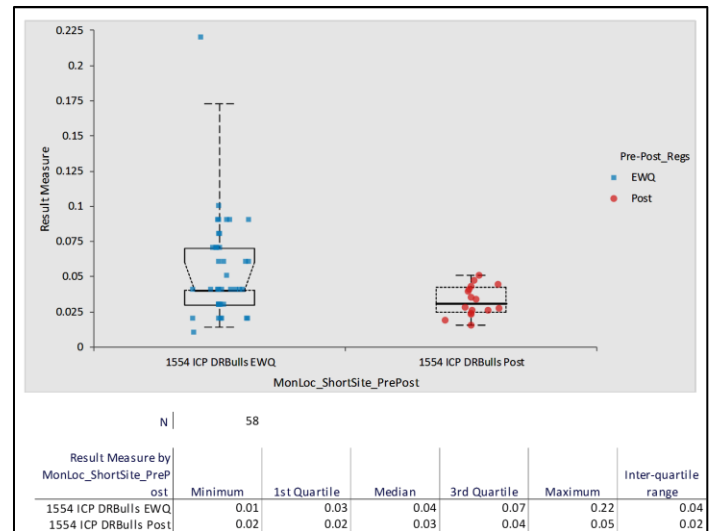
Existing Water Quality (Table 2T):

Median 0.04 mg/l
Lower 95% Confidence Interval 0.04 mg/l
Upper 95% Confidence Interval 0.06 mg/l

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	0.01	0.03	0.04	0.07	0.22	0.04
1554 ICP DRBulls Post	0.02	0.02	0.03	0.04	0.05	0.02

N = 58

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	42	427.5	10.18
1554 ICP DRBulls Post	16	1122.3	70.14

H statistic	5.48
X² approximation	5.48
DF	1
p-value	0.0192 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

No water quality degradation is evident. Orthophosphate concentrations apparently declined between the EWQ and post-EWQ periods. However, potential laboratory artifacts and differences in flow condition representativeness introduced uncertainty to conclusions.

Post-EWQ median orthophosphate fell below the EWQ lower 95% confidence interval, though the interval was established around the detection limit. OP is unrelated to flow in EWQ data, but weakly related to flow in post-EWQ data. Flow is plotted on logarithmic scale. There were no independent data to confirm DRBC results. DRBC detection limits improved between the two periods, but this had no bearing on the results since there was only one non-detect result in the EWQ data set and none in the post-EWQ data set. There may be a water quality improvement, as there are no post-EWQ concentrations higher than 0.05 mg/l.

Chapter 7: 1554 ICP

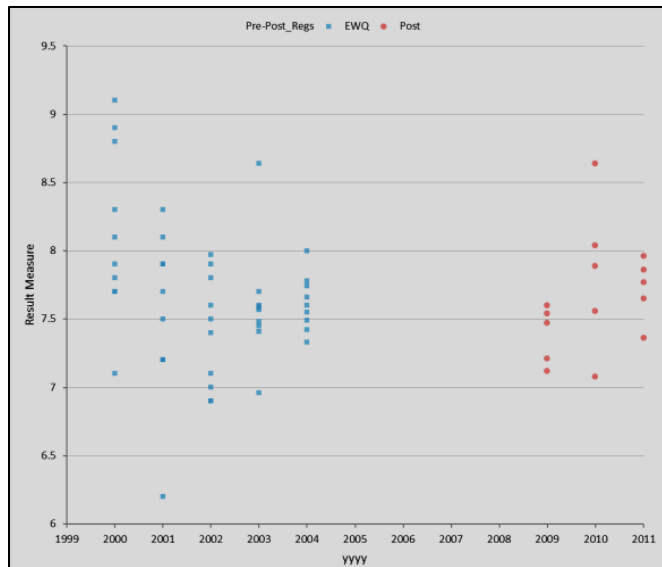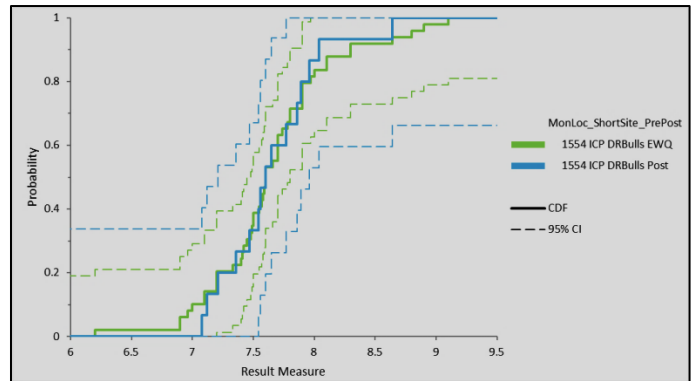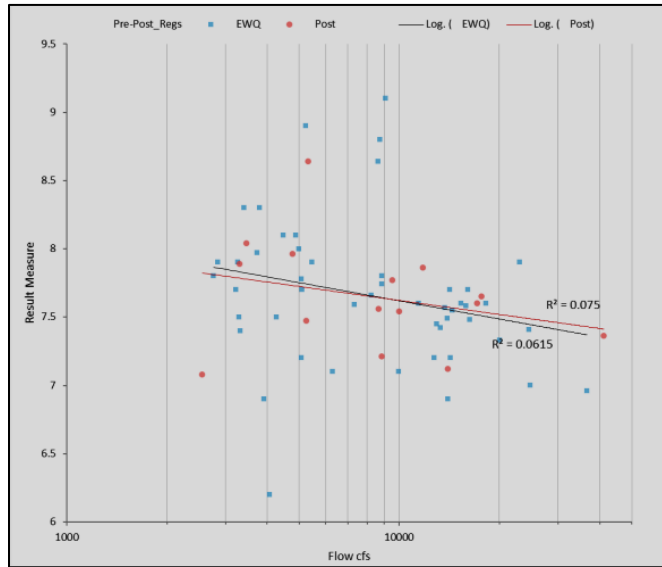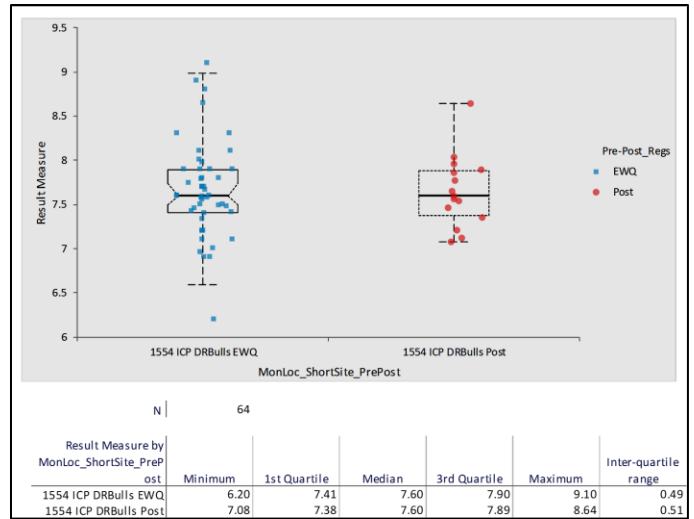Delaware River at Bulls Island Foot Bridge, NJ/PA

