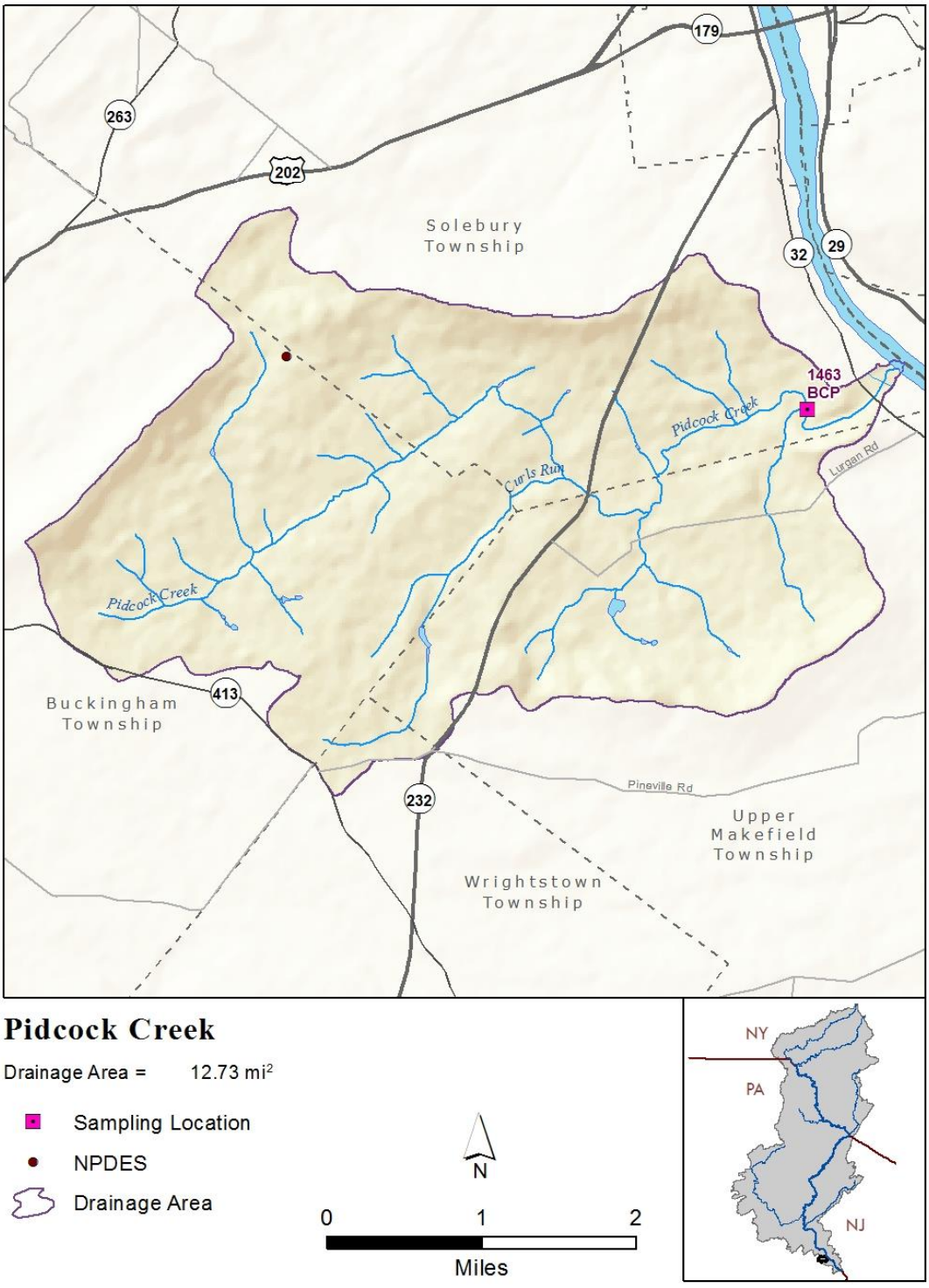
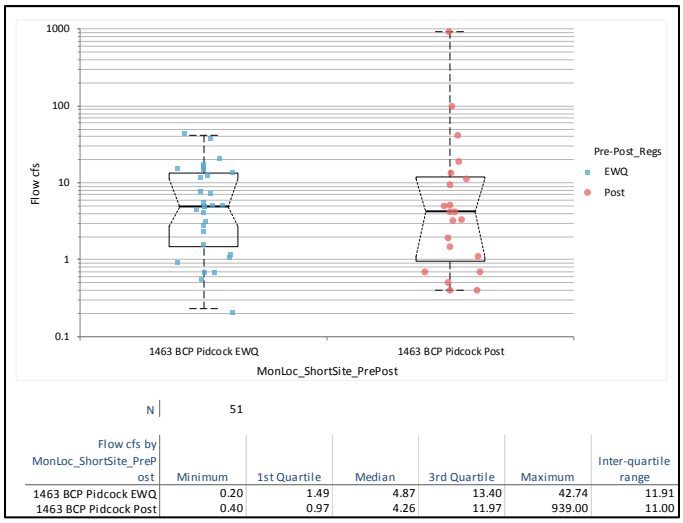
Chapter 3: 1463 BCP Pidcock Creek, Bucks County, PA



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



N	51

Flow cfs by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	0.20	1.49	4.87	13.40	42.74	11.91
1463 BCP Pidcock Post	0.40	0.97	4.26	11.97	939.00	11.00

Kruskal-Wallis test

Flow cfs by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	20.0	0.67
1463 BCP Pidcock Post	21	28.6	1.36

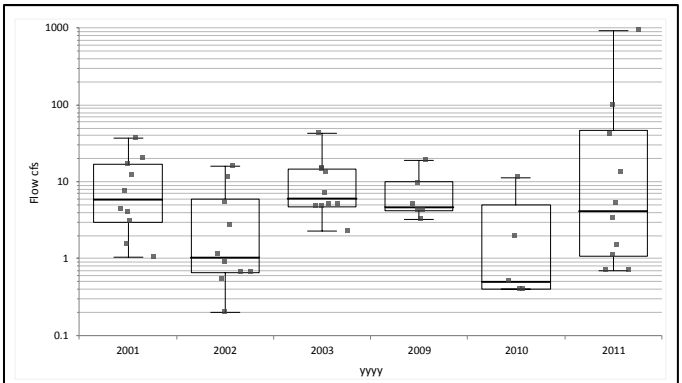
H statistic	0.22
X^2 approximation	0.22
DF	1
p-value	0.6391 [1]

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.

Flow was not significantly different between the two periods. On an annual flow-duration curve, "normal" flow of Pidcock Creek is about 11.3 cfs. The flow conditions shown here represent actual measurements taken during the May to September periods of multiple years. Summer flow conditions are usually much dryer as plant growth takes up much of the rainfall and reduces baseflow.

Upstream ICP: Delaware River at Lambertville 1487 ICP
Downstream ICP: Delaware River at Washington Crossing 1418 ICP

At the Bowman's Hill Wildflower Preserve sampling site the upstream drainage area is about 11.7 square miles. Overall watershed size is 12.7 square miles. The watershed is about 60% forested, only 0.3% urban lands, and the underlying geology contains only 2.8% carbonate bedrock. We chose Pidcock Creek as a representative small Piedmont Watershed.



