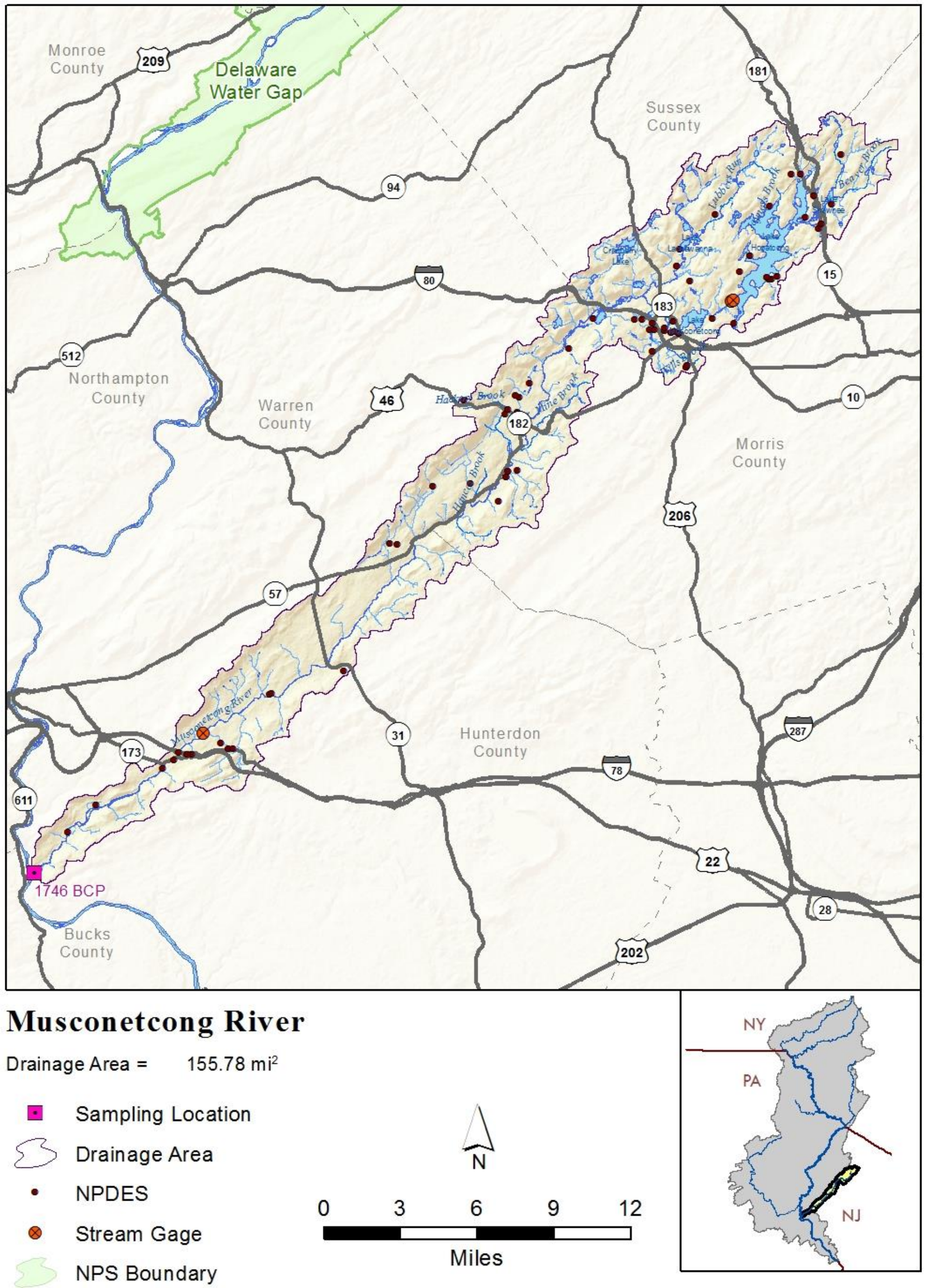
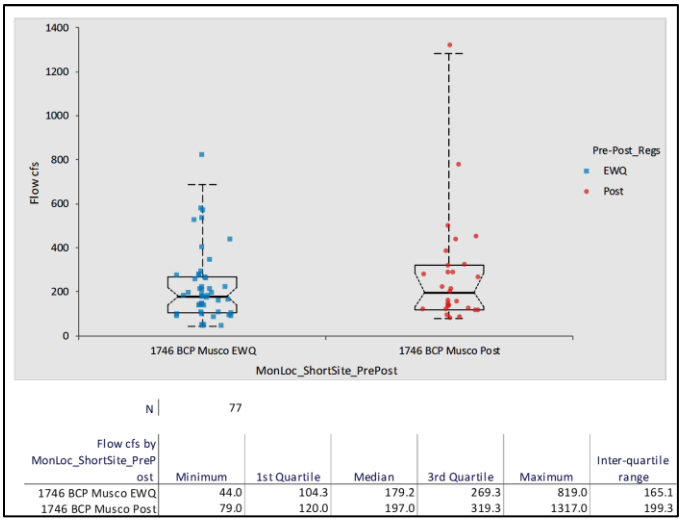
Chapter 14: 1746 BCP Musconetcong River, Hunterdon, Warren, Sussex and Morris Counties, NJ



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



N	77					
Flow cfs by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	44.0	104.3	179.2	269.3	819.0	165.1
1746 BCP Musco Post	79.0	120.0	197.0	319.3	1317.0	199.3

Flow was roughly the same between the EWQ and post-EWQ periods. Fewer samples were collected in the post-EWQ period. The range of flow conditions sampled was wider in the post-EWQ period, but there were fewer samples taken during low-flow conditions.

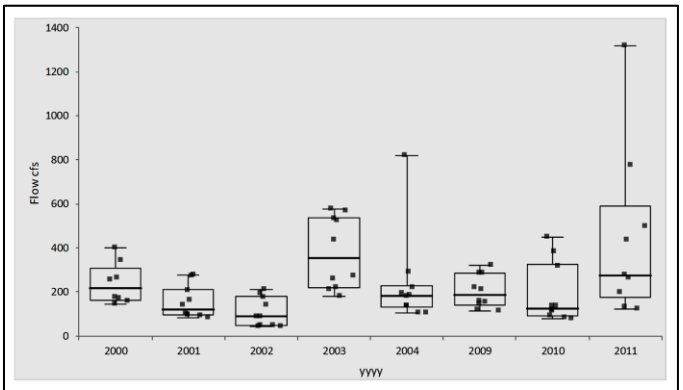
Kruskal-Wallis test

Flow cfs by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	48	94.9	1.98
1746 BCP Musco Post	29	157.1	5.42

H statistic	0.50
X^2 approximation	0.50
DF	1
p-value	0.4779[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.

The 155.9 square mile Musconetcong River watershed is a large tributary to the Delaware River, and has been designated in the federal Wild and Scenic River system. The watershed is about 58% forested, and contains 11.3% urban land cover – one of the more urbanized watersheds in the Lower Delaware. The watershed is about 25% underlain by carbonate bedrock, and about 48% influenced by glacial activity. There are numerous municipal and industrial dischargers in the watershed, and significant agriculture in the valley. Human activity in the watershed is sufficiently complex that the Musconetcong is a good candidate for construction of a watershed water quality model to assess cumulative effects, particularly since the Musconetcong presently deteriorates downstream Delaware River water quality.



N	77					
Flow cfs by yyyy	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
2000	145.9	163.2	215.8	309.9	399.4	146.7
2001	82.5	94.4	119.8	212.0	277.1	117.7
2002	44.0	46.6	88.5	179.1	212.4	132.5
2003	180.5	220.8	355.6	536.3	577.4	315.5
2004	103.0	131.7	182.0	227.8	819.0	96.1
2009	115.0	141.8	185.5	284.0	320.0	142.2
2010	79.0	93.1	127.0	324.5	449.0	231.4
2011	121.0	175.3	277.0	590.3	1317.0	415.0

Annual May to September flow statistics associated with water quality measurements are plotted above. These are flow measurements or sometimes estimates associated with the time of each water quality sample. Mean annual flow is about 302 cfs; and harmonic mean flow is about 187 cfs (USGS Stream Stats retrieval, Feb. 2014) which is more typical of summer flow conditions. Though a wide range of flows were sampled by DRBC, these data appear to be most representative of low to normal flow conditions. Flows corresponding to each water quality sample were estimated using instantaneous data from the USGS gage No. 01457000 on the Musconetcong River near Bloomsbury times a drainage area weighting factor.

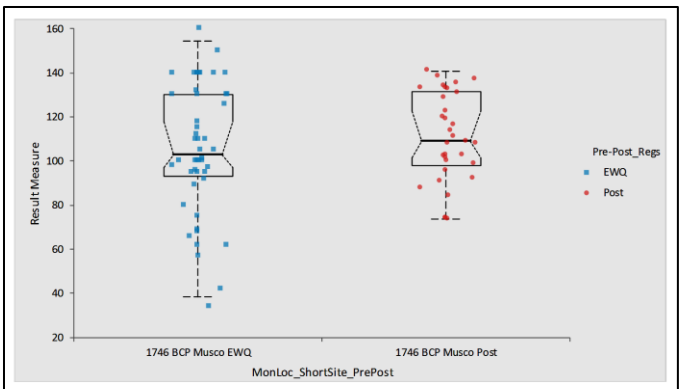
Upstream ICP: Delaware River at Riegelsville 1748 ICP
Downstream ICP: Delaware River at Milford 1677 ICP

Chapter 14: 1746 BCP Musconetcong River, NJ

Alkalinity as CaCO3, Total mg/l

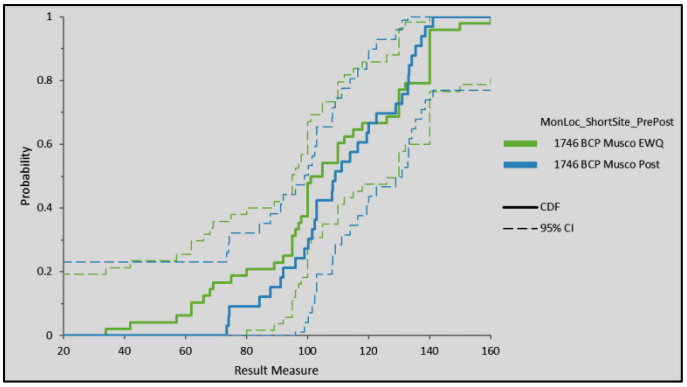
Existing Water Quality (Table 2M):

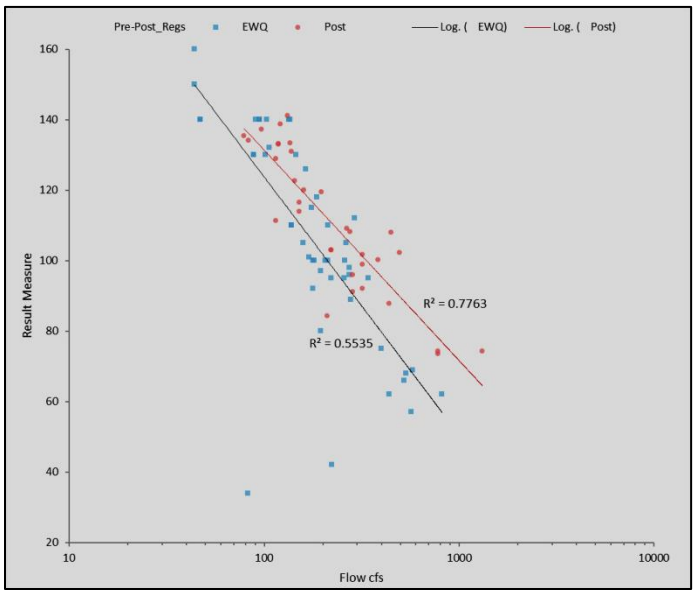
Median 103 mg/l
Lower 95% Confidence Interval 97 mg/l
Upper 95% Confidence Interval 118 mg/l
Defined in regulations as a flow-related parameter

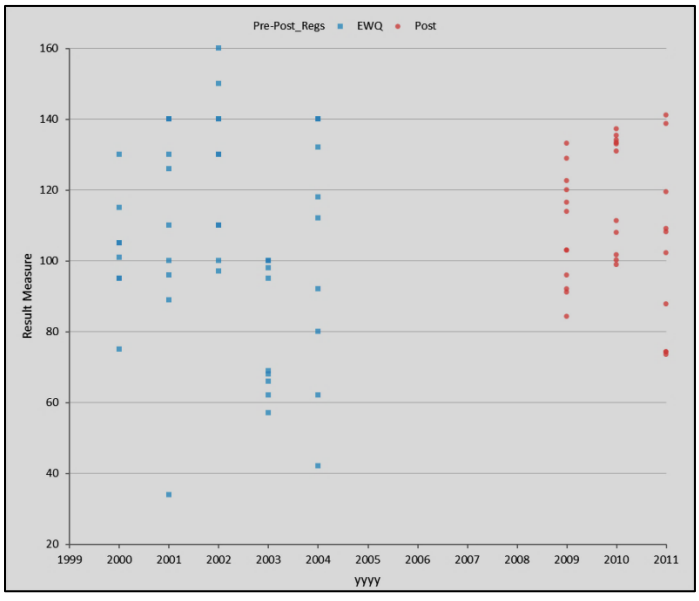


N	81

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	34	93	103	130	160	37
1746 BCP Musco Post	74	98	109	132	141	34







Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	48	112.5	2.34
1746 BCP Musco Post	33	163.7	4.96

H statistic	0.50
X^2 approximation	0.50
DF	1
p-value	0.4796 [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.

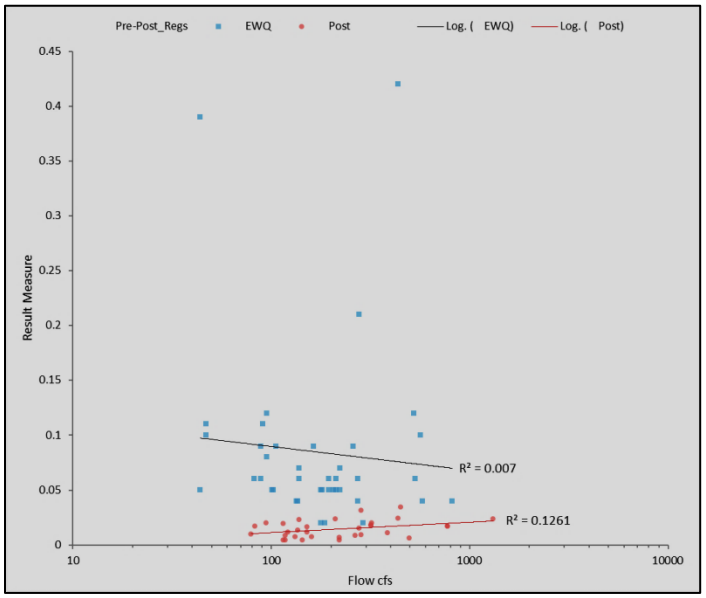
No water quality degradation is evident here. Alkalinity did not measurably change between the EWQ and post-EWQ periods. Uncertainty was introduced into comparisons by potential laboratory artifacts. Alkalinity is inversely related to flow in both data sets. Post-EWQ median alkalinity fell within EWQ 95% confidence intervals. Flow is plotted on a logarithmic scale. Limestone-influences are apparent at these alkalinity concentrations.