pH, units

Existing Water Quality (Table 2T):

Median 7.60 standard units
Lower 95% Confidence Interval 7.50 standard units
Upper 95% Confidence Interval 7.74 standard units

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	6.20	7.41	7.60	7.90	9.10	0.49
1554 ICP DRBulls Post	7.08	7.38	7.60	7.89	8.64	0.51

N | 64

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	49	0.1	0.00
1554 ICP DRBulls Post	15	0.4	0.03

H statistic	0.00
X² approximation	0.00
DF	1
p-value	0.9684 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. pH did not measurably change between the EWQ and post-EWQ periods. Post-EWQ median pH fell between the EWQ 95% confidence intervals. Under higher flow conditions, pH tends toward neutral. During low flow and high primary productivity periods, pH criteria are occasionally exceeded at this location. Flow is plotted on a logarithmic scale.

Chapter 7: 1554 ICP
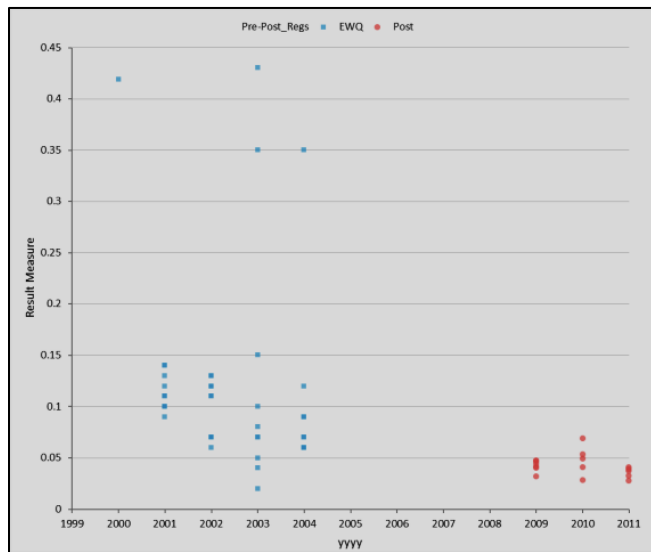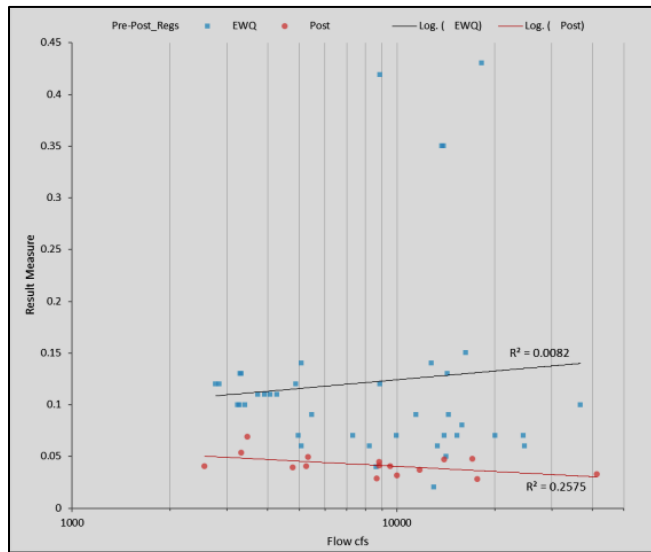Delaware River at Bulls Island Foot Bridge, NJ/PA