N	51

Flow cfs by yyyy	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
2001	1.0	3.0	5.8	17.1	36.9	14.2
2002	0.2	0.7	1.0	5.9	16.1	5.3
2003	2.3	4.7	6.0	14.5	42.7	9.9
2009	3.3	4.2	4.7	10.2	18.9	6.0
2010	0.4	0.4	0.5	5.1	11.3	4.7
2011	0.7	1.1	4.2	46.5	939.0	45.4

Annual flow statistics are plotted above. Flow is plotted on a logarithmic scale. These are May to September flow measurements associated with the time of each water quality sample. "Normal" flow is about 11.3 cfs at this location, but less (about 4 cfs) during the summer. Note the maximum flow sampled in 2011, which was sampled during a major flood (flow estimated). The lowest flow we ever measured was 0.2 cfs in 2002. In this watershed, a high-flow event is difficult to sample unless specifically targeted. This is because the geology of this Piedmont stream does not retain water very well. Most rainfall runs off within a very short period. This "flashy" condition persists in many other Piedmont streams of the Lower Delaware.

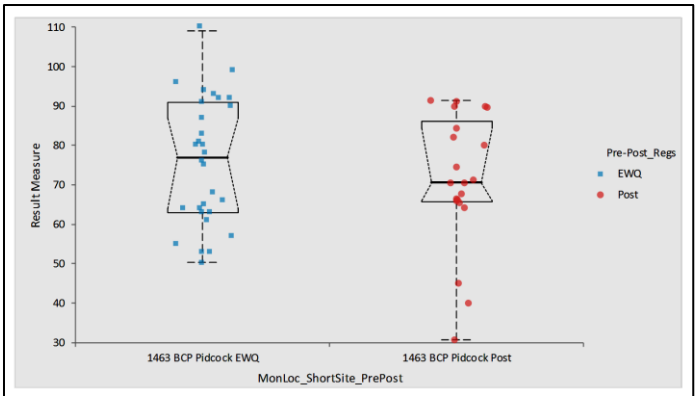
Under low to normal flow conditions, Pidcock Creek is captured by the Delaware Canal. Its water quality influence upon the Delaware River is minimal except during high flow conditions. Many of the small Pennsylvania streams located between Morrisville and Easton are captured by the canal unless aqueducts were historically built to pass canal flow over the stream.

Chapter 3: 1463 BCP
Pidcock Creek, PA

Alkalinity as CaCO3, Total mg/l

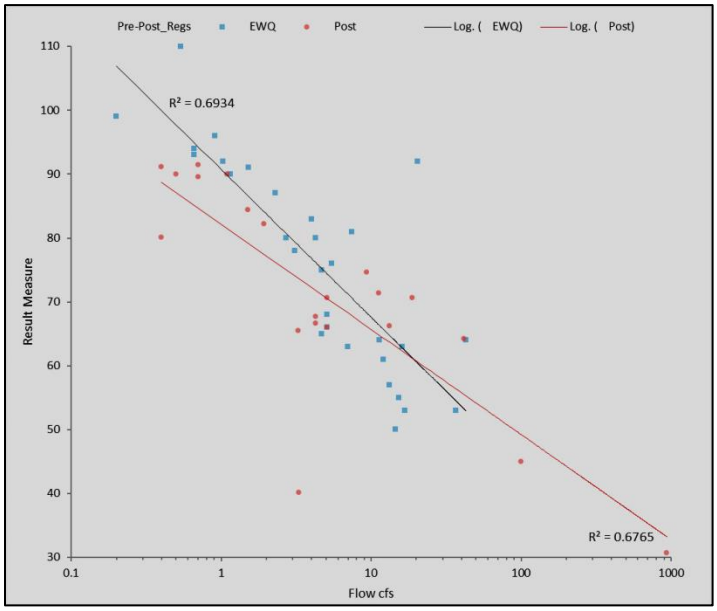
Existing Water Quality (Table 2X):

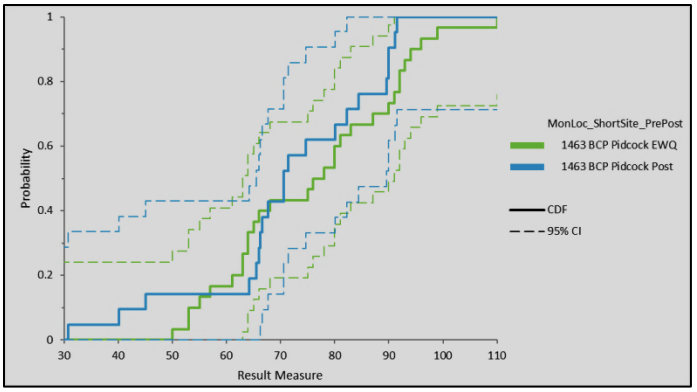
Median 77 mg/l
Lower 95% Confidence Interval 64 mg/l
Upper 95% Confidence Interval 87 mg/l
Defined in regulations as a flow-related parameter

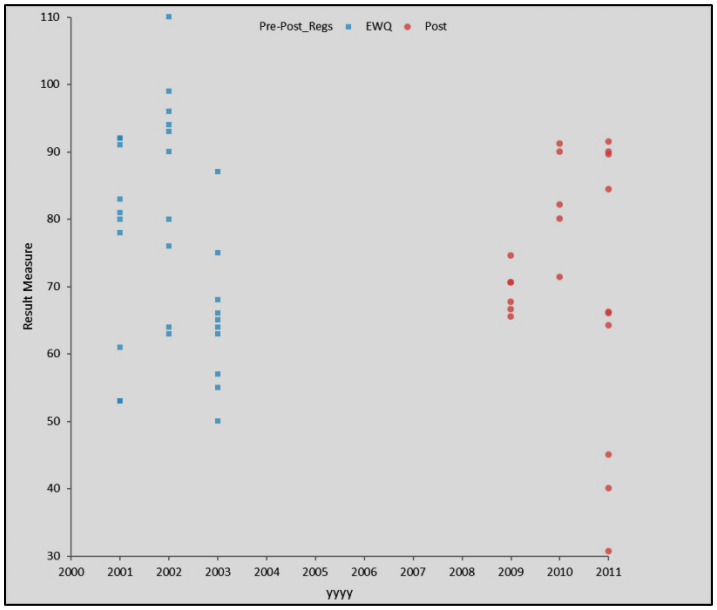


N	51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	50.0	63.0	77.0	91.1	110.0	28.1
1463 BCP Pidcock Post	30.7	65.8	70.6	86.1	91.5	20.3







Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	25.2	0.84
1463 BCP Pidcock Post	21	36.0	1.71

H statistic	0.28
X² approximation	0.28
DF	1
p-value	0.5986[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.