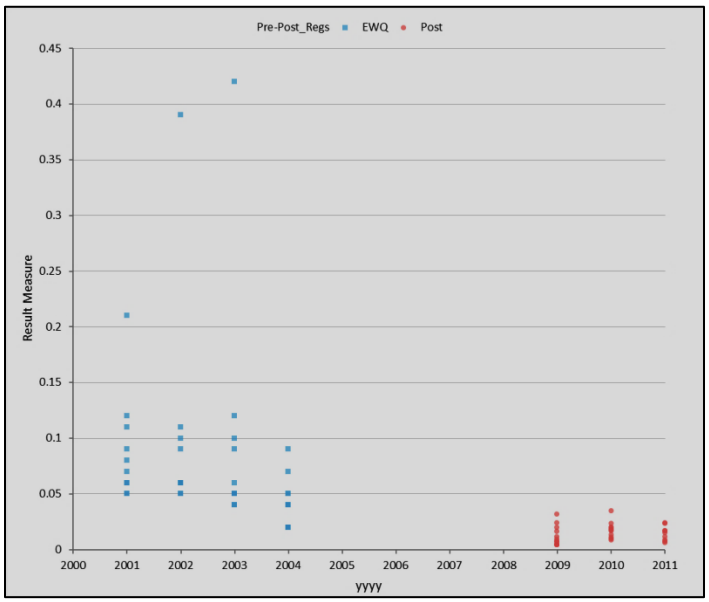
Chapter 14: 1746 BCP Musconetcong River, NJ

Ammonia Nitrogen as N, Total mg/l

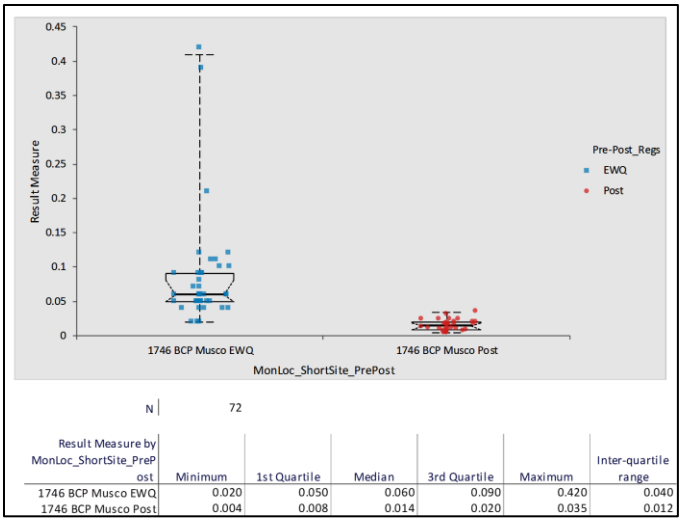
Existing Water Quality (Table 2M):

Median 0.06 mg/l
Lower 95% Confidence Interval 0.05 mg/l
Upper 95% Confidence Interval 0.08 mg/l



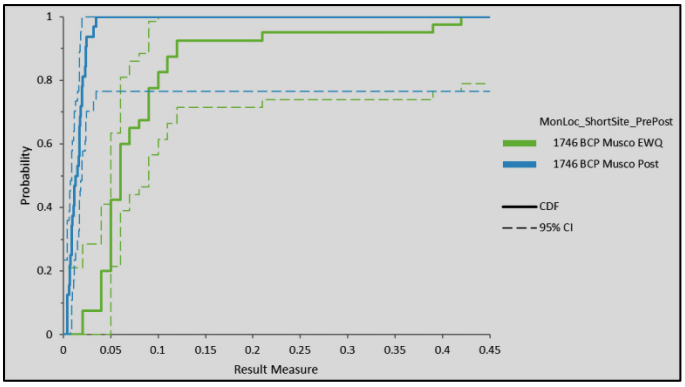


No water quality degradation is evident here. Ammonia concentrations apparently declined. Uncertainty was introduced into comparisons by potential laboratory artifacts and declining detection limits. Post-EWQ median ammonia concentration was below the EWQ lower 95% confidence interval. New Jersey and USGS data were available and validated these results.



N 72

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	0.020	0.050	0.060	0.090	0.420	0.040
1746 BCP Musco Post	0.004	0.008	0.014	0.020	0.035	0.012



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	40	9625.5	240.64
1746 BCP Musco Post	32	12031.9	376.00

H statistic	49.63
X^2 approximation	49.63
DF	1
p-value	<0.0001 [1]

H0: $\theta_i = \theta_j = \theta...$
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.

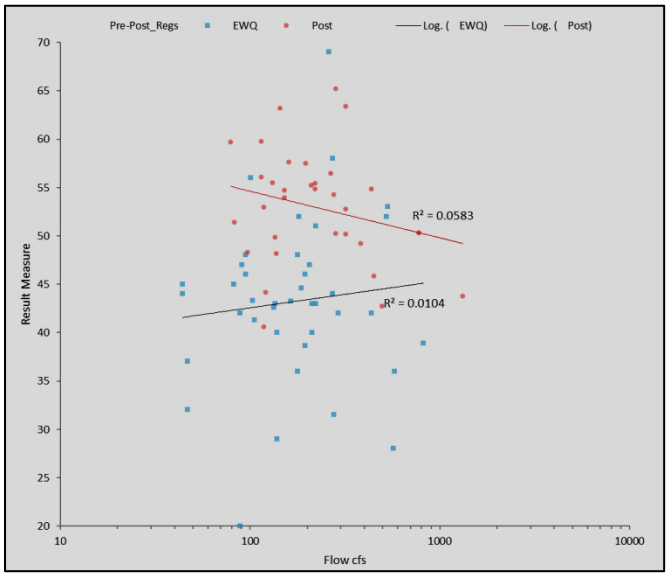
Flow is plotted on a logarithmic scale. DRBC's post-EWQ detection limit was much lower than during the EWQ period. EWQ data possessed 12/40 undetected results out of 40 samples at detection limits of 0.02-0.05 mg/l. 2009-2011 detection levels were 0.004-0.006 mg/l, and there were still 5/32 undetected results. So rather than a real change in ambient concentrations data may show actual low-level concentrations. Evidence of water quality improvement is possible as post-EWQ DRBC, NJDEP and USGS data contained no concentrations over 0.035 mg/l.

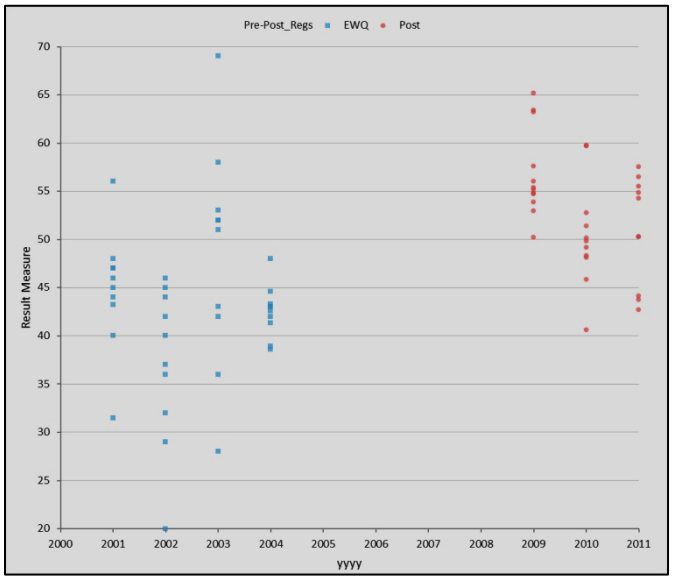
Chapter 14: 1746 BCP Musconetcong River, NJ

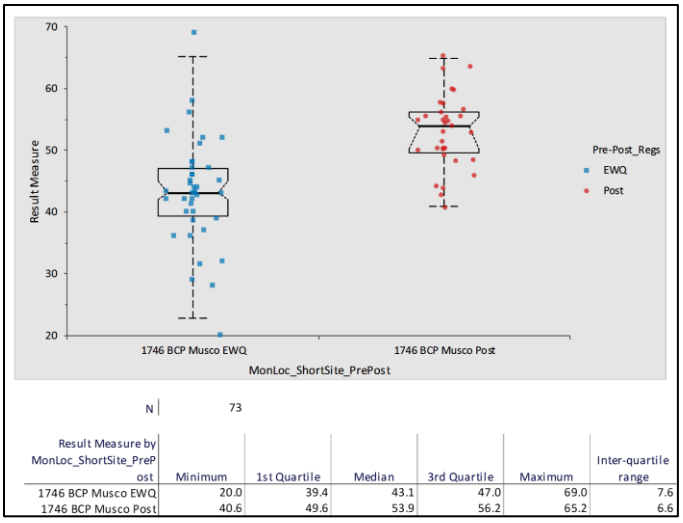
Chloride, Total mg/l

Existing Water Quality (Table 2M):

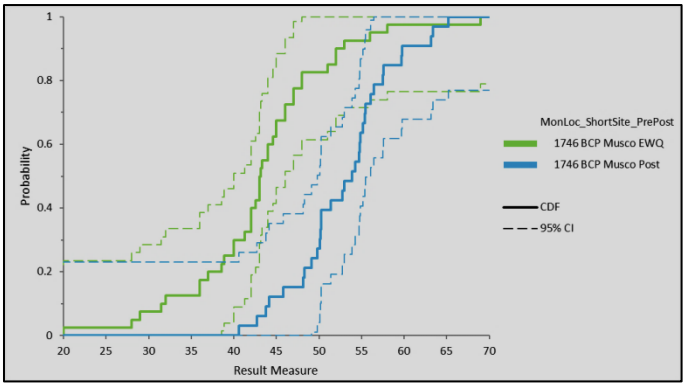
Median 43 mg/l
Lower 95% Confidence Interval 42 mg/l
Upper 95% Confidence Interval 45 mg/l







N	73					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	20.0	39.4	43.1	47.0	69.0	7.6
1746 BCP Musco Post	40.6	49.6	53.9	56.2	65.2	6.6



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	40	5175.6	129.39
1746 BCP Musco Post	33	6273.5	190.11

H statistic	25.44
X^2 approximation	25.44
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.

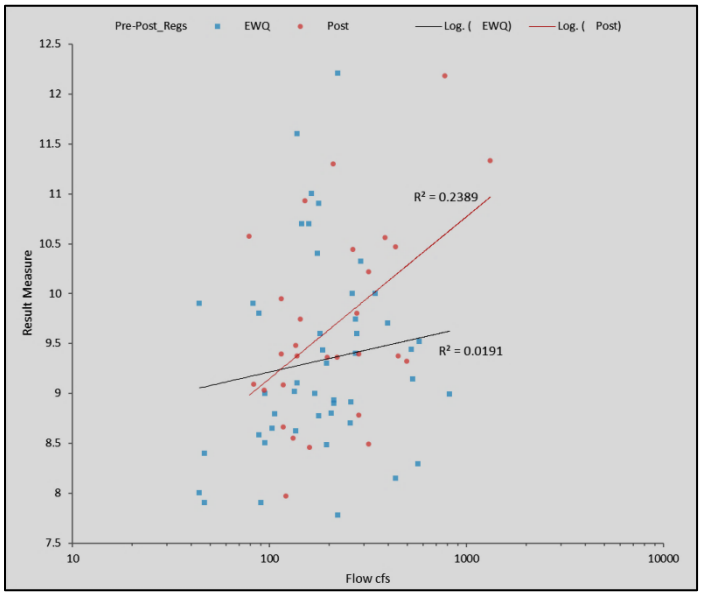
Water quality degradation is evident here. Chloride concentrations apparently rose by about 11 mg/l between the two periods, a 25% increase. Uncertainty was introduced into comparisons by potential laboratory artifacts. Post-EWQ median concentration rose above the EWQ upper 95% confidence interval. Chloride concentration is unrelated to flow in this data set. Note that flow is plotted on a logarithmic scale. NJDEP and USGS data validated this conclusion.

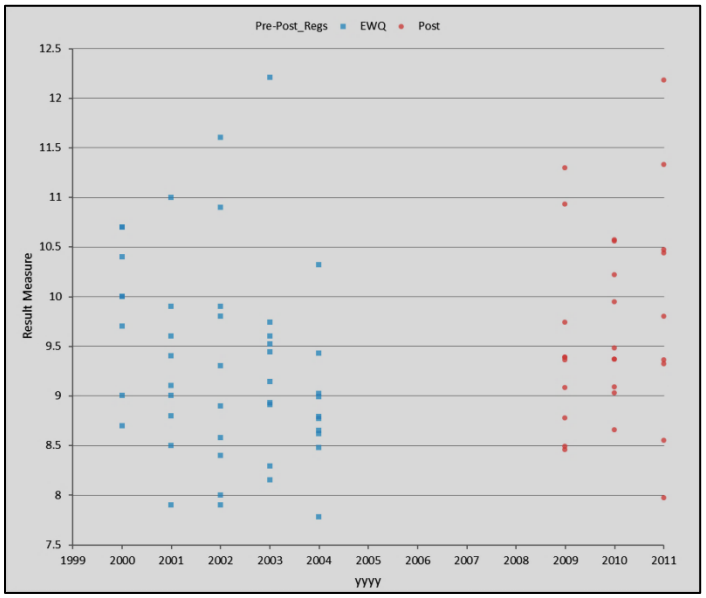
Chapter 14: 1746 BCP Musconetcong River, NJ

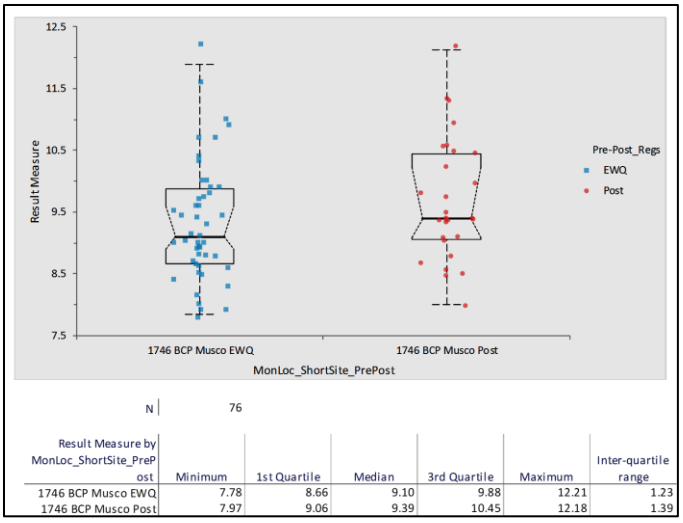
Dissolved Oxygen (DO) mg/l

Existing Water Quality (Table 2M):

Median 9.10 mg/l
Lower 95% Confidence Interval 8.90 mg/l
Upper 95% Confidence Interval 9.60 mg/l

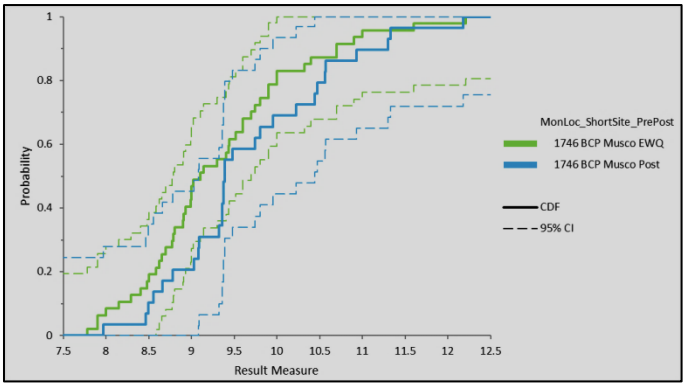






N	76

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	7.78	8.66	9.10	9.88	12.21	1.23
1746 BCP Musco Post	7.97	9.06	9.39	10.45	12.18	1.39



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	47	414.0	8.81
1746 BCP Musco Post	29	671.0	23.14

H statistic	2.23
X^2 approximation	2.23
DF	1
p-value	0.1358[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.