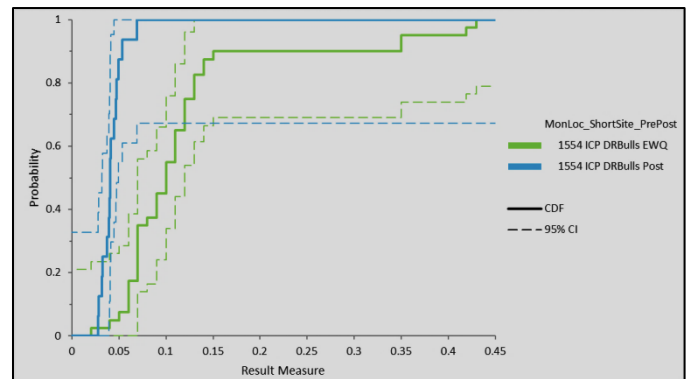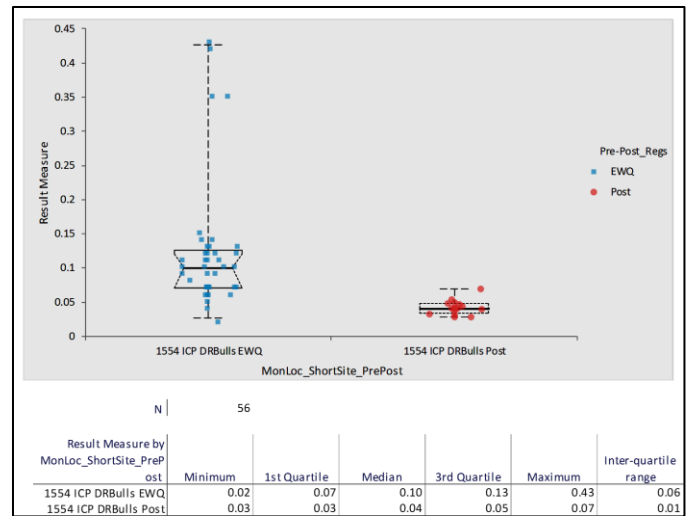Phosphorus as P, Total (TP) mg/l

Existing Water Quality (Table 2T):

Median 0.10 mg/l
Lower 95% Confidence Interval 0.07 mg/l
Upper 95% Confidence Interval 0.12 mg/l

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	0.02	0.07	0.10	0.13	0.43	0.06
1554 ICP DRBulls Post	0.03	0.03	0.04	0.05	0.07	0.01

N = 56

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	40	2073.6	51.84
1554 ICP DRBulls Post	16	5184.0	324.00

H statistic	27.38
X² approximation	27.38
DF	1
p-value	<0.0001 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.

No water quality degradation is indicated. Total Phosphorus (TP) concentrations apparently declined between the EWQ and post-EWQ periods. However, potential laboratory artifacts and insufficient post-EWQ data (n=16) produced uncertainty to conclusions.

Post-EWQ median TP fell below the EWQ lower 95% confidence interval. TP is unrelated to flow in the EWQ data set, and weakly related to flow in the post-EWQ data set. The decline in concentration may be partially attributable to improved laboratory detection limits or method sensitivity, although all results were well above the detection limits. No independent data were available to confirm these results.

Chapter 7: 1554 ICP
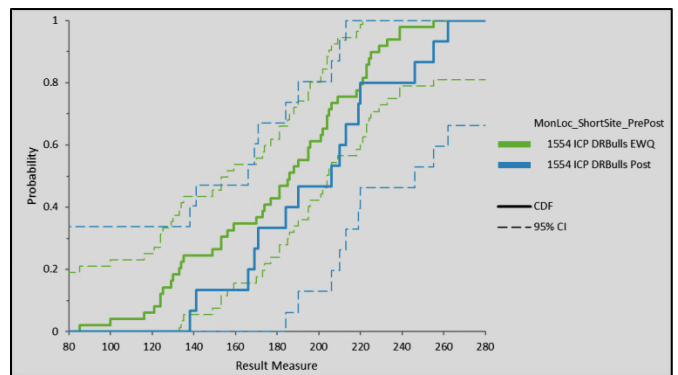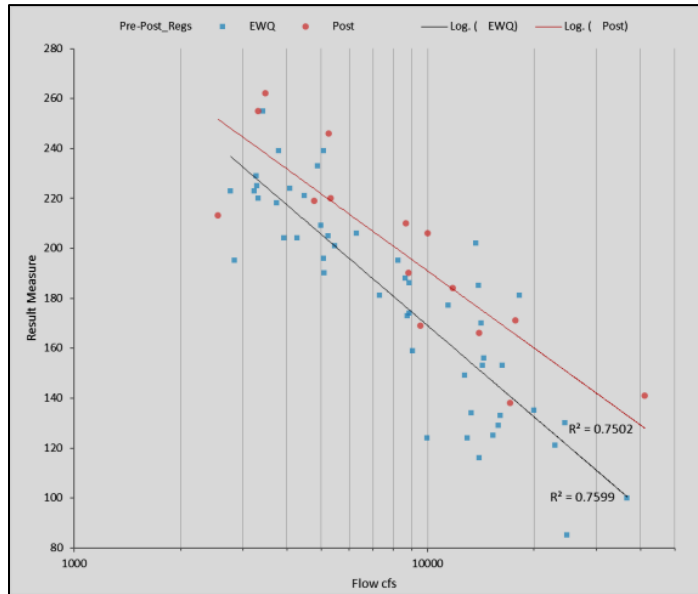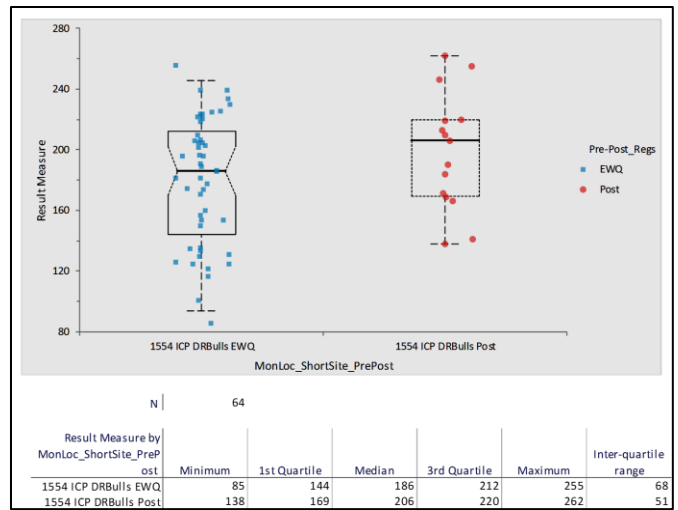Delaware River at Bulls Island Foot Bridge, NJ/PA