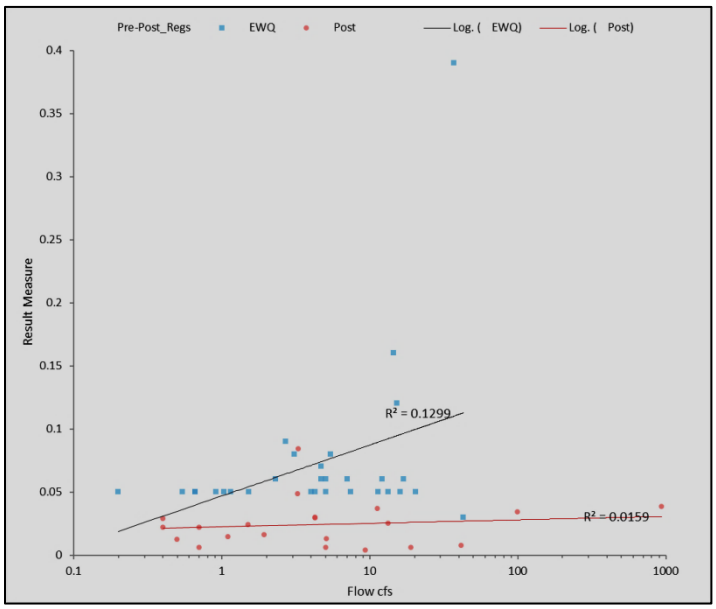
No water quality degradation is indicated. Alkalinity did not measurably change between the EWQ and post-EWQ periods. Alkalinity is inversely related to flow in both data sets. Post-EWQ median alkalinity fell within EWQ 95% confidence intervals, and the post-EWQ data were under-represented by dry weather samples. The unusually low values seen on the post-EWQ box plot are all high-flow samples. Flow is plotted on a logarithmic axis because the flood samples stand out so much that they obscure the view of the remaining data.

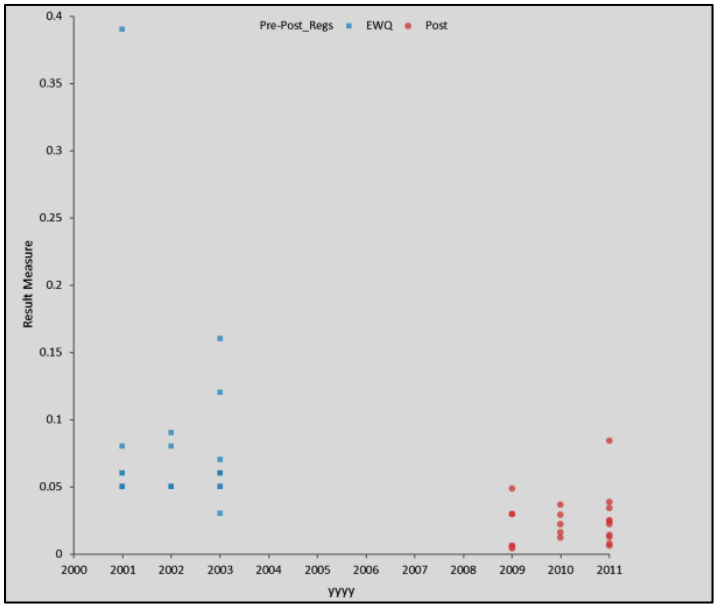
Chapter 3: 1463 BCP
Pidcock Creek, PA

Ammonia Nitrogen as N, Total mg/l

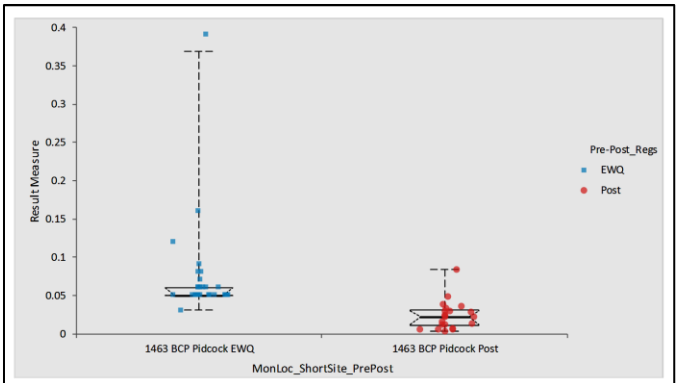
Existing Water Quality (Table 2X):

Median <0.05 mg/l (corrected from 0.05)
Lower 95% Confidence Interval <0.05 mg/l
Upper 95% Confidence Interval 0.06 mg/l

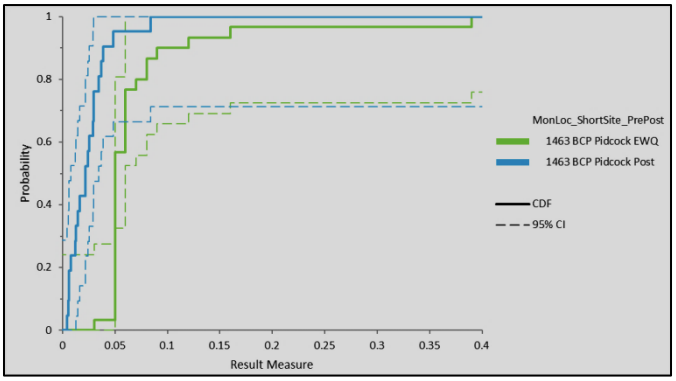




No water quality degradation is indicated. Ammonia concentrations appeared to decline. No independent data were available to validate the decline.



N	51					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	0.030	0.050	0.050	0.061	0.390	0.011
1463 BCP Pidcock Post	0.004	0.011	0.022	0.031	0.084	0.020



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	2707.5	90.25
1463 BCP Pidcock Post	21	3867.9	184.18

H statistic	30.75
X^2 approximation	30.75
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.

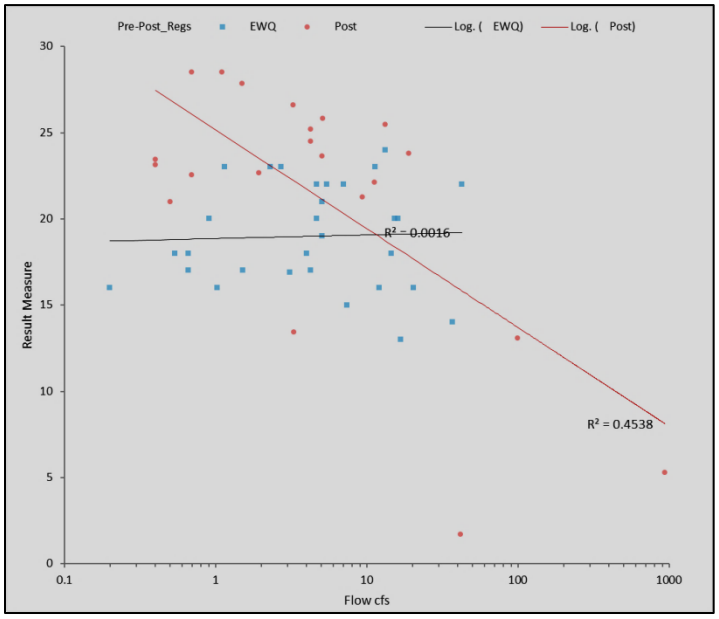
DRBC's post-EWQ detection limit was much lower than during the EWQ period. The EWQ data set possessed fairly high frequencies of non-detect results (17 of 30 samples), interfering with estimation of the median. There were 2 non-detect results in the 2009-2011 data. Thus the result found by DRBC is most likely due to adoption of more sensitive laboratory methods rather than a real change in ambient concentrations. Some improvement possibly took place, as the post-EWQ data contained fewer high concentrations. Flow is plotted on a logarithmic axis.