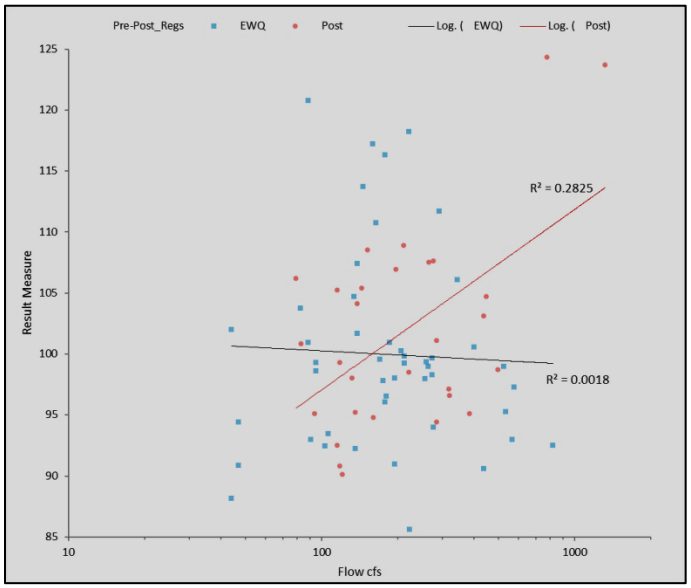
No water quality degradation is evident here. No measurable change took place between the EWQ and Post-EWQ periods. Post-EWQ median DO concentration fell within the EWQ 95% confidence intervals. DO concentration is unrelated to flow in both data sets. Note that flow is plotted on a logarithmic scale.

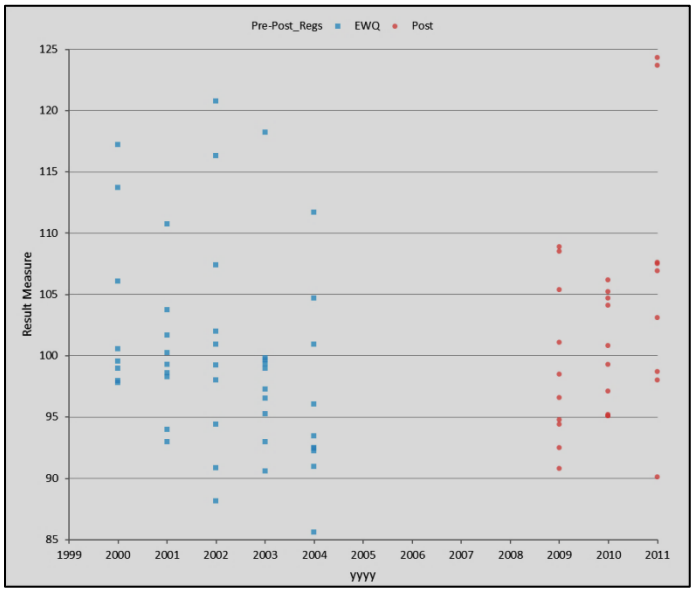
Chapter 14: 1746 BCP Musconetcong River, NJ

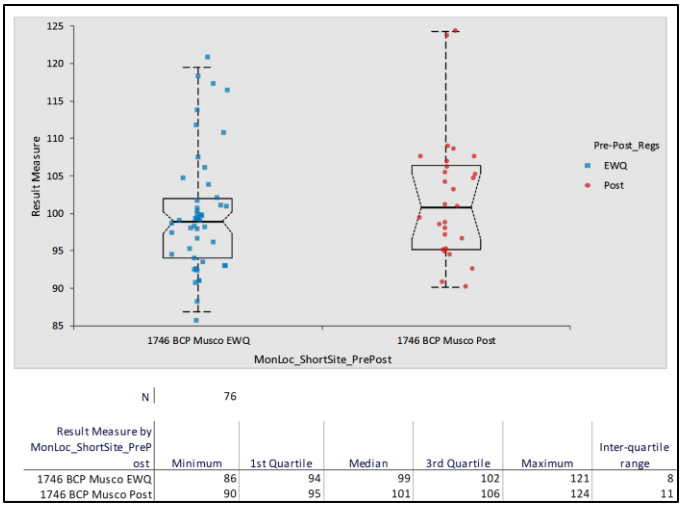
Dissolved Oxygen Saturation %

Existing Water Quality (Table 2M):

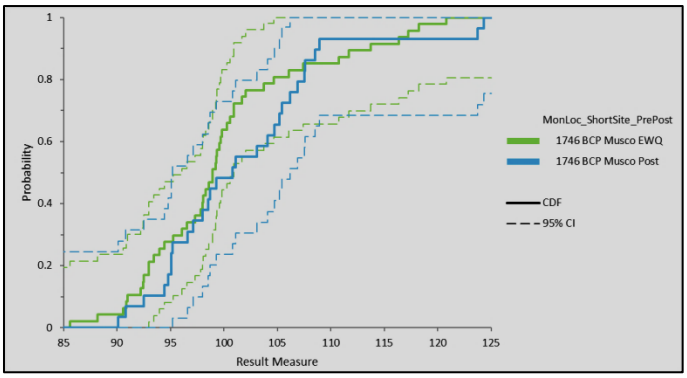
Median 99%
Lower 95% Confidence Interval 97%
Upper 95% Confidence Interval 100%







	N	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
Result Measure by MonLoc_ShortSite_PrePost	76						
1746 BCP Musco EWQ		86	94	99	102	121	8
1746 BCP Musco Post		90	95	101	106	124	11



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	47	210.6	4.48
1746 BCP Musco Post	29	341.4	11.77

H statistic	1.13
X^2 approximation	1.13
DF	1
p-value	0.2873[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.

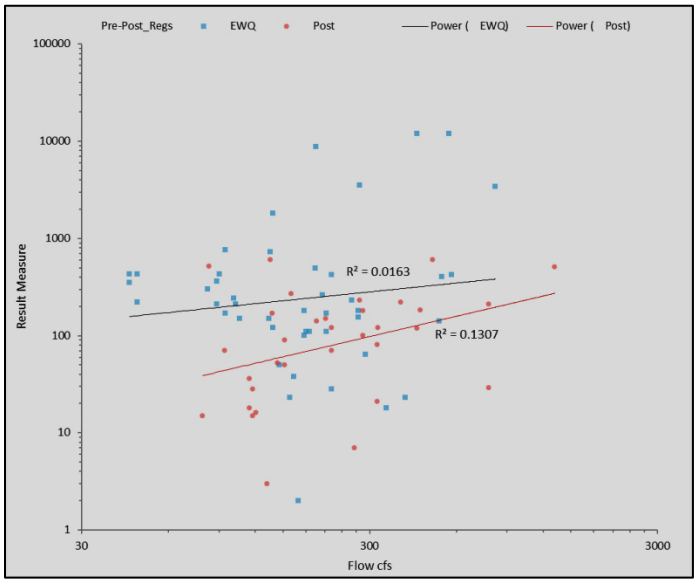
No water quality degradation is evident here. Dissolved Oxygen Saturation is unrelated to flow, and did not measurably change between the EWQ and post-EWQ periods. Post-EWQ median DO saturation increased above the upper EWQ 95% confidence interval but the increase was not significant. An increase in DO saturation would represent a water quality improvement anyway.

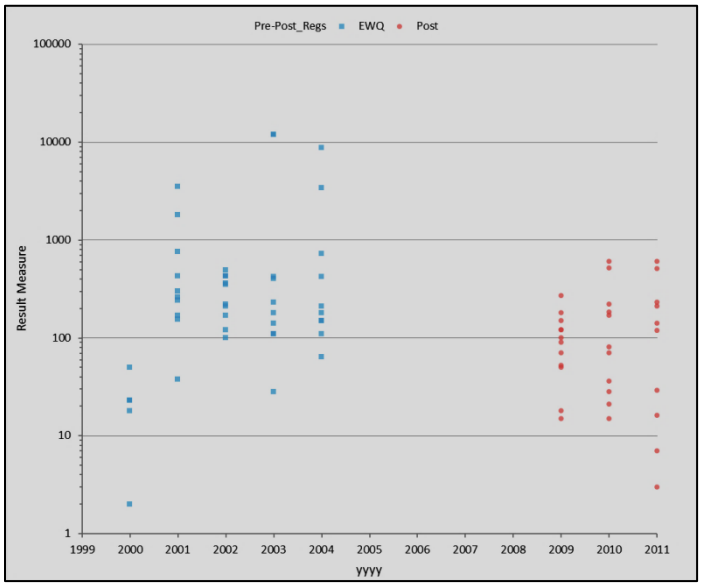
Chapter 14: 1746 BCP Musconetcong River, NJ

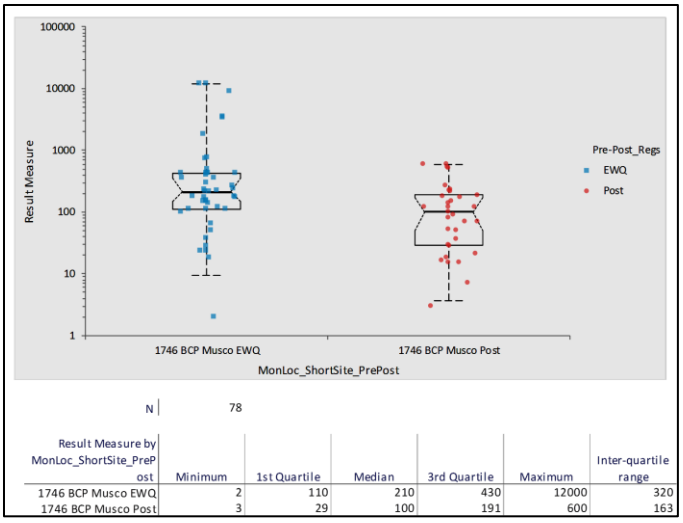
Enterococcus colonies/100 ml

Existing Water Quality (Table 2M):

Median 210/100 ml
Lower 95% Confidence Interval 150/100 ml
Upper 95% Confidence Interval 360/100 ml

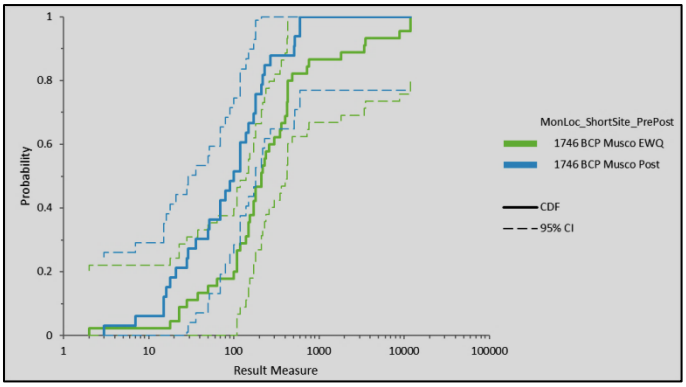






N	78

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	2	110	210	430	12000	320
1746 BCP Musco Post	3	29	100	191	600	163



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	45	1947.0	43.27
1746 BCP Musco Post	33	2655.0	80.46

H statistic	8.97
X^2 approximation	8.97
DF	1
p-value	0.0027 [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.

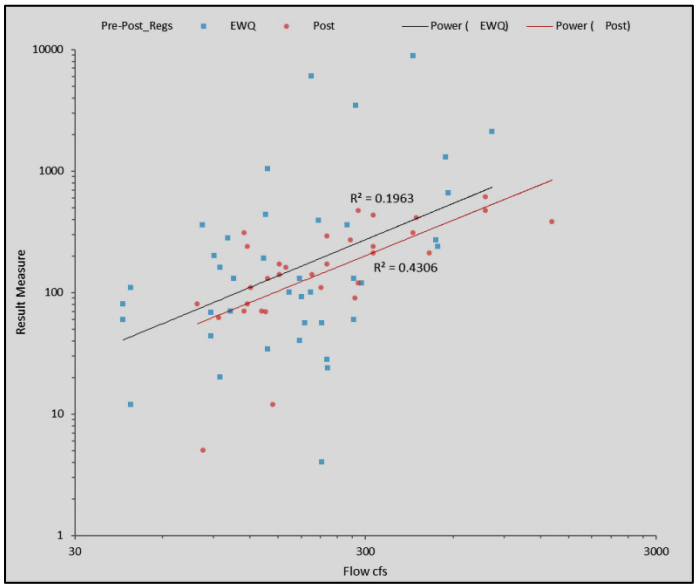
No water quality degradation is evident here. Enterococci apparently declined between the EWQ and Post-EWQ periods. Uncertainty was introduced into comparisons by potential laboratory artifacts. Enterococcus concentrations are unrelated to flow in both data sets. Note that concentrations and flows are plotted on a logarithmic scale, and the regression is a power relationship. Post-EWQ median enterococcus concentrations fell below the lower EWQ 95% confidence interval.

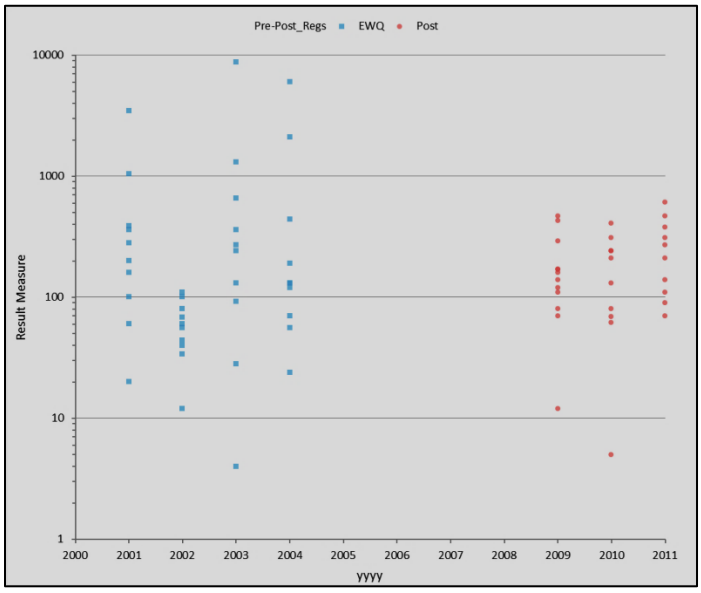
Chapter 14: 1746 BCP Musconetcong River, NJ

Escherichia coli colonies/100 ml

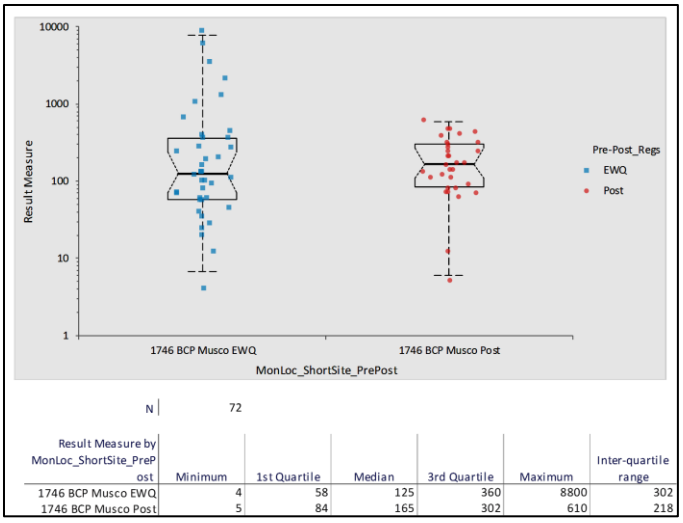
Existing Water Quality (Table 2M):

Median 125/100 ml
Lower 95% Confidence Interval 70/100 ml
Upper 95% Confidence Interval 240/100 ml



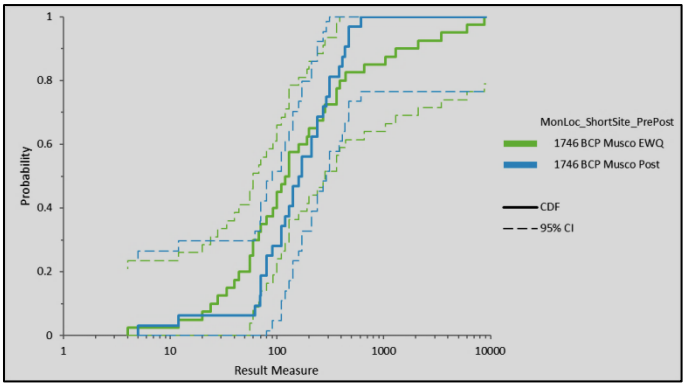


No water quality degradation is evident here. E. coli concentrations did not measurably change between the EWQ and Post-EWQ periods. Uncertainty was introduced into comparisons by potential laboratory artifacts.