Specific Conductance µmho/cm

Existing Water Quality (Table 2T):

Median 186 µmho/cm
Lower 95% Confidence Interval 170 µmho/cm
Upper 95% Confidence Interval 202 µmho/cm
Defined in regulations as a flow-related parameter

N	64					
Result Measure by MonLoc_ShortSite_PreP ost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	85	144	186	212	255	68
1554 ICP DRBulls Post	138	169	206	220	262	51

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PreP ost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	49	163.5	3.34
1554 ICP DRBulls Post	15	534.0	35.60

H statistic	2.01
X² approximation	2.01
DF	1
p-value	0.1560 [1]

H0: θ₁ = θ₂ = θ...
The median of the populations are all equal.
H1: θᵢ ≠ θⱼ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.
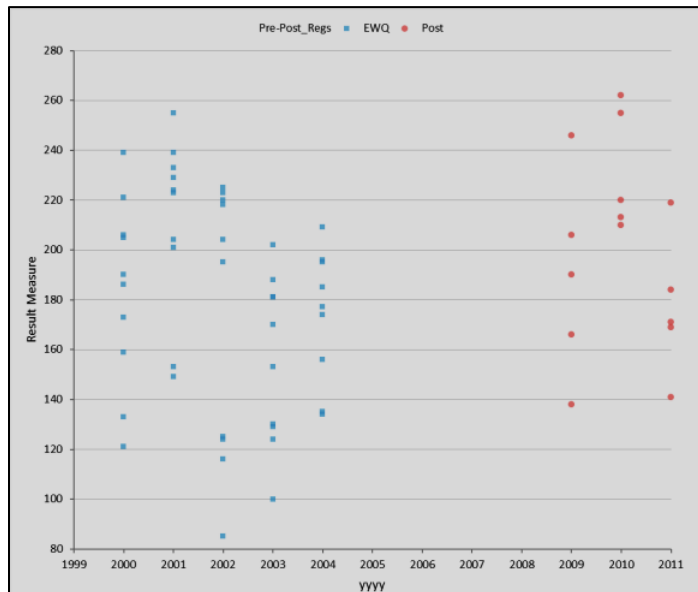
Slight evidence indicates water quality degradation. Specific conductance did not measurably change between the EWQ and post-EWQ periods. However, there were too few post-EWQ data (n=15) for reliable statistical comparison. In both data sets, specific conductance is strongly and inversely related to flow. Post-EWQ median specific conductance rose above the EWQ upper 95% confidence interval, but the overall distribution was not significantly different.   Flow is plotted on a logarithmic scale.