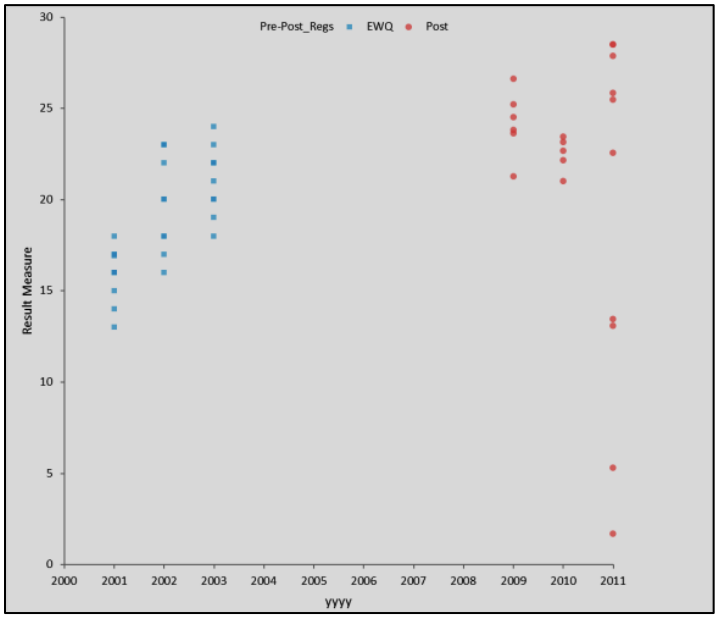
Chapter 3: 1463 BCP
Pidcock Creek, PA

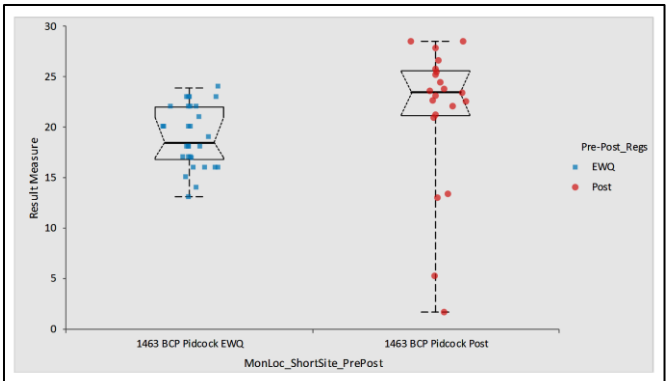
Chloride, Total mg/l

Existing Water Quality (Table 2X):

Median 19 mg/l
Lower 95% Confidence Interval 17 mg/l
Upper 95% Confidence Interval 21 mg/l
Defined in regulations as a flow-related parameter

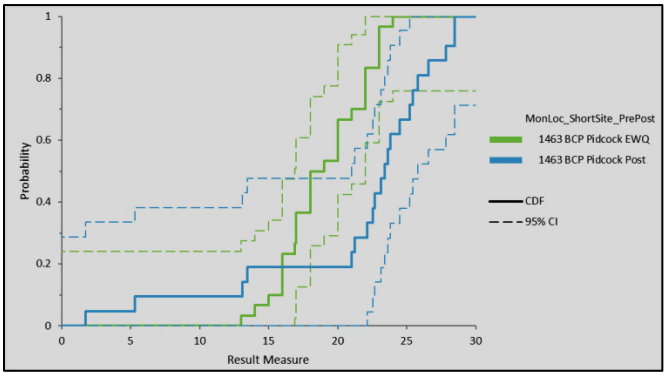






N	51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	13.0	16.8	18.5	22.0	24.0	5.2
1463 BCP Pidcock Post	1.7	21.2	23.4	25.6	28.5	4.4



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	842.7	28.09
1463 BCP Pidcock Post	21	1203.9	57.33

H statistic	9.28
X^2 approximation	9.28
DF	1
p-value	0.0023 [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.

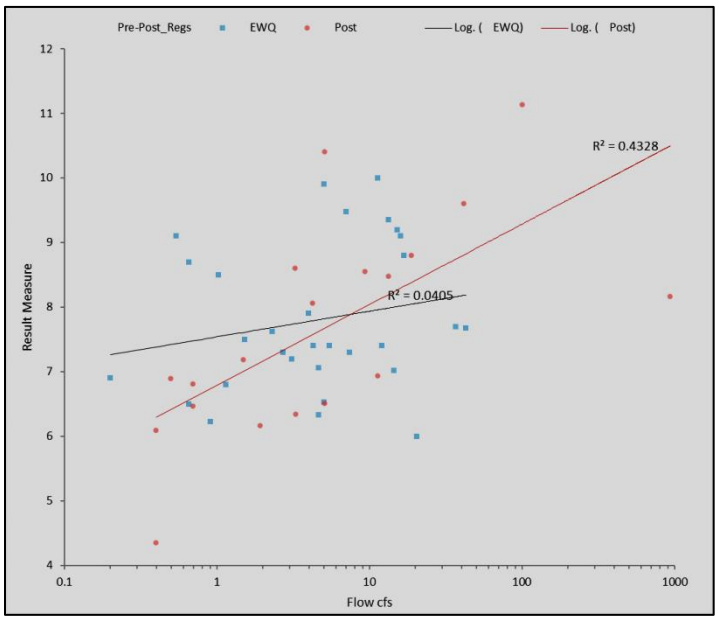
Water quality degradation is evident. Chloride concentrations increased by about 5 mg/l between the two periods. Post-EWQ median concentration rose above the EWQ upper 95% confidence interval. 2011 data varied most widely. The unusually low concentrations on the annual plot in 2011 were from samples taken under high flow or flood conditions. Flow is plotted on a logarithmic scale.