N	72

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	4	58	125	360	8800	302
1746 BCP Musco Post	5	84	165	302	610	218



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	40	113.9	2.85
1746 BCP Musco Post	32	142.4	4.45

H statistic	0.59
X^2 approximation	0.59
DF	1
p-value	0.4442 [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.

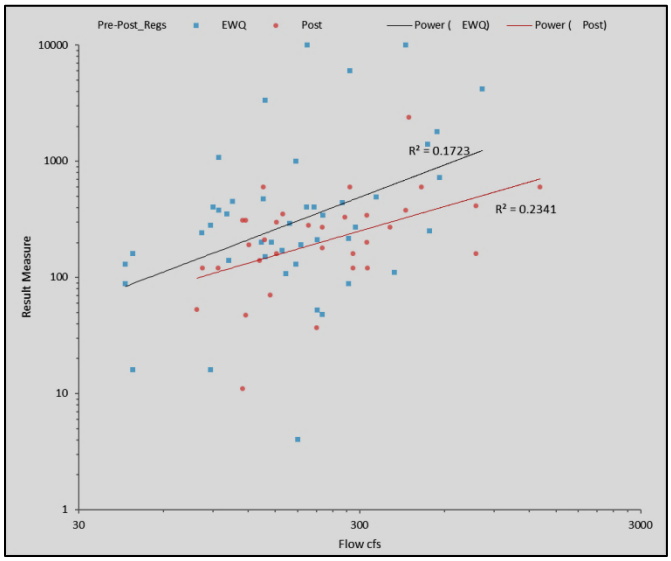
Post-EWQ median E. coli fell within the EWQ 95% confidence intervals. Note that concentrations and flows are plotted on a logarithmic scale. E. coli concentrations are unrelated to flow in the EWQ data set, but positively related to flow in the post-EWQ data set. New Jersey DEP and USGS data validated results and were virtually identical with DRBC data.

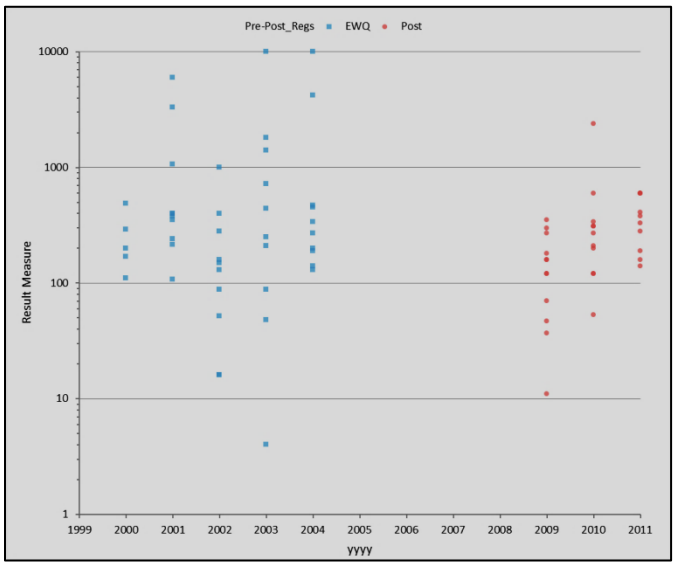
Chapter 14: 1746 BCP Musconetcong River, NJ

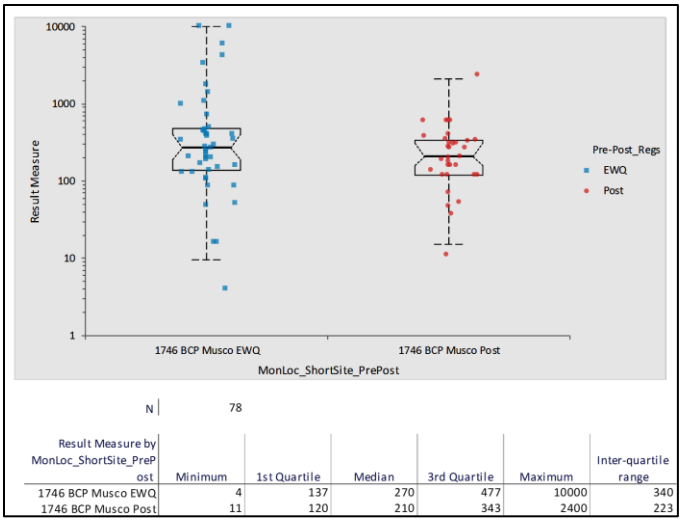
Fecal coliform colonies/100 ml

Existing Water Quality (Table 2M):

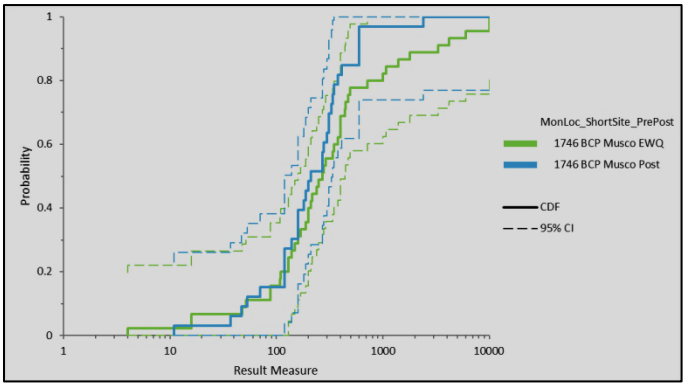
Median 270/100 ml
Lower 95% Confidence Interval 190/100 ml
Upper 95% Confidence Interval 400/100 ml







N	78					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	4	137	270	477	10000	340
1746 BCP Musco Post	11	120	210	343	2400	223



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	45	281.3	6.25
1746 BCP Musco Post	33	383.5	11.62

H statistic	1.30
X^2 approximation	1.30
DF	1
p-value	0.2550[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.

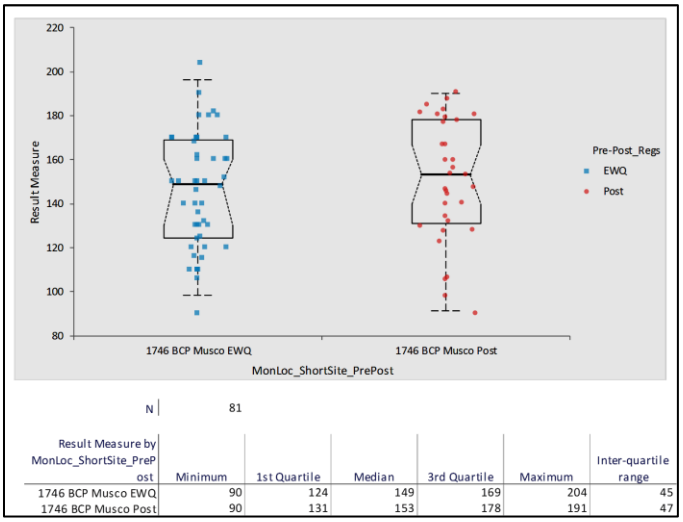
No water quality degradation is evident here. Fecal coliform concentrations did not measurably change between the EWQ and post-EWQ periods. Uncertainty was introduced into comparisons by potential laboratory artifacts. Four sample results were truncated at upper quantification levels by the laboratory, but these did not interfere with comparisons. Fecal coliform concentrations are unrelated to flow in both data sets. Post-EWQ median concentrations were within the EWQ 95% confidence intervals. Note that concentrations and flows are plotted on a logarithmic scale. NJDEP and USGS data validated DRBC results.

Chapter 14: 1746 BCP Musconetcong River, NJ

Hardness as CaCO3, Total mg/l

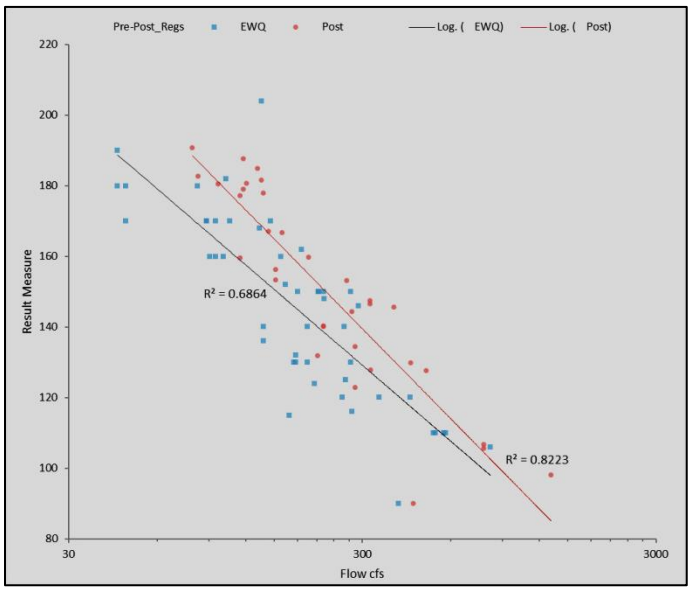
Existing Water Quality (Table 2M):

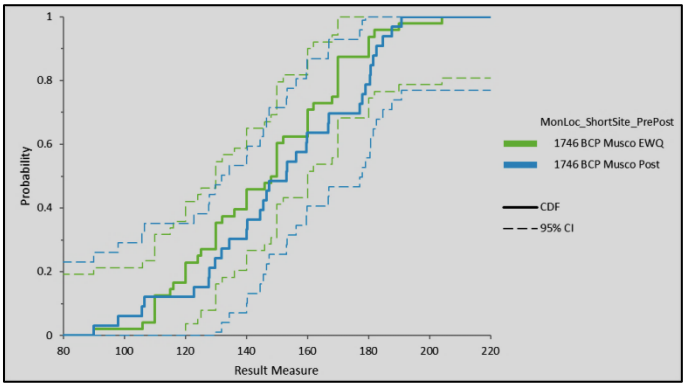
Median 149 mg/l
Lower 95% Confidence Interval 130 mg/l
Upper 95% Confidence Interval 160 mg/l
Defined in regulations as a flow-related parameter

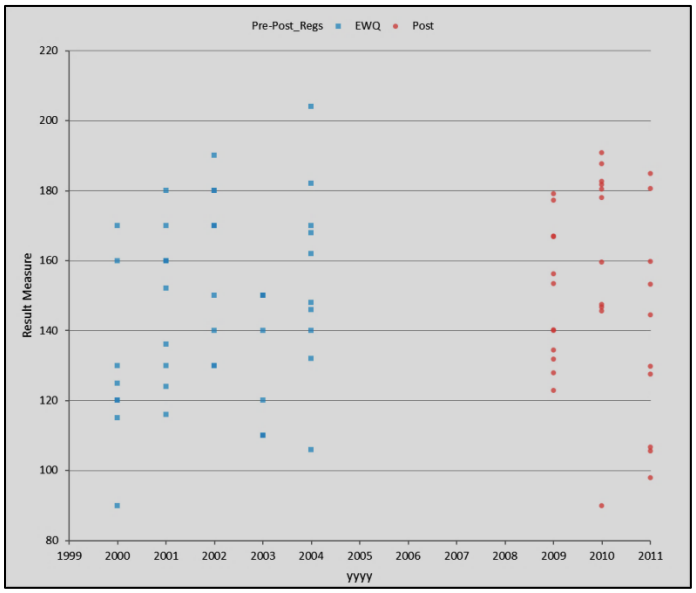


N	81

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	90	124	149	169	204	45
1746 BCP Musco Post	90	131	153	178	191	47







Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	48	192.0	4.00
1746 BCP Musco Post	33	279.3	8.46

H statistic	0.85
X^2 approximation	0.85
DF	1
p-value	0.3559 [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.

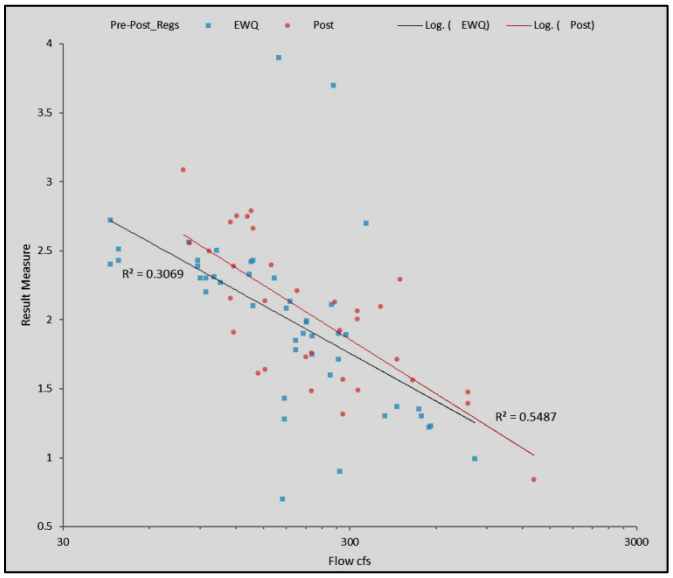
No water quality degradation is evident here. Hardness did not measurably change between the EWQ and post-EWQ periods. Uncertainty was introduced into comparisons by potential laboratory artifacts. Hardness is inversely related to flow in both data sets. Post-EWQ median hardness fell within the EWQ 95% confidence intervals. Flow is plotted on a logarithmic scale. USGS data validated DRBC results. These hardness concentrations reflect limestone influences.