Chapter 7: 1554 ICP
Delaware River at Bulls Island Foot Bridge, NJ/PA
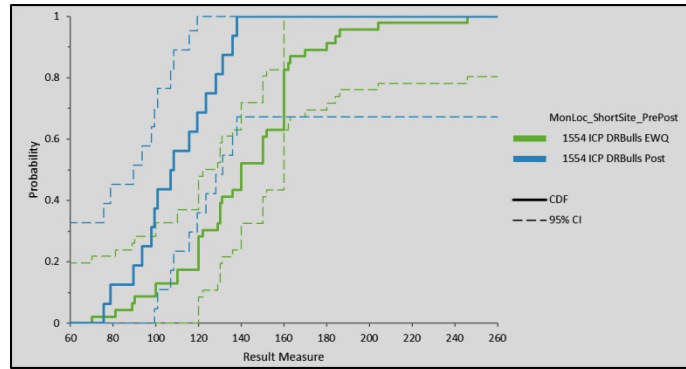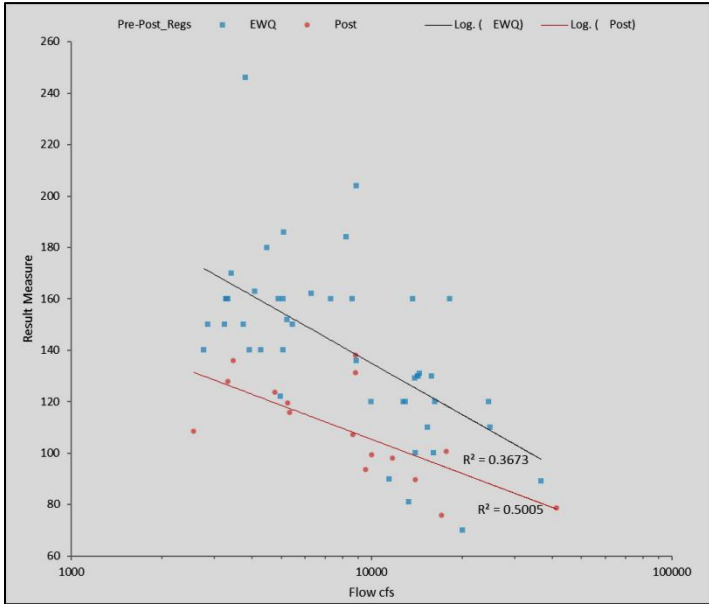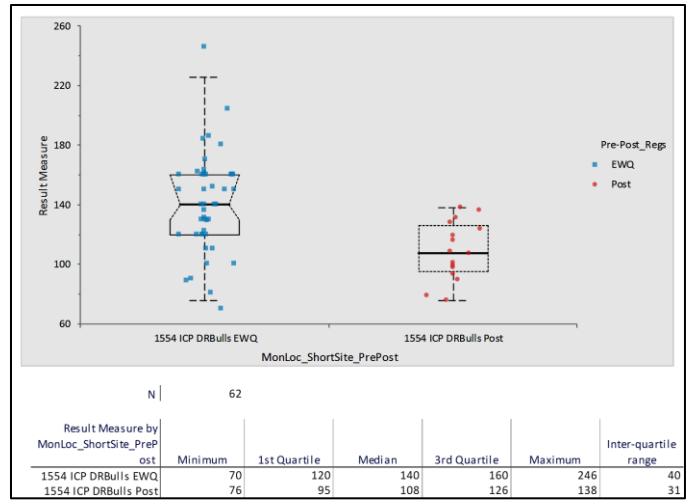
Total Dissolved Solids (TDS) mg/l

Existing Water Quality (Table 2T):

Median 140 mg/l
Lower 95% Confidence Interval 130 mg/l
Upper 95% Confidence Interval 160 mg/l
Defined in regulations as a flow-related parameter

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	70	120	140	160	246	40
1554 ICP DRBulls Post	76	95	108	126	138	31

N = 62

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	46	913.6	19.86
1554 ICP DRBulls Post	16	2626.6	164.16

H statistic	10.92
X² approximation	10.92
DF	1
p-value	0.0010[1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 5% significance level.
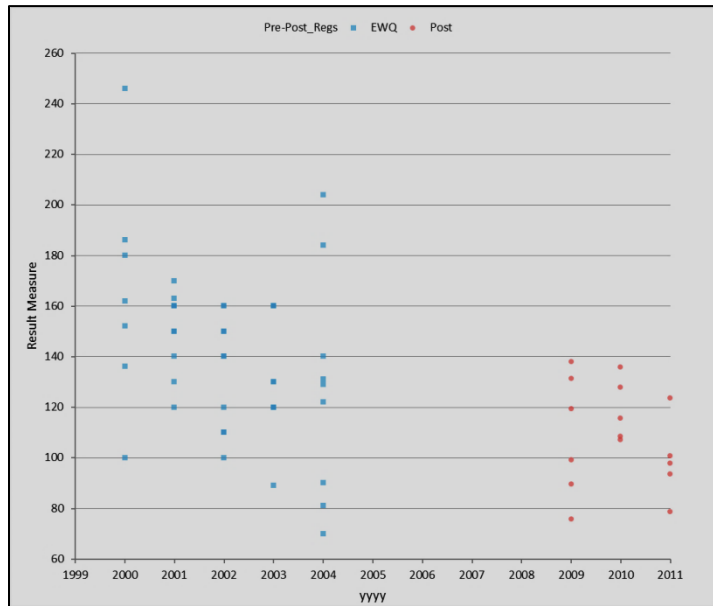
No water quality degradation is evident. TDS measurably declined between the EWQ and post-EWQ periods. However, potential laboratory artifacts and insufficient post-EWQ data produced uncertainty in conclusions. TDS is inversely related to flow in the EWQ data set, but unrelated to flow in the post-EWQ data set – probably due to insufficient sampling not fully representative of flow conditions. Post-EWQ median TDS was well below the EWQ 95% lower confidence interval. Post-EWQ detection limits were lower than EWQ detection limits, though there were no non-detect results in either data set. Flow is plotted on a logarithmic scale.