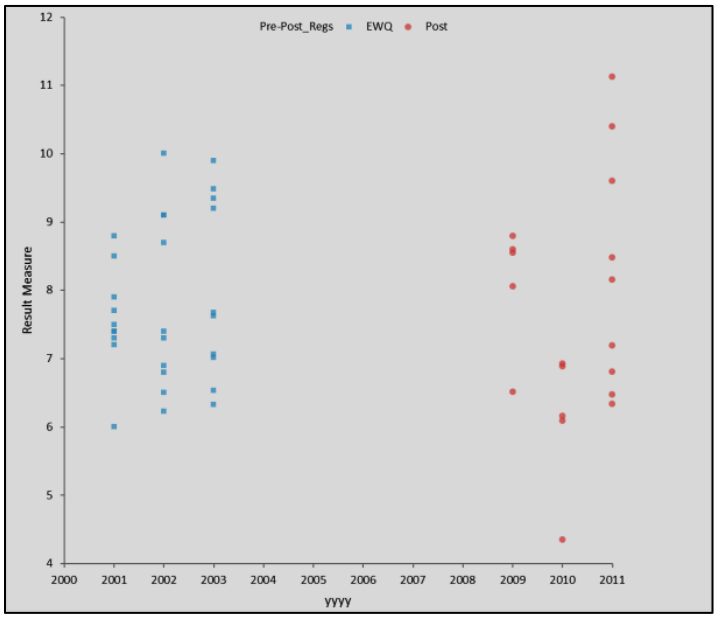
Chapter 3: 1463 BCP
Pidcock Creek, PA

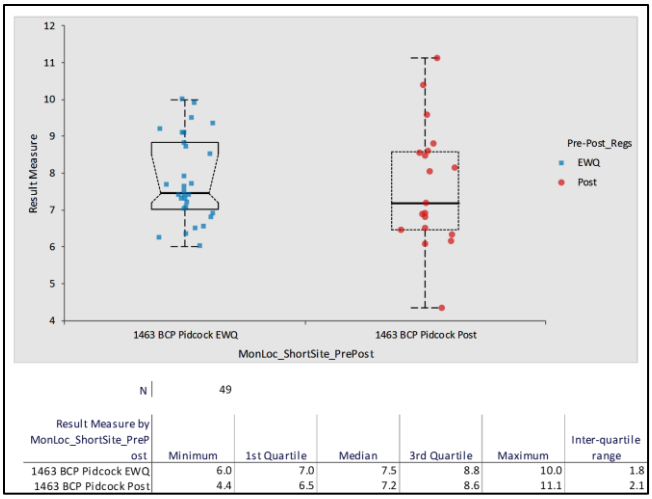
Dissolved Oxygen (DO) mg/l

Existing Water Quality (Table 2X):

Median 7.45 mg/l
Lower 95% Confidence Interval 7.2 mg/l
Upper 95% Confidence Interval 8.5 mg/l

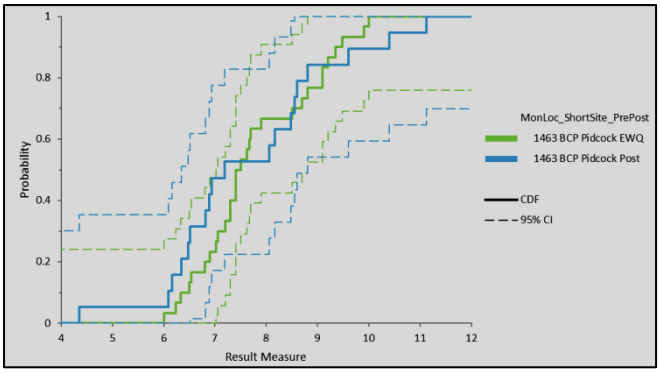






N	49

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	6.0	7.0	7.5	8.8	10.0	1.8
1463 BCP Pidcock Post	4.4	6.5	7.2	8.6	11.1	2.1



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	35.2	1.17
1463 BCP Pidcock Post	19	55.6	2.93

H statistic	0.44
X^2 approximation	0.44
DF	1
p-value	0.5048 [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.

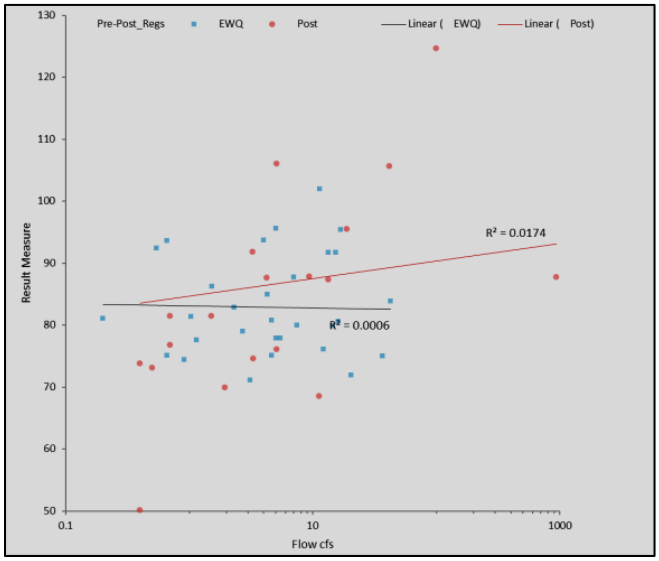
No water quality degradation is indicated. No measurable change took place between the EWQ and Post-EWQ periods. There was one sample in 2010 that violated PA dissolved oxygen criteria. In June 2010, DO concentration was 4.35 mg/l at mid-day. This occurred during extreme low-flow conditions, when only standing pools were visible in the stream. There was no flow across riffles; only interstitial flow between pools. There was probably enough decomposing material in the stream to create substantial oxygen demand that was not offset by primary production. DO saturation for this sample was 50.1%. Flow is plotted on a logarithmic axis.

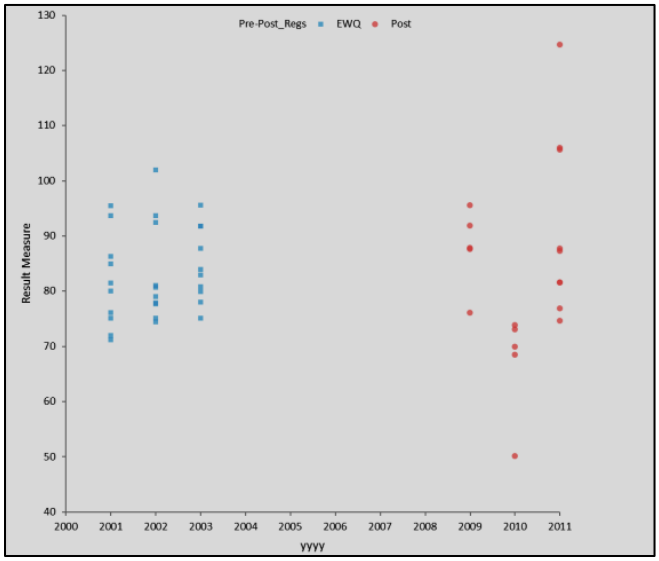
Chapter 3: 1463 BCP
Pidcock Creek, PA

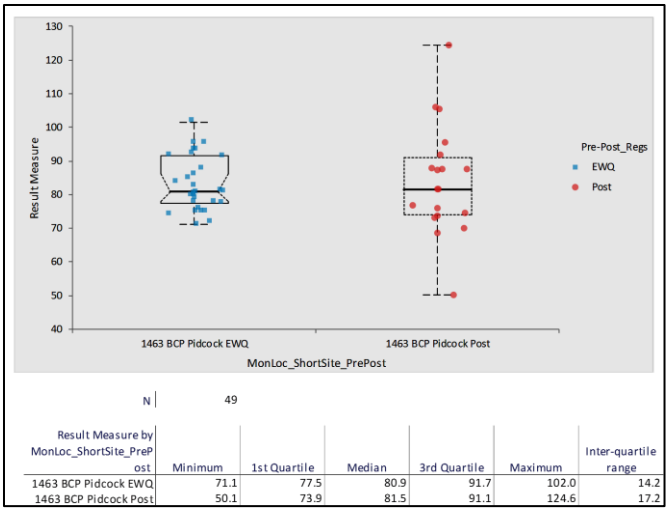
Dissolved Oxygen Saturation %

Existing Water Quality (Table 2X):