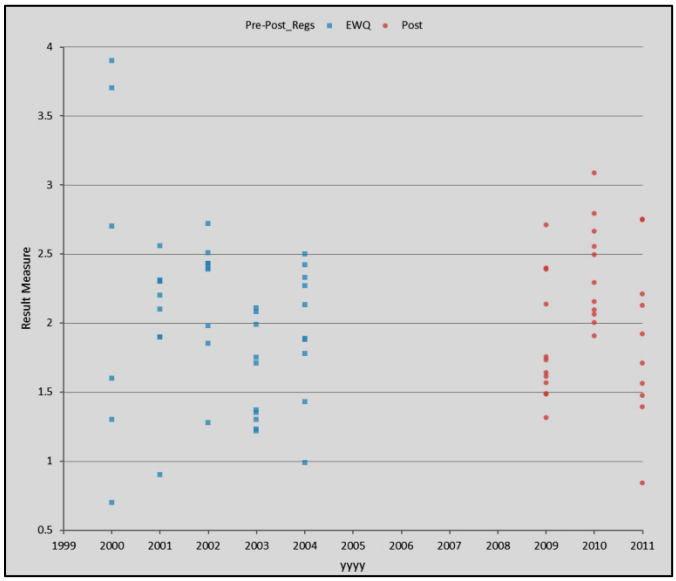
Chapter 14: 1746 BCP Musconetcong River, NJ

Nitrate + Nitrite as N, Total mg/l

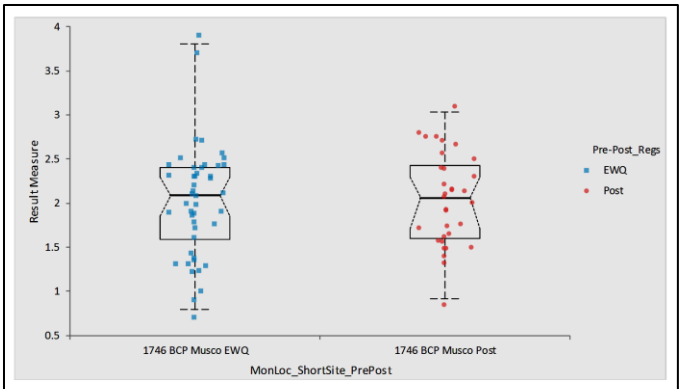
Existing Water Quality (Table 2M, as Nitrate only):

Median 2.09 mg/l
Lower 95% Confidence Interval 1.85 mg/l
Upper 95% Confidence Interval 2.30 mg/l



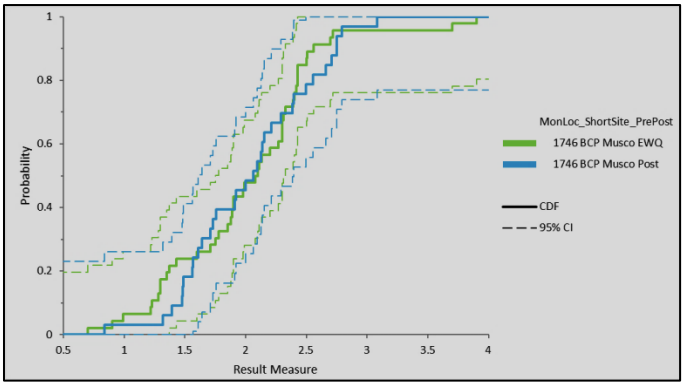


No water quality degradation is evident here. Nitrate concentrations, somewhat high in the Musconetcong, apparently did not change between the EWQ and post-EWQ periods. Uncertainty was introduced into comparisons by potential laboratory artifacts.



N	79

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	0.70	1.59	2.09	2.40	3.90	0.82
1746 BCP Musco Post	0.84	1.60	2.06	2.43	3.09	0.83



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	46	14.7	0.32
1746 BCP Musco Post	33	20.5	0.62

H statistic	0.07
X^2 approximation	0.07
DF	1
p-value	0.7960[1]

H0: $\theta_i = \theta_2 = \theta...$
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.

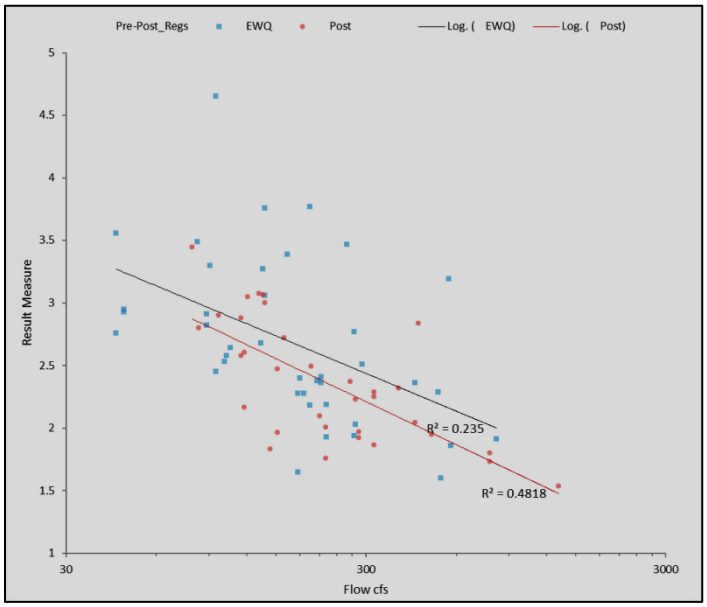
Both data sets are inversely related to flow. EWQ and post-EWQ data distributions were nearly identical. Post-EWQ nitrate + nitrite concentrations were assumed equivalent for comparison with EWQ nitrate concentrations since EWQ nitrite concentrations were never detected. Independent data were not available for validation of results (USGS measures dissolved instead of total nitrate). At other sites where concentrations are lower data interpretation was problematic due to changing detection limits. Concentrations are sufficiently high in the Musconetcong River that no such problems arose.

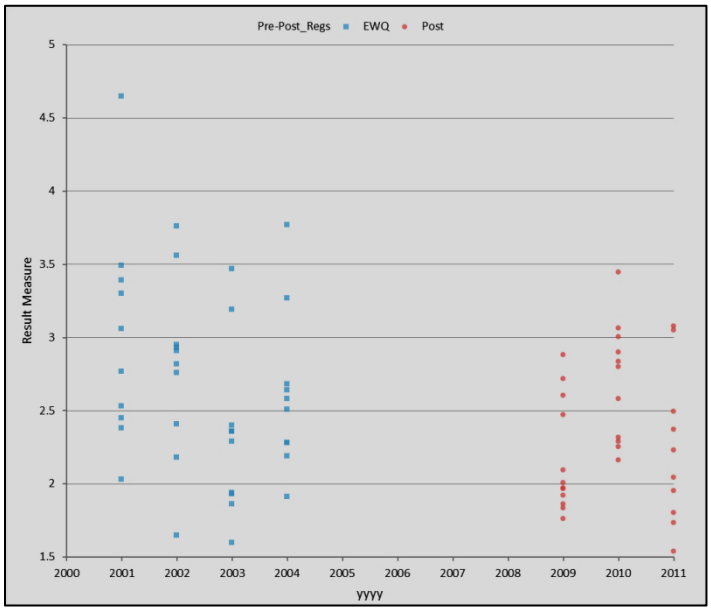
Chapter 14: 1746 BCP Musconetcong River, NJ

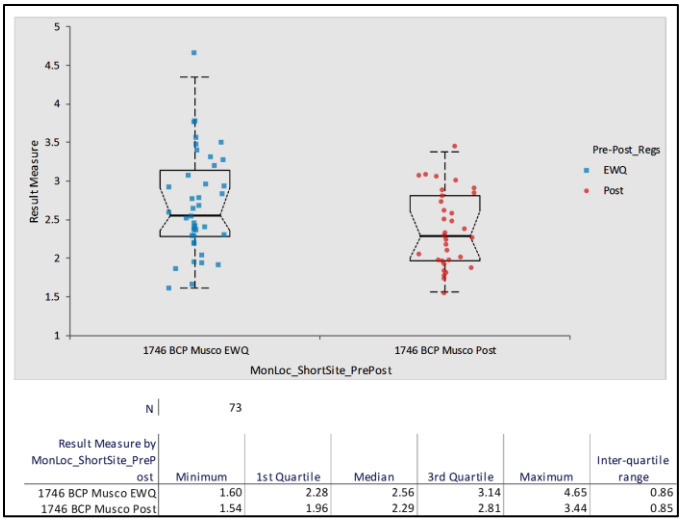
Nitrogen as N, Total (TN) mg/l

Existing Water Quality (Table 2M):

Median 2.56 mg/l
Lower 95% Confidence Interval 2.36 mg/l
Upper 95% Confidence Interval 2.91 mg/l

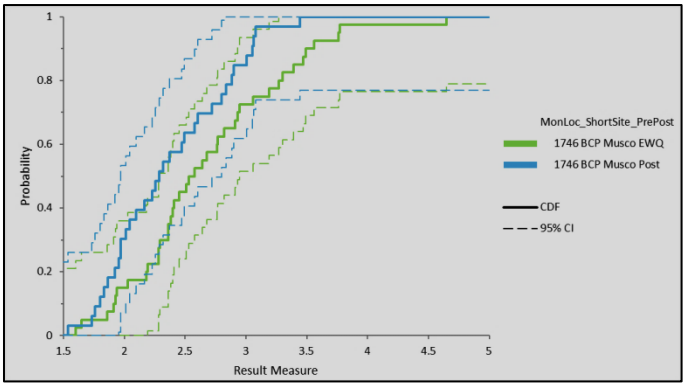






N	73

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	1.60	2.28	2.56	3.14	4.65	0.86
1746 BCP Musco Post	1.54	1.96	2.29	2.81	3.44	0.85



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	40	902.5	22.56
1746 BCP Musco Post	33	1093.9	33.15

H statistic	4.43
X^2 approximation	4.43
DF	1
p-value	0.0352 [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.

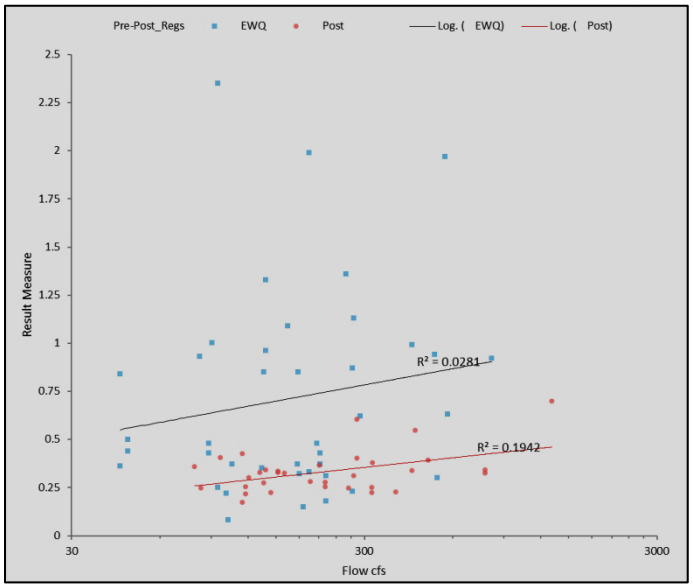
No water quality degradation is evident here. Total Nitrogen concentrations apparently declined between the EWQ and post-EWQ periods. Uncertainty was introduced into comparisons by potential laboratory artifacts. TN is weakly related to flow in the EWQ data, but inversely related to flow in the post-EWQ data. USGS data displayed a similar decline but were too few in number for statistical significance. Post-EWQ median TN concentrations fell below the EWQ lower 95% confidence intervals, possibly indicating a water quality improvement. Musconetcong River Total Nitrogen concentrations remain among the highest in comparison with other Delaware River tributaries.

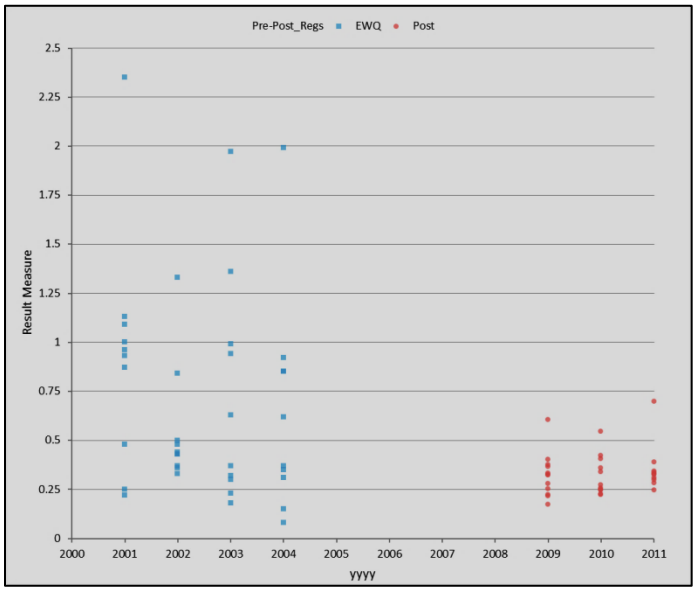
Chapter 14: 1746 BCP Musconetcong River, NJ

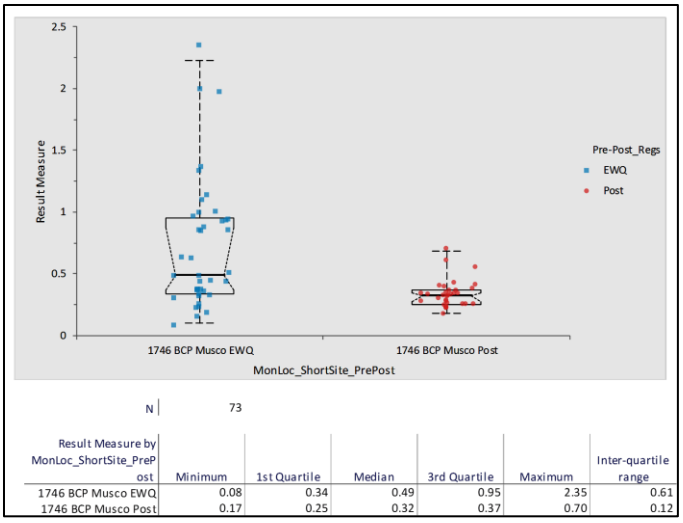
Nitrogen, Kjeldahl as N, Total (TKN) mg/l

Existing Water Quality (Table 2M):

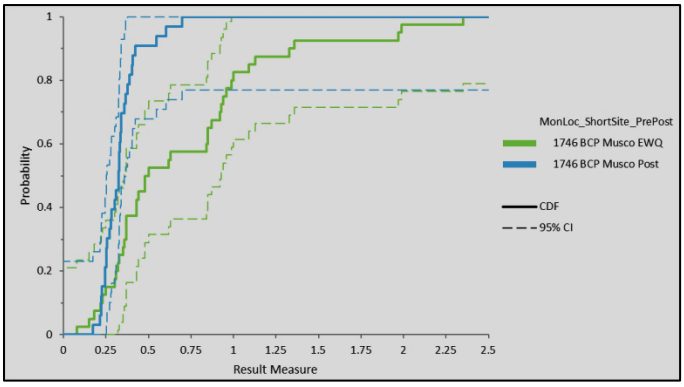
Median 0.49 mg/l
Lower 95% Confidence Interval 0.37 mg/l
Upper 95% Confidence Interval 0.87 mg/l







N	73					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	0.08	0.34	0.49	0.95	2.35	0.61
1746 BCP Musco Post	0.17	0.25	0.32	0.37	0.70	0.12



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	40	2958.4	73.96
1746 BCP Musco Post	33	3585.9	108.66

H statistic	14.54
X^2 approximation	14.54
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.