Chapter 7: 1554 ICP
Delaware River at Bulls Island Foot Bridge, NJ/PA
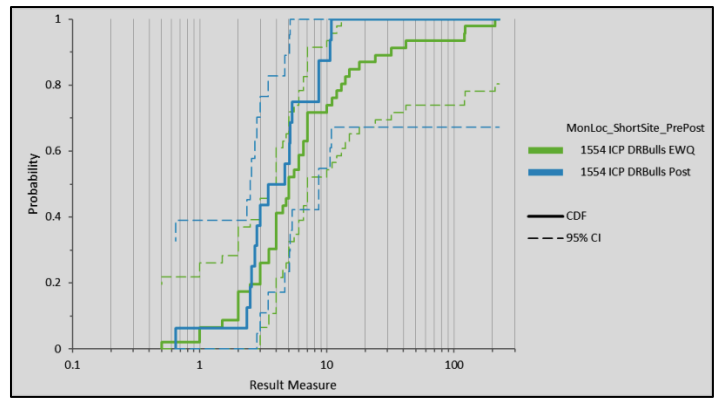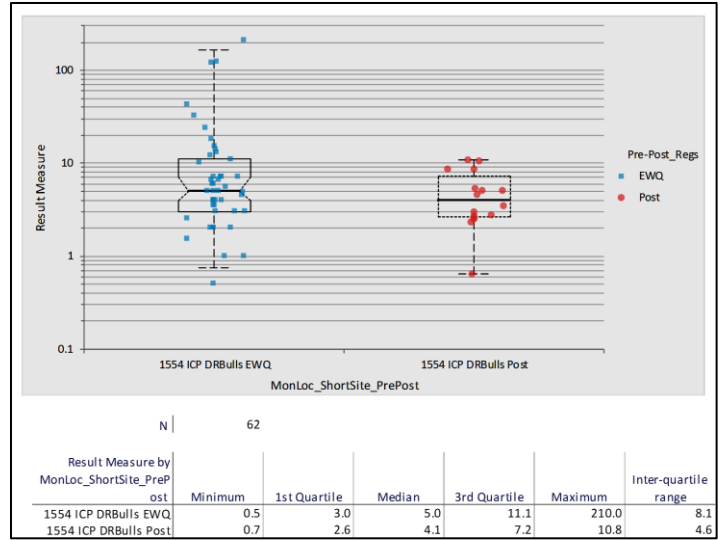
Total Suspended Solids (TSS) mg/l

Existing Water Quality (Table 2T):

Median 5.0 mg/l
Lower 95% Confidence Interval 4.0 mg/l
Upper 95% Confidence Interval 7.0 mg/l
Defined in regulations as a flow-related parameter

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	0.5	3.0	5.0	11.1	210.0	8.1
1554 ICP DRBulls Post	0.7	2.6	4.1	7.2	10.8	4.6

N | 62

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	46	119.0	2.59
1554 ICP DRBulls Post	16	342.3	21.39

H statistic	1.42
X^2 approximation	1.42
DF	1
p-value	0.2336[1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. TSS did not measurably change between the EWQ and post-EWQ periods. TSS is positively related to flow in both data sets. Post-EWQ median TSS was within the EWQ 95% confidence intervals. Flow and concentrations are plotted on a logarithmic scale, and the regressions are power equations.
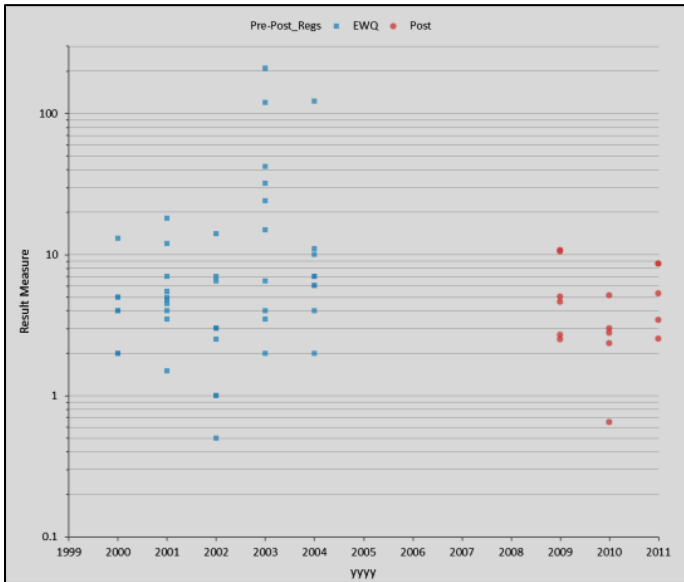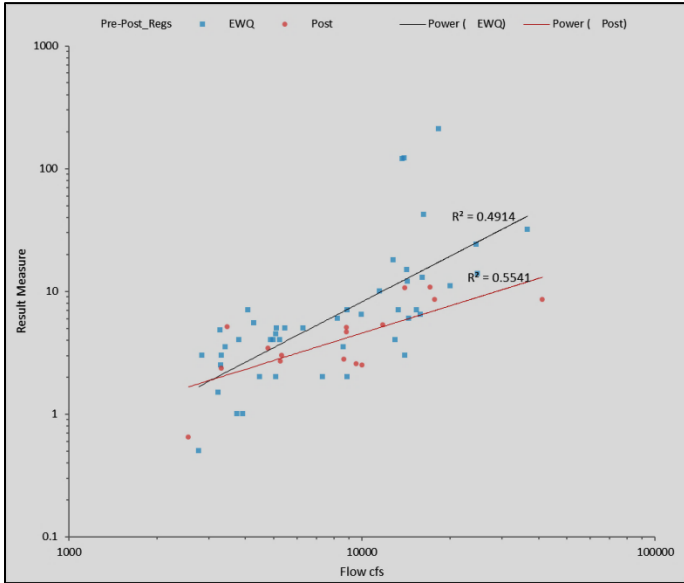
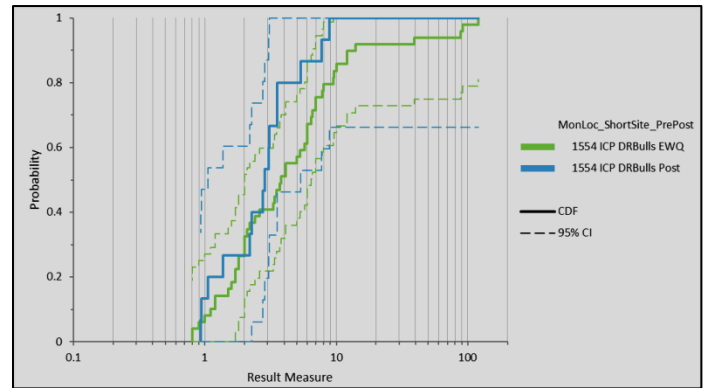Chapter 7: 1554 ICP