Median 81%
Lower 95% Confidence Interval 78%
Upper 95% Confidence Interval 86%

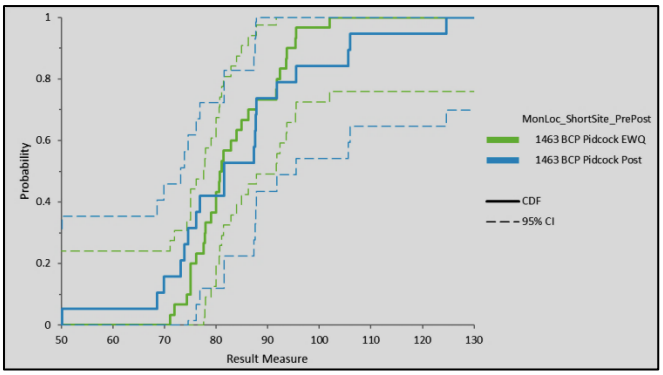






N	49

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	71.1	77.5	80.9	91.7	102.0	14.2
1463 BCP Pidcock Post	50.1	73.9	81.5	91.1	124.6	17.2



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	0.3	0.01
1463 BCP Pidcock Post	19	0.5	0.02

H statistic	0.00
X^2 approximation	0.00
DF	1
p-value	0.9509 [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.

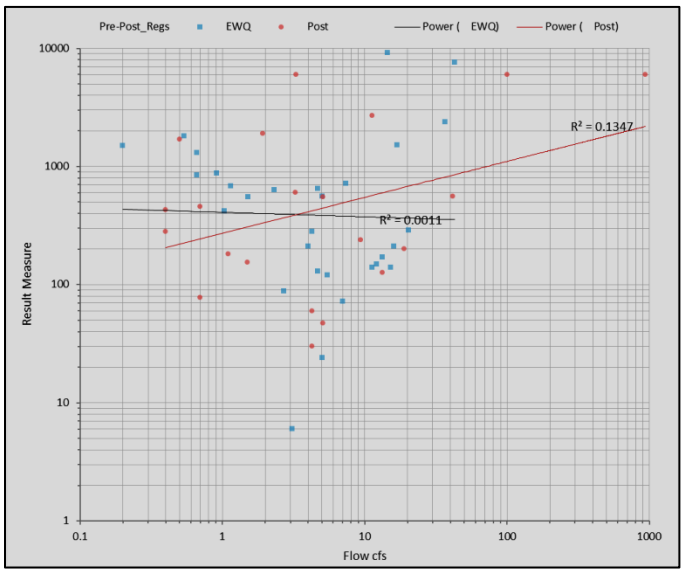
No water quality degradation is indicated. Dissolved Oxygen Saturation is unrelated to flow, and did not measurably change between the EWQ and post-EWQ periods. In terms of DO and DO%, water quality is not optimal at this location. Optimally, there is a balance between oxygen produced by plants and oxygen demand by decomposing materials in the stream, and DO% should be around 100%. As a rule of thumb, DO% below 80% indicates excessive oxygen demand, and over 120% indicates over-production of algae and plant material. Note that flow is plotted on a logarithmic scale.

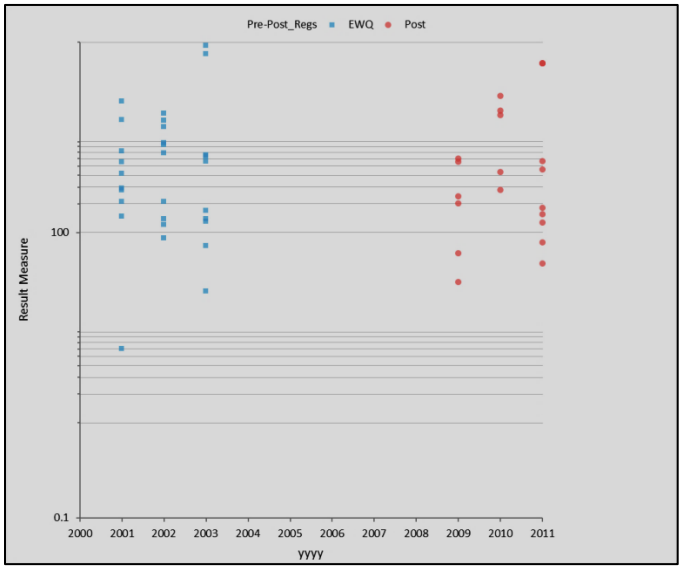
Chapter 3: 1463 BCP
Pidcock Creek, PA

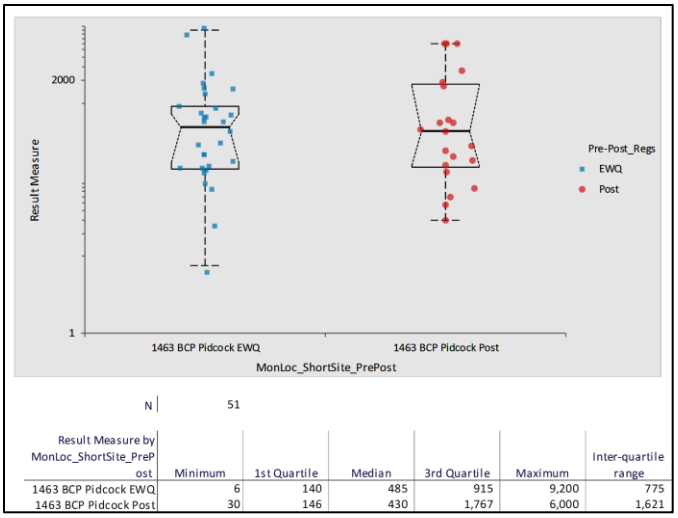
Enterococcus colonies/100 ml

Existing Water Quality (Table 2X):

Median 485/100 ml
Lower 95% Confidence Interval 170/100 ml
Upper 95% Confidence Interval 720/100 ml

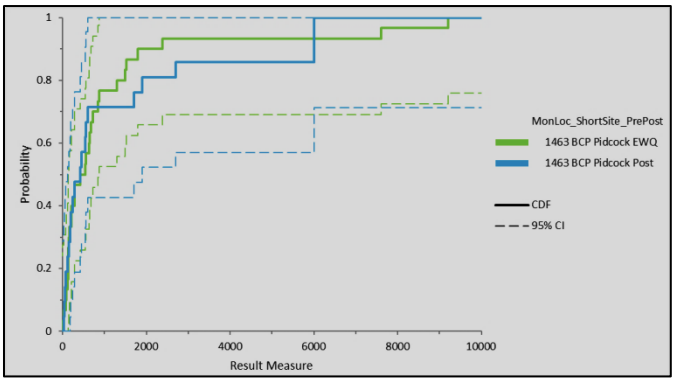






N	51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	6	140	485	915	9,200	775
1463 BCP Pidcock Post	30	146	430	1,767	6,000	1,621



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	0.4	0.01
1463 BCP Pidcock Post	21	0.6	0.03

H statistic	0.00
X^2 approximation	0.00
DF	1
p-value	0.9466 [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.