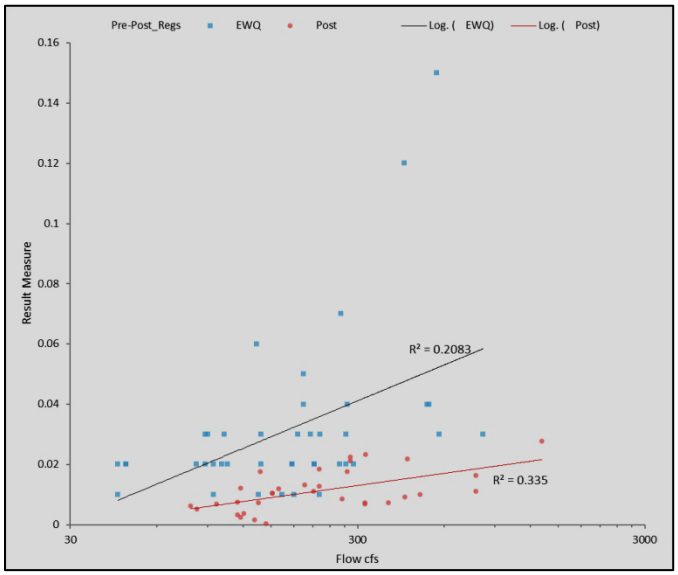
No water quality degradation is evident here. TKN concentrations apparently declined between the EWQ and post-EWQ periods. Uncertainty was introduced into comparisons by potential laboratory artifacts. The post-EWQ range was far narrower and all concentrations were less than 0.75 mg/l. TKN concentration is unrelated to flow in both data sets. Post-EWQ median TKN fell below the lower EWQ 95% confidence interval. There were insufficient USGS data to confirm DRBC results.

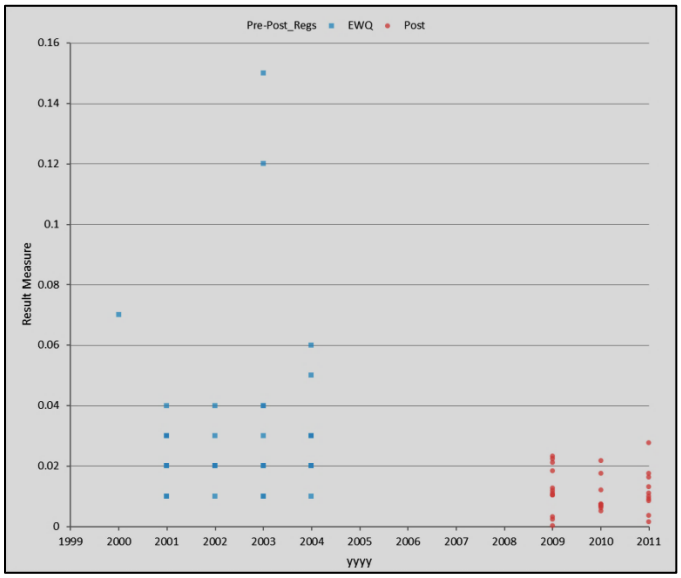
Chapter 14: 1746 BCP Musconetcong River, NJ

Orthophosphate as P, Total mg/l

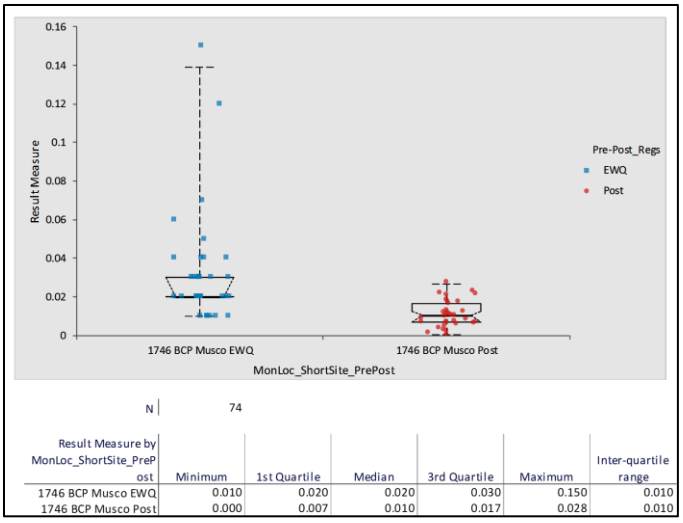
Existing Water Quality (Table 2M):

Median 0.02 mg/l
Lower 95% Confidence Interval 0.02 mg/l
Upper 95% Confidence Interval 0.03 mg/l



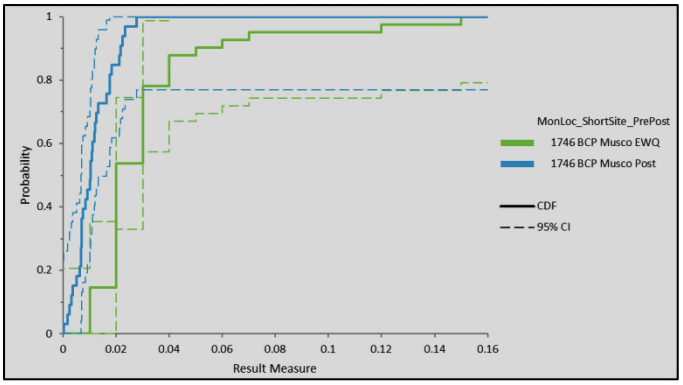


No water quality degradation is evident here. Orthophosphate concentrations apparently declined between the EWQ and post-EWQ periods. Uncertainty was introduced into comparisons by potential laboratory artifacts and detection limit differences.



N	74

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	0.010	0.020	0.020	0.030	0.150	0.010
1746 BCP Musco Post	0.000	0.007	0.010	0.017	0.028	0.010



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	41	5892.0	143.71
1746 BCP Musco Post	33	7320.4	221.83

H statistic	28.96
X^2 approximation	28.96
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.

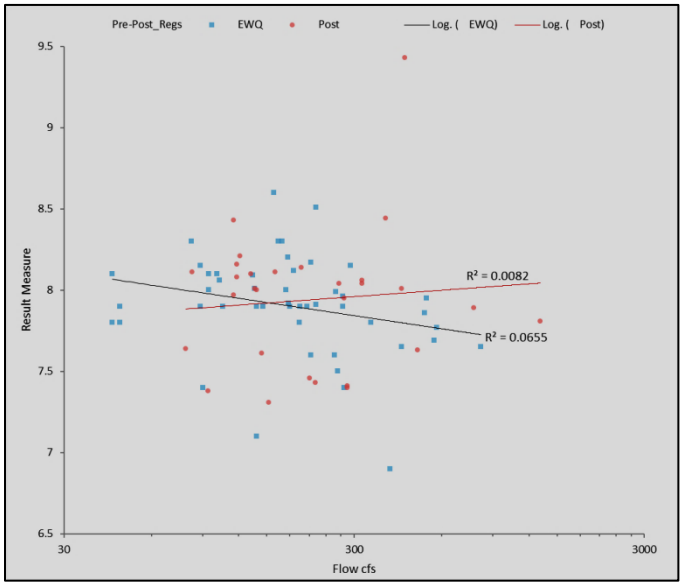
Orthophosphate is weakly related to flow in both data sets. Post-EWQ median orthophosphate fell below the EWQ lower 95% confidence interval. This has little to do with the improvement in detection limits because there were only 4 non-detect results in the EWQ data. A possible water quality improvement is indicated in that there were no post-EWQ concentrations higher than 0.03 mg/l, though this may be a laboratory artifact. Post-EWQ orthophosphate also ranged much less widely than EWQ data. There were no independent data to confirm DRBC results.

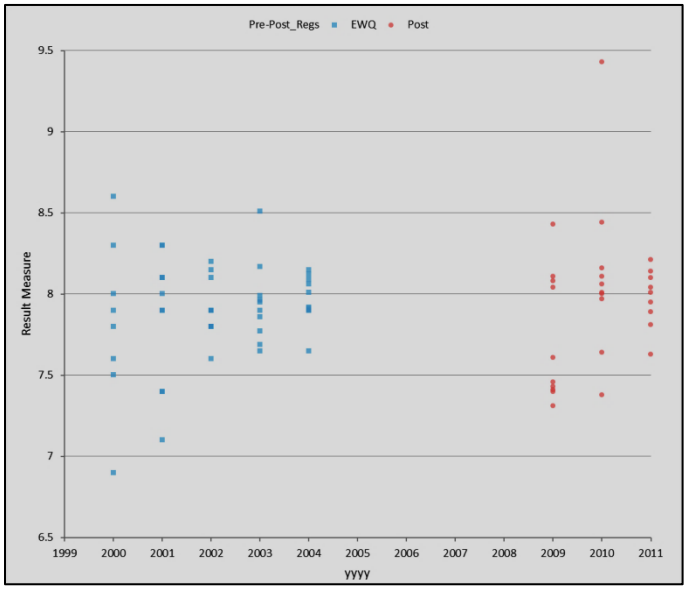
Chapter 14: 1746 BCP Musconetcong River, NJ

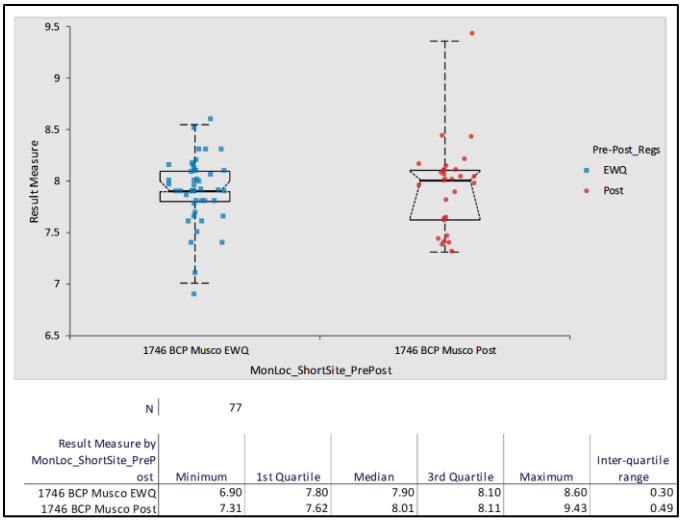
pH

Existing Water Quality (Table 2M):

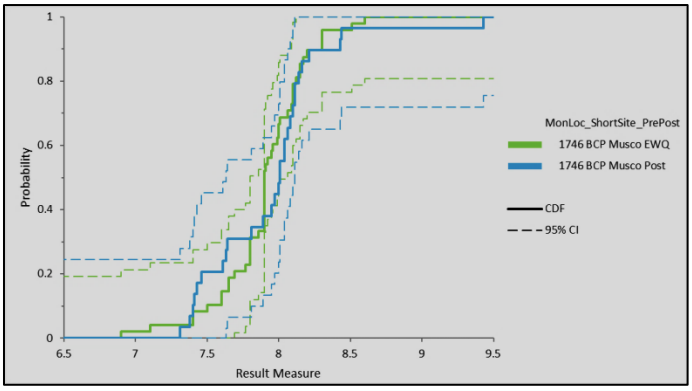
Median 7.90 standard units
Lower 95% Confidence Interval **7.80*** standard units
Upper 95% Confidence Interval 8.00 standard units
* Typographical error (7.90) in regulations







N	77					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	6.90	7.80	7.90	8.10	8.60	0.30
1746 BCP Musco Post	7.31	7.62	8.01	8.11	9.43	0.49



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	48	27.8	0.58
1746 BCP Musco Post	29	45.9	1.58

H statistic	0.15
X^2 approximation	0.15
DF	1
p-value	0.7009 [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.

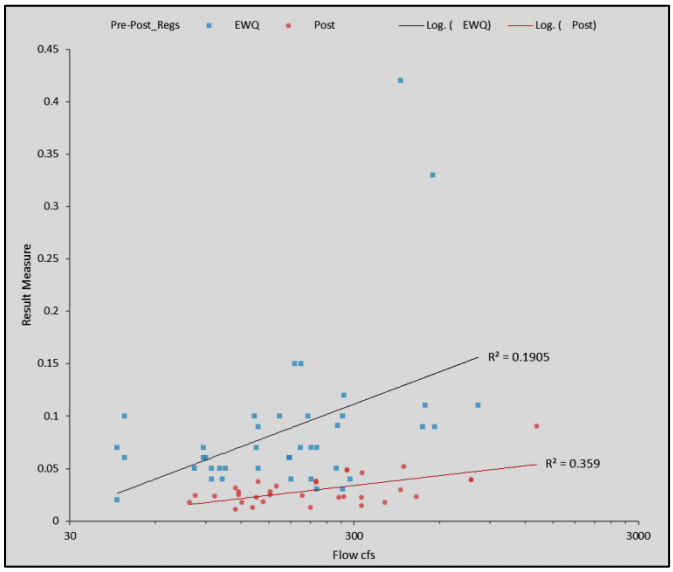
No water quality degradation is evident here. pH did not measurably change between the EWQ and post-EWQ periods. pH is unrelated to flow in both data sets. Post-EWQ median pH was above the upper EWQ 95% confidence interval, but the result was not statistically significant. In 2010 there was one spike above pH 9, indicating high algal productivity during that dry sampling period. USGS data confirm these results.

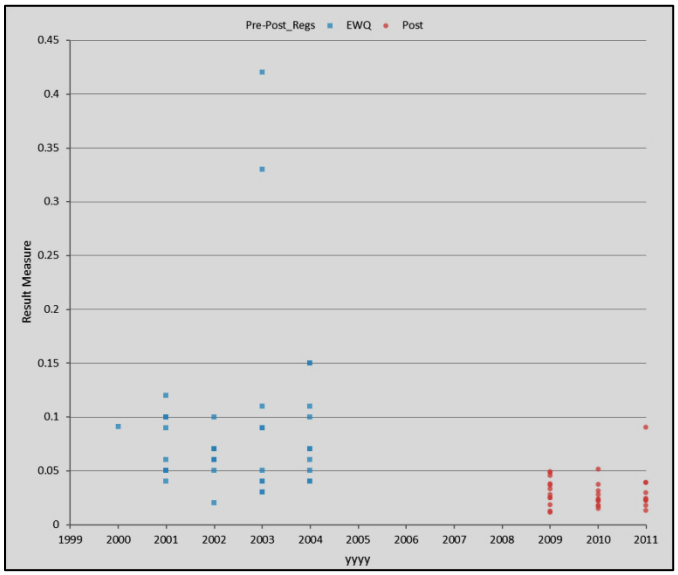
Chapter 14: 1746 BCP Musconetcong River, NJ

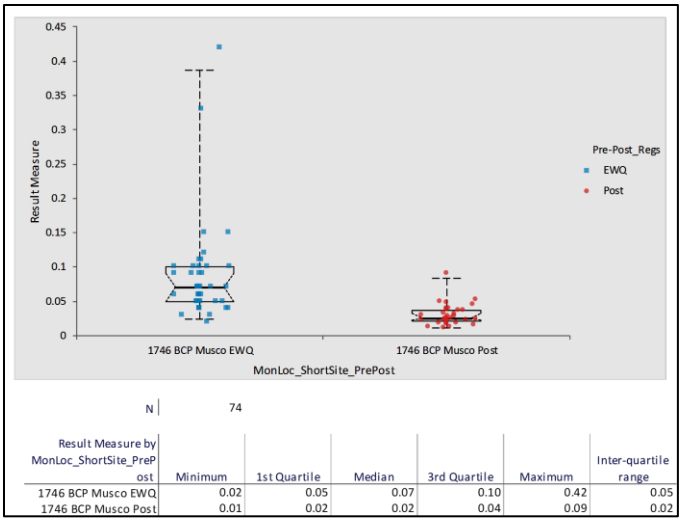
Phosphorus as P, Total (TP) mg/l

Existing Water Quality (Table 2M):

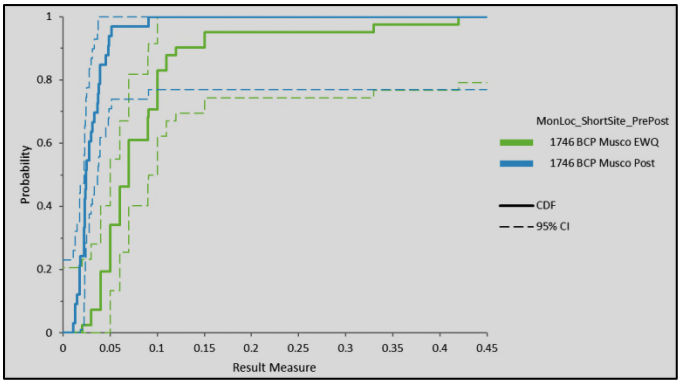
Median 0.07 mg/l
Lower 95% Confidence Interval 0.05 mg/l
Upper 95% Confidence Interval 0.09 mg/l







N	74					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	0.02	0.05	0.07	0.10	0.42	0.05
1746 BCP Musco Post	0.01	0.02	0.02	0.04	0.09	0.02



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	41	8106.2	197.71
1746 BCP Musco Post	33	10071.3	305.19

H statistic	39.38
X^2 approximation	39.38
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.