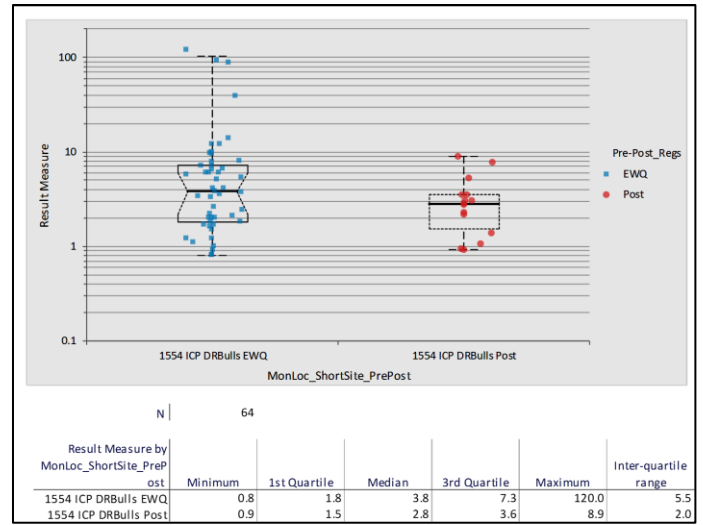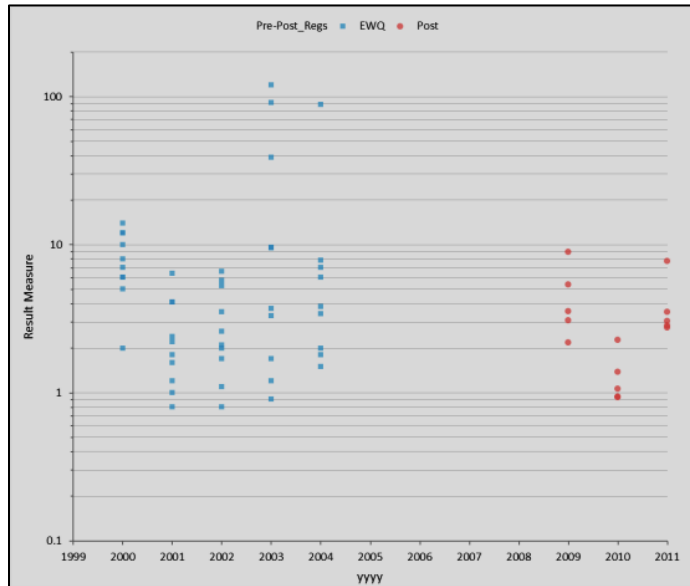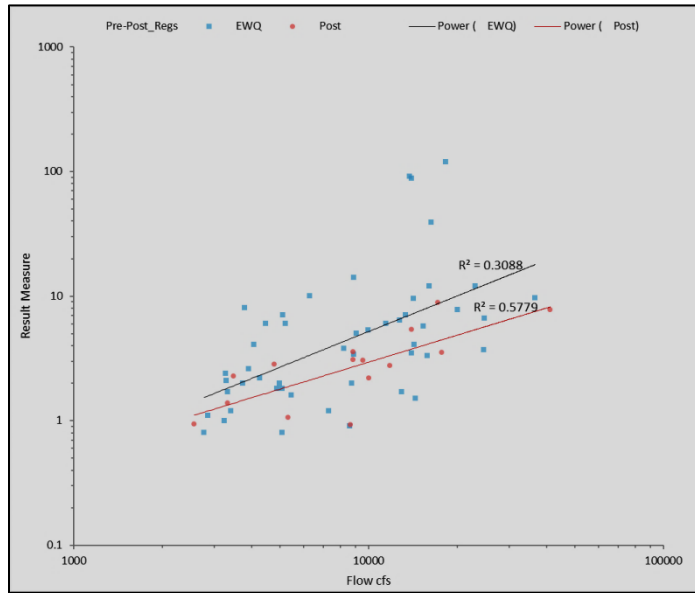Delaware River at Bulls Island Foot Bridge, NJ/PA

Turbidity NTU

Existing Water Quality (Table 2T):

Median 3.8 NTU
Lower 95% Confidence Interval 2.2 NTU
Upper 95% Confidence Interval 6.0 NTU

Result Measure by MonLoc_ShortSite_PreP ost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	0.8	1.8	3.8	7.3	120.0	5.5
1554 ICP DRBulls Post	0.9	1.5	2.8	3.6	8.9	2.0

N | 64

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PreP ost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	49	145.7	2.97
1554 ICP DRBulls Post	15	476.0	31.73