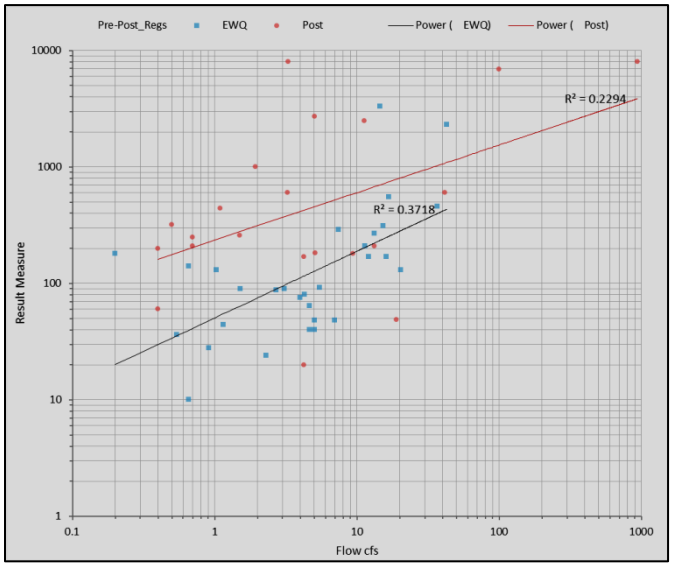
No water quality degradation is evident. Enterococci did not measurably change between the EWQ and Post-EWQ periods. Sources of analytical uncertainty included potential laboratory artifacts and insufficient post-EWQ sampling (n=21). Enterococcus concentrations are unrelated to flow in both data sets. Note that concentrations and flows are plotted on a logarithmic scale.

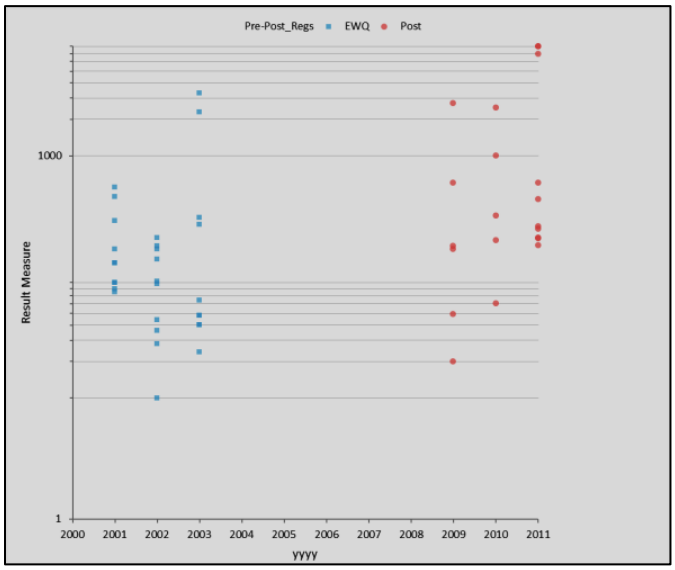
Chapter 3: 1463 BCP
Pidcock Creek, PA

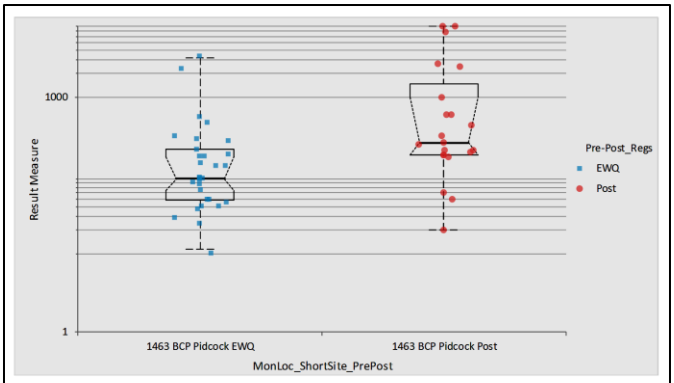
Escherichia coli colonies/100 ml

Existing Water Quality (Table 2X):

Median 91/100 ml
Lower 95% Confidence Interval 64/100 ml
Upper 95% Confidence Interval 170/100 ml
Defined in regulations as a flow-related parameter

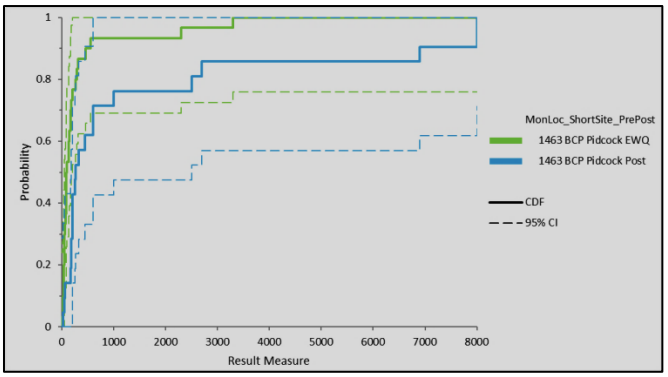






N	51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	10	48	91	215	3,300	167
1463 BCP Pidcock Post	20	181	260	1,500	8,000	1,319



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	896.5	29.88
1463 BCP Pidcock Post	21	1280.8	60.99

H statistic	9.86
X^2 approximation	9.86
DF	1
p-value	0.0017 [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.

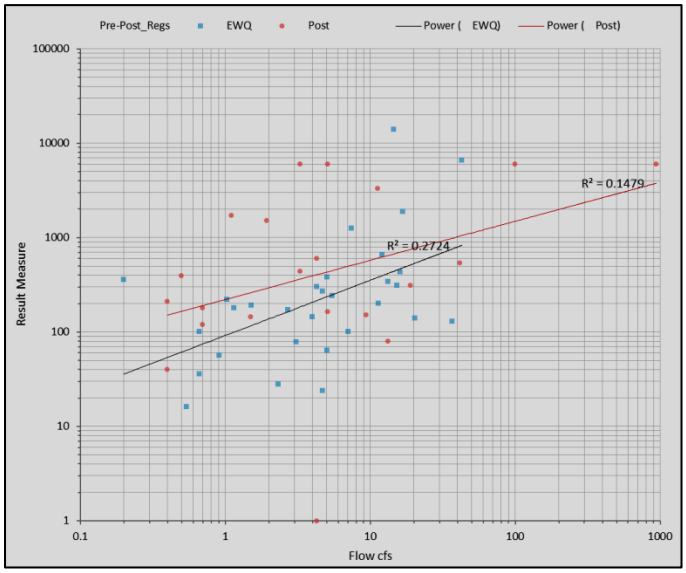
Water quality degradation is evident. E. coli concentrations apparently rose between the EWQ and Post-EWQ periods. Sources of analytical uncertainty included potential laboratory artifacts and insufficient post-EWQ sampling (n=21). Note that concentrations and flows are plotted on a logarithmic scale. No independent data were available at this site to validate DRBC's conclusion. The increase is reported as such in the summary matrix, but confidence in the conclusion is low because of low N and high variability. The reason for the increase remains unexplained.