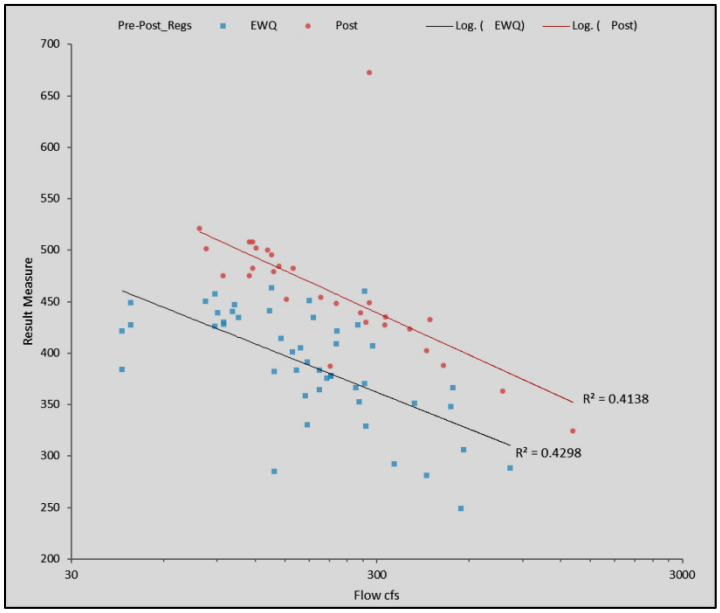
No water quality degradation is evident here. Total Phosphorus (TP) concentrations apparently declined between the EWQ and post-EWQ periods. No water quality degradation is evident here. Uncertainty was introduced into comparisons by potential laboratory artifacts and detection limit differences. Post-EWQ median total phosphorus fell below the EWQ lower 95% confidence interval. TP is weakly related to flow in both data sets. USGS data confirm DRBC results, though not strongly. Some decline in concentrations is shown in USGS data, but only the DRBC post-EWQ data line up with USGS results. It appears that, in the EWQ period, DRBC results were more variable than USGS data.

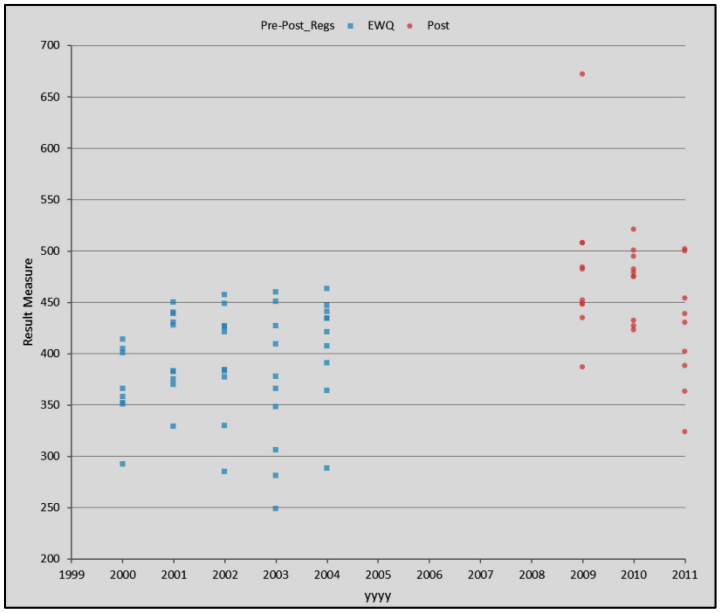
Chapter 14: 1746 BCP Musconetcong River, NJ

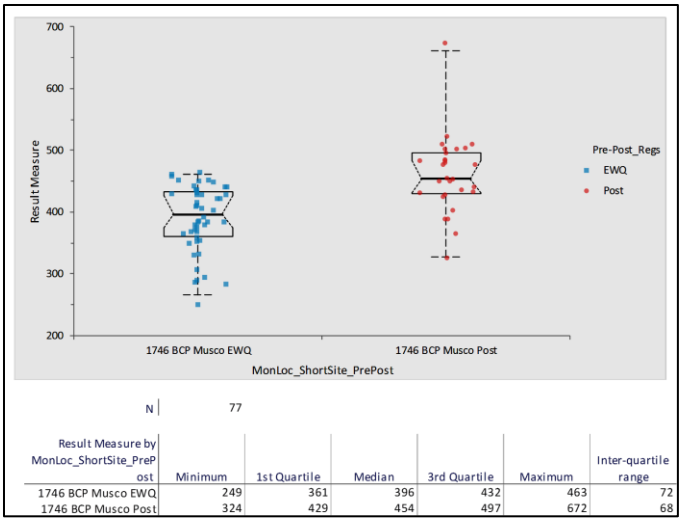
Specific Conductance µmho/cm

Existing Water Quality (Table 2M):

Median 396 µmho/cm
Lower 95% Confidence Interval 375 µmho/cm
Upper 95% Confidence Interval 426 µmho/cm
Defined in regulations as a flow-related parameter

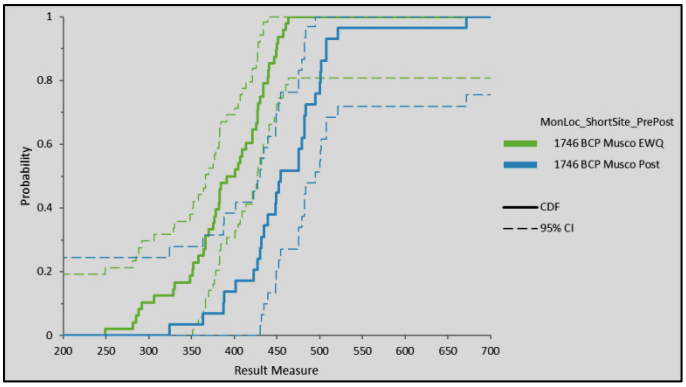






N	77

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	249	361	396	432	463	72
1746 BCP Musco Post	324	429	454	497	672	68



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	48	4246.9	88.48
1746 BCP Musco Post	29	7029.4	242.39

H statistic	22.53
X² approximation	22.53
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.

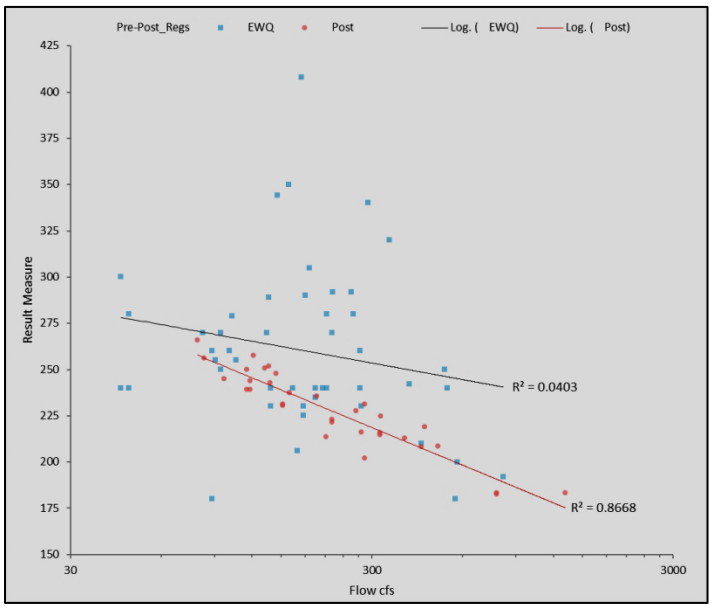
Water quality degradation is evident here. Specific conductance rose by 58 µmho/cm; well above the EWQ upper 95% confidence interval. Specific conductance is inversely related to flow in both data sets. The rise in specific conductance may be partially attributable to the concurrent rise in chloride concentrations. Median specific conductance has risen from 396 to 454 µmhos/cm; a 15% increase in a few years' time. Further investigation is recommended, as 454 µmho/cm is high even for limestone streams in the region. USGS data confirm DRBC results.

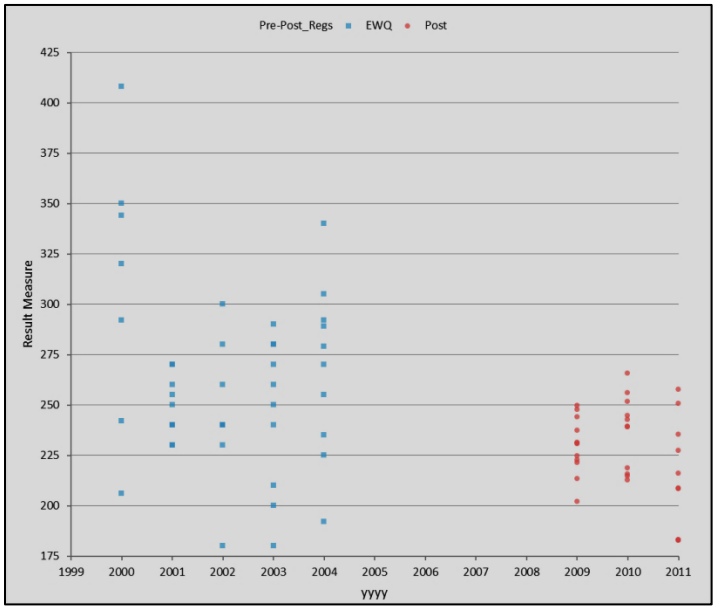
Chapter 14: 1746 BCP Musconetcong River, NJ

Total Dissolved Solids (TDS) mg/l

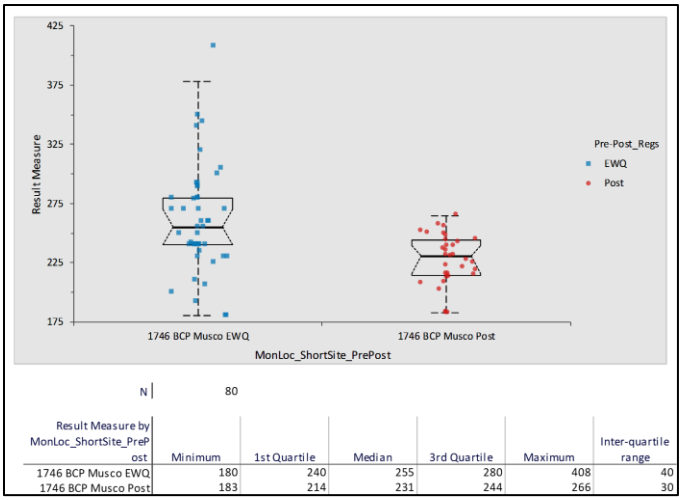
Existing Water Quality (Table 2M):

Median 255 mg/l
Lower 95% Confidence Interval 240 mg/l
Upper 95% Confidence Interval 270 mg/l
Defined in regulations as a flow-related parameter



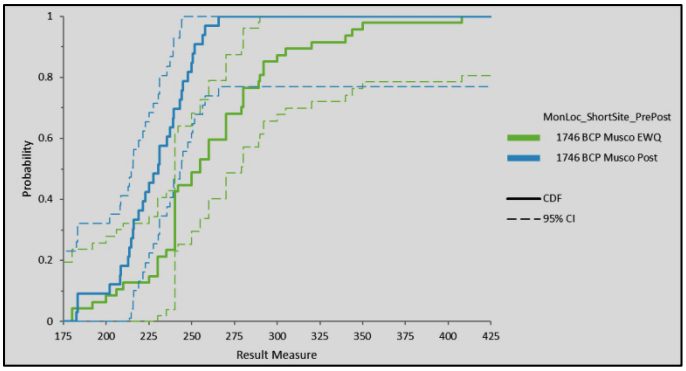


No water quality degradation is evident here. TDS apparently declined between the EWQ and post-EWQ periods. Uncertainty was introduced into comparisons by potential laboratory artifacts.



N	80

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	180	240	255	280	408	40
1746 BCP Musco Post	183	214	231	244	266	30



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	47	3261.1	69.39
1746 BCP Musco Post	33	4644.6	140.75

H statistic	14.67
X^2 approximation	14.67
DF	1
p-value	0.000[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.

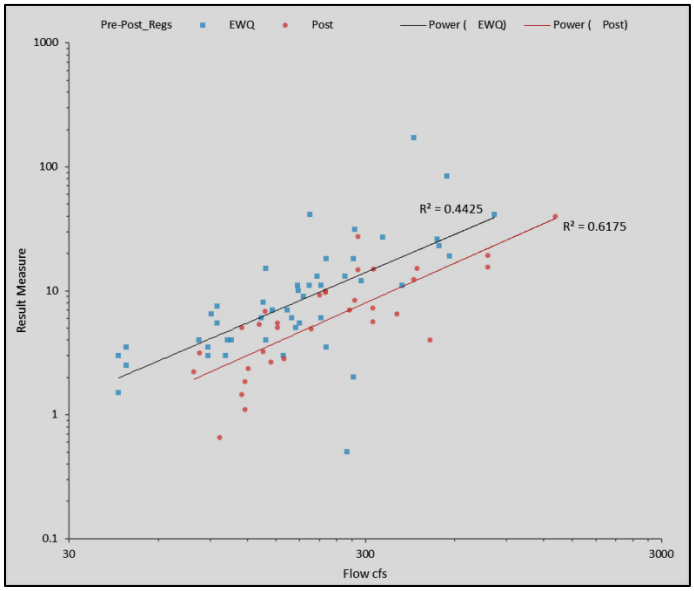
TDS is unrelated to flow in the EWQ data set, though it was designated in the rules as flow related. TDS was inversely related to flow in the post-EWQ data set. Post-EWQ median TDS fell below the EWQ lower 95% lower confidence interval, and was much less variable than the baseline samples as well. Post-EWQ detection limits were lower than EWQ detection limits, though there were no non-detect results at any time. USGS data ranged similarly with DRBC data, but the decline was not evident. The USGS TDS slightly increased, which is logical given the increases in chlorides and specific conductance. DRBC EWQ data were more variable, so perhaps the decline shown in these results is a laboratory artifact rather than a real water quality improvement.