H statistic	1.79
X² approximation	1.79
DF	1
p-value	0.1804 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. Turbidity did not measurably change between the EWQ and post-EWQ periods. All post-EWQ turbidity results were below 9 NTU. The post-EWQ median turbidity was within the EWQ 95% confidence intervals. In the EWQ data set, the turbidity vs. flow relationship is weakly positive, and strongly positive in the post-EWQ data set. Both concentration and flow are represented on a logarithmic scale.
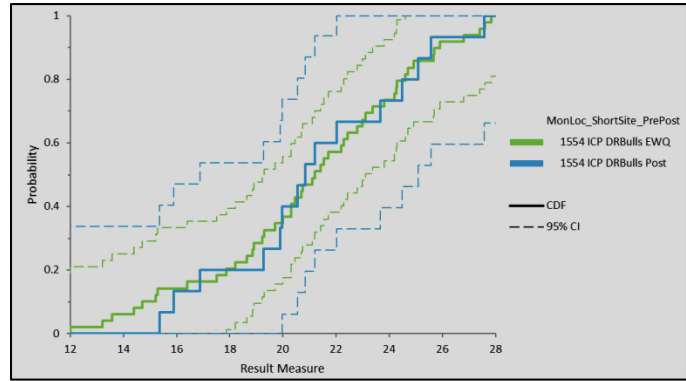
Chapter 7: 1554 ICP
Delaware River at Bulls Island Foot Bridge, NJ/PA

Water Temperature, degrees C

Not included in DRBC Existing Water Quality rules
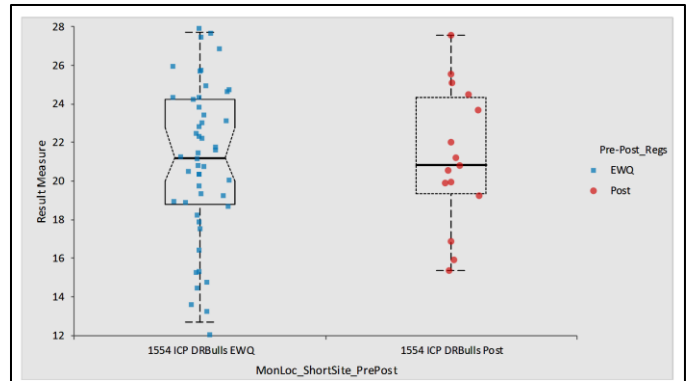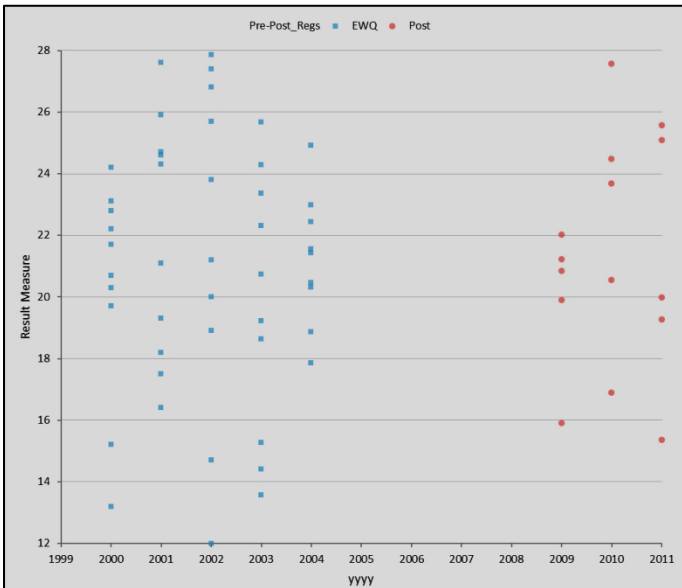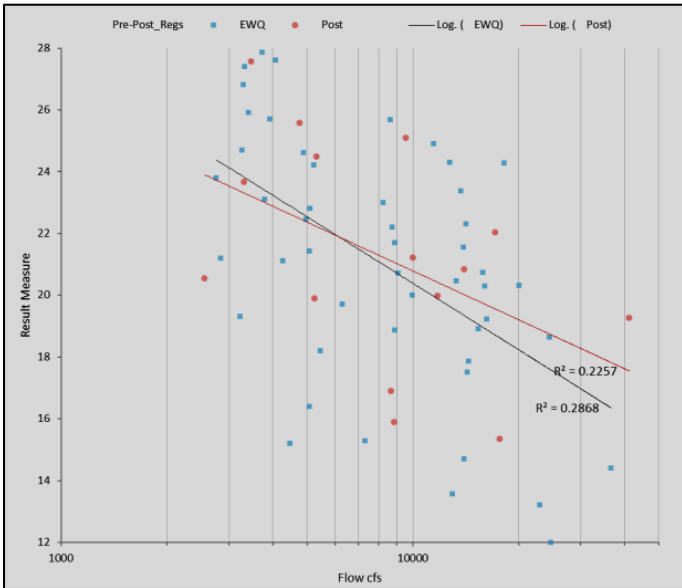
N	64					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1554 ICP DRBulls EWQ	12.0	18.8	21.2	24.2	27.9	5.4
1554 ICP DRBulls Post	15.4	19.4	20.8	24.3	27.6	5.0

Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1554 ICP DRBulls EWQ	49	0.6	0.01
1554 ICP DRBulls Post	15	2.0	0.13

H statistic	0.01
X² approximation	0.01
DF	1
p-value	0.9305 [1]

H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

No water quality degradation is evident. Water temperature did not measurably change between the EWQ and post-EWQ periods. Water temperature is inversely related to flow, though the relationship is weak. The distributions were almost identical.