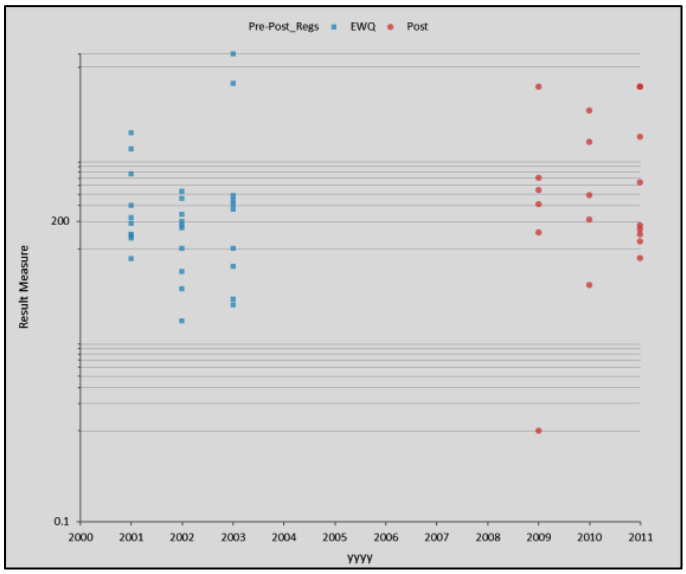
Chapter 3: 1463 BCP
Pidcock Creek, PA

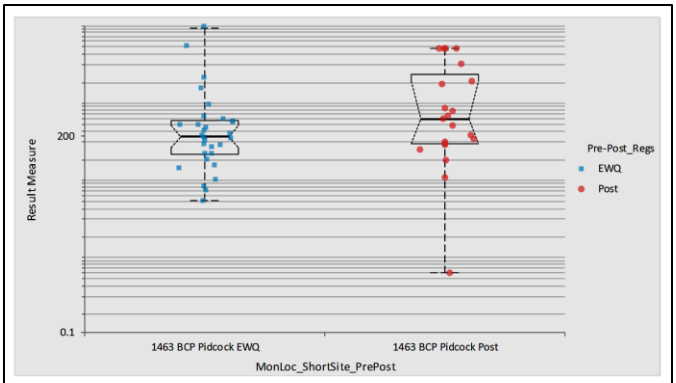
Fecal coliform colonies/100 ml

Existing Water Quality (Table 2X):

Median 195/100 ml
Lower 95% Confidence Interval 130/100 ml
Upper 95% Confidence Interval 310/100 ml
Defined in regulations as a flow-related parameter

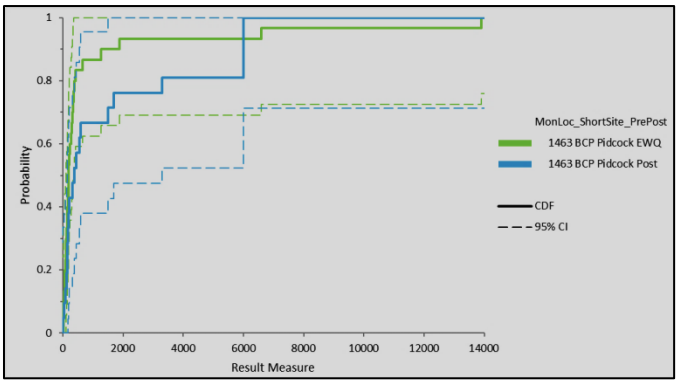






N	51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	16	98	195	362	13,900	264
1463 BCP Pidcock Post	1	148	390	2,233	6,000	2,085



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	232.4	7.75
1463 BCP Pidcock Post	21	332.0	15.81

H statistic	2.56
X^2 approximation	2.56
DF	1
p-value	0.1099 [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.

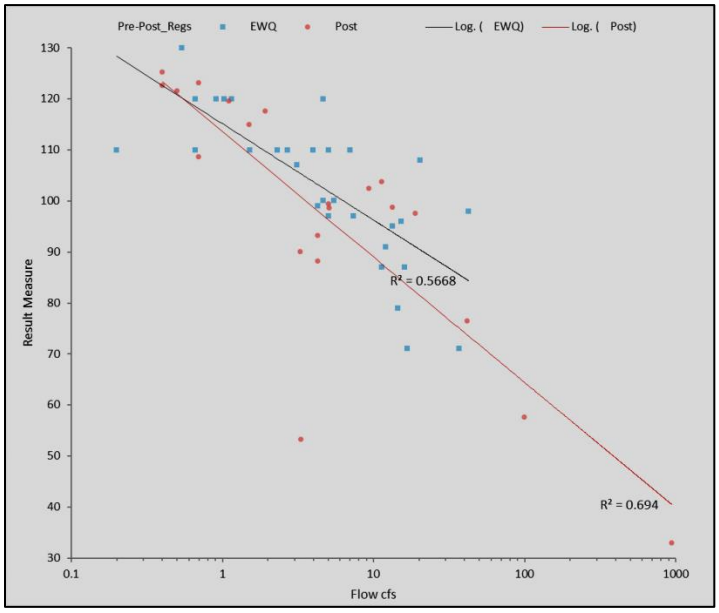
No water quality degradation is evident. Fecal coliform concentrations apparently did not measurably change between the EWQ and post-EWQ periods. Sources of analytical uncertainty included potential laboratory artifacts and insufficient post-EWQ sampling (n=21). Fecal coliform concentrations are positively but weakly related to flow. Post-EWQ median concentrations were above the EWQ upper 95% confidence interval, but the data are so variable that no statistical difference was detectable. Note that concentrations and flows are plotted on a logarithmic scale.

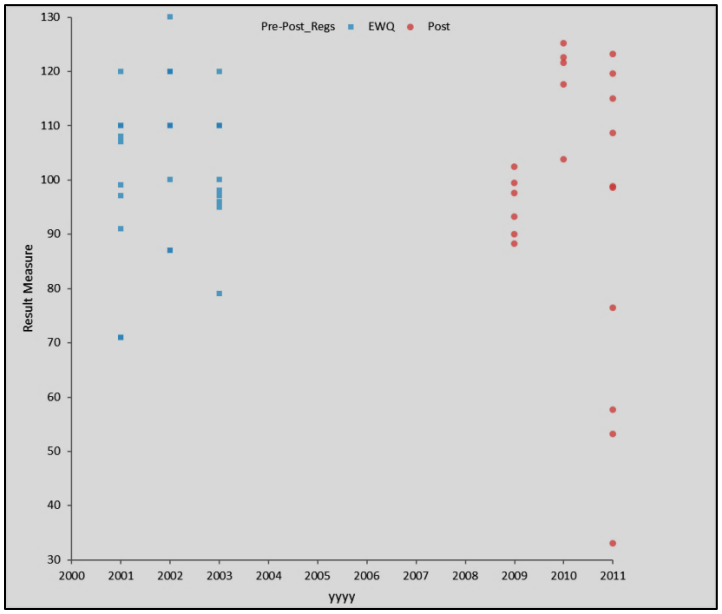
Chapter 3: 1463 BCP
Pidcock Creek, PA