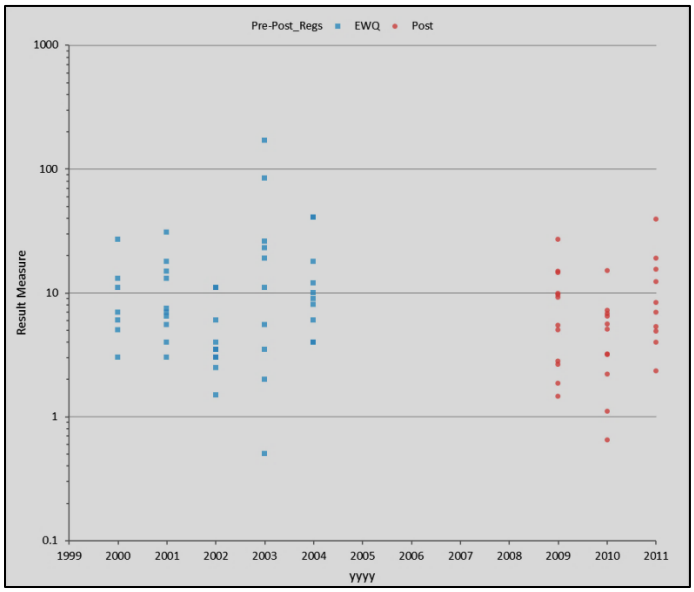
Chapter 14: 1746 BCP Musconetcong River, NJ

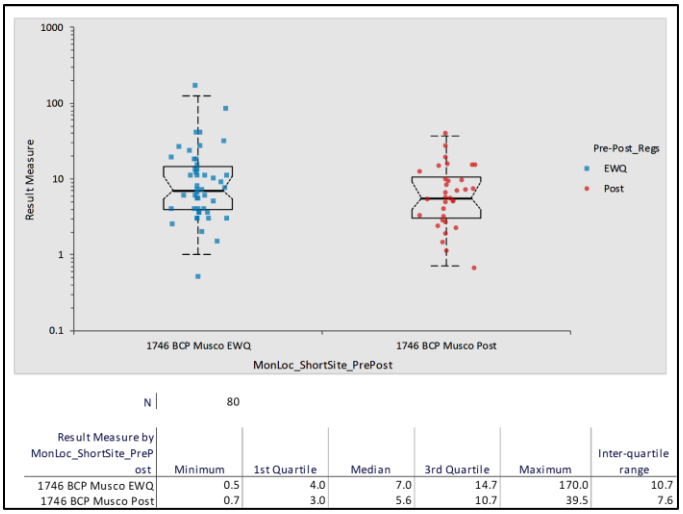
Total Suspended Solids (TSS) mg/l

Existing Water Quality (Table 2M):

Median 7.0 mg/l
Lower 95% Confidence Interval 5.5 mg/l
Upper 95% Confidence Interval 11.0 mg/l
<u>Should have been designated in rules as flow-related</u>

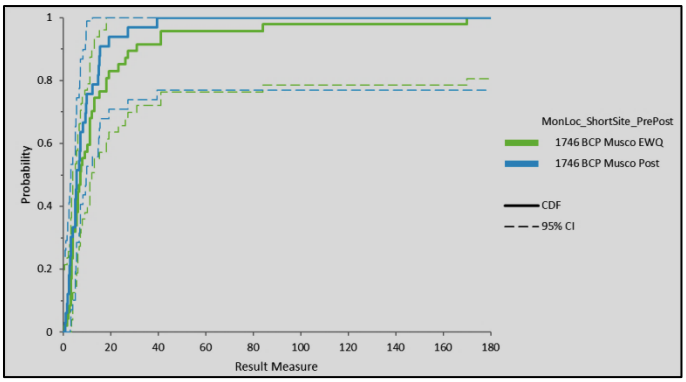






N	80

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	0.5	4.0	7.0	14.7	170.0	10.7
1746 BCP Musco Post	0.7	3.0	5.6	10.7	39.5	7.6



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	47	379.2	8.07
1746 BCP Musco Post	33	540.1	16.37

H statistic	1.70
X^2 approximation	1.70
DF	1
p-value	0.1919[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.

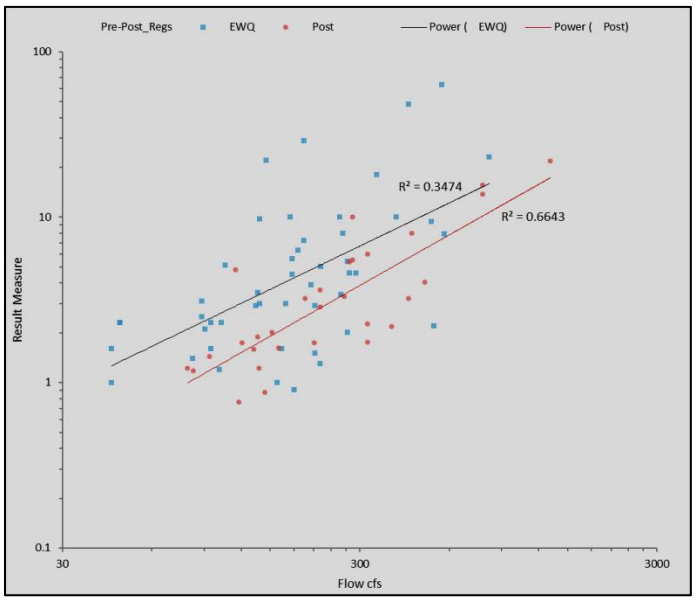
No water quality degradation is evident here. TSS did not measurably change between the EWQ and post-EWQ periods. Uncertainty was introduced into comparisons by potential laboratory artifacts. TSS is positively related to flow in both data sets. Post-EWQ median TSS fell within the EWQ 95% confidence intervals, though post-EWQ median TSS was near the lower EWQ 95% confidence interval. Both flow and concentration are plotted on a logarithmic scale, and the regression is a power relationship. USGS data were too few for trend evaluation, but closely resembled DRBC results.

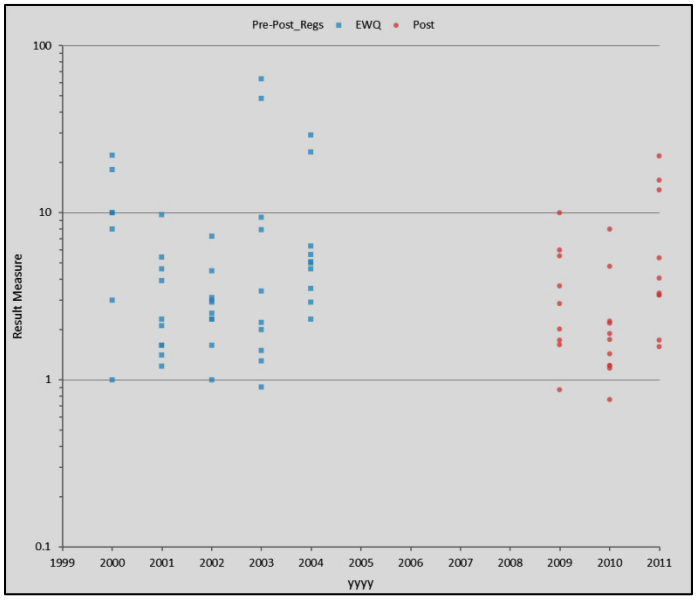
Chapter 14: 1746 BCP Musconetcong River, NJ

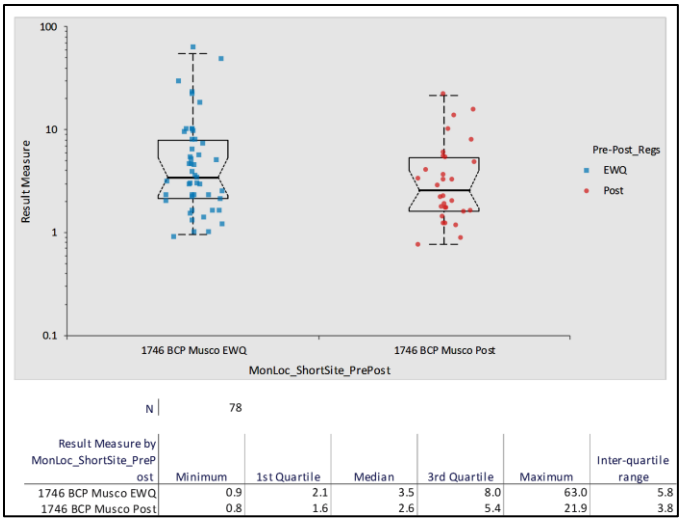
Turbidity NTU

Existing Water Quality (Table 2M):

Median 3.5 NTU
Lower 95% Confidence Interval 2.3 NTU
Upper 95% Confidence Interval 5.4 NTU
Defined in regulations as a flow-related parameter

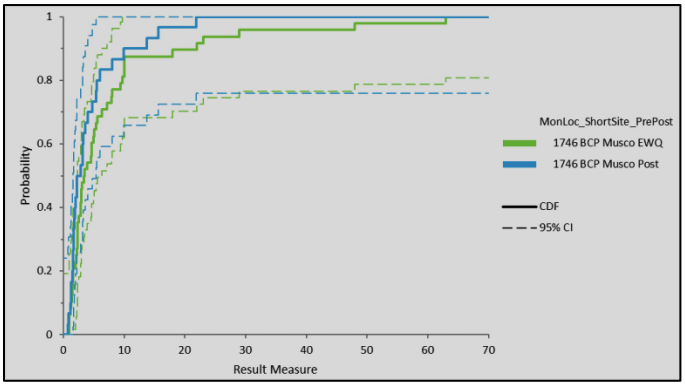






N	78

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	0.9	2.1	3.5	8.0	63.0	5.8
1746 BCP Musco Post	0.8	1.6	2.6	5.4	21.9	3.8



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	48	438.0	9.13
1746 BCP Musco Post	30	700.8	23.36

H statistic	2.22
X^2 approximation	2.22
DF	1
p-value	0.1364 [1]

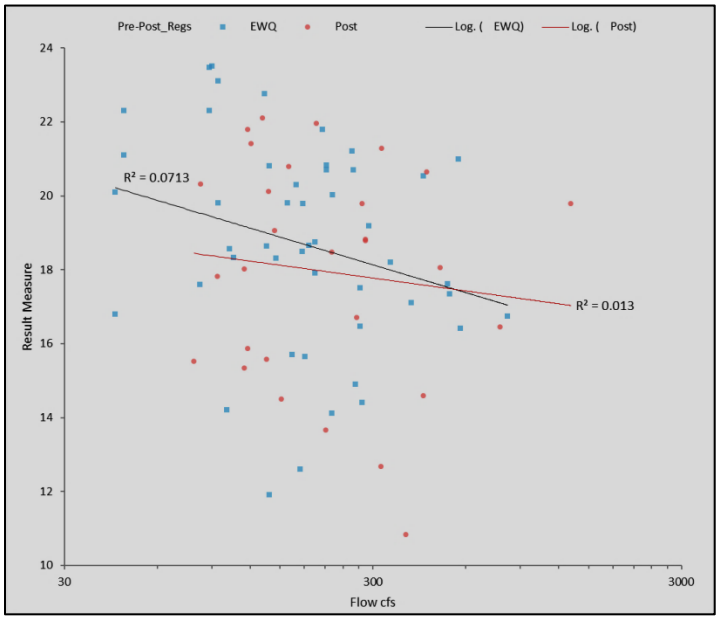
H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

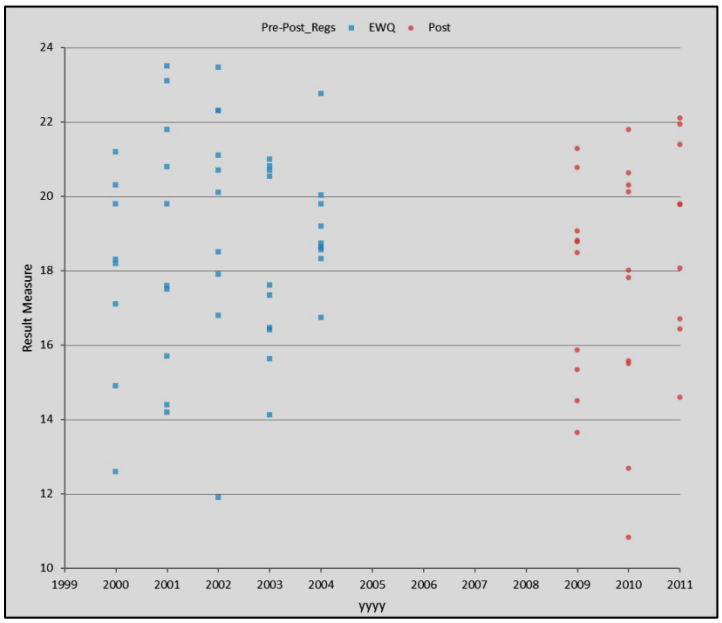
No water quality degradation is evident here. Turbidity did not measurably change between the EWQ and post-EWQ periods. The post-EWQ median turbidity fell within the EWQ 95% confidence intervals of the median. Turbidity is positively related to flow in both data sets. Both concentration and flow are presented on logarithmic scale, and the regression is a power relationship. There were very few USGS data available for comparison with DRBC results, but USGS and DRBC results ranged similarly.

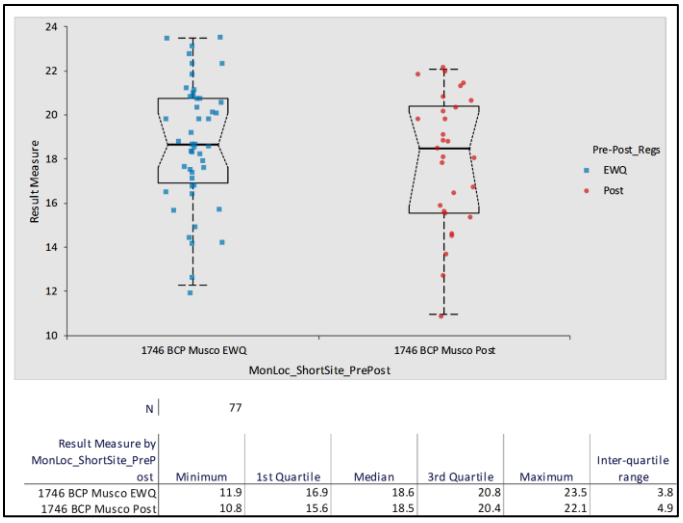
Chapter 14: 1746 BCP Musconetcong River, NJ

Water Temperature, degrees C

Not included in DRBC Existing Water Quality rules

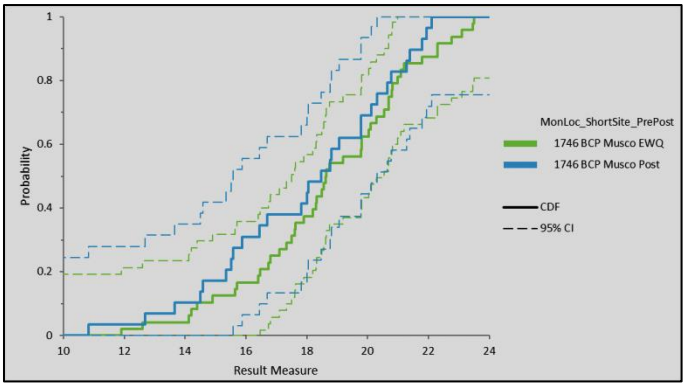






N 77

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1746 BCP Musco EWQ	11.9	16.9	18.6	20.8	23.5	3.8
1746 BCP Musco Post	10.8	15.6	18.5	20.4	22.1	4.9



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1746 BCP Musco EWQ	48	161.3	3.36
1746 BCP Musco Post	29	267.0	9.21

H statistic	0.86
X^2 approximation	0.86
DF	1
p-value	0.3549 [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 here. Water temperature did not measurably change between the EWQ and post-EWQ periods. Water temperature is unrelated to flow in both data sets. Flows are plotted on a logarithmic scale. DRBC data did not differ from NJDEP and USGS results, though there were more DRBC data in the May to September period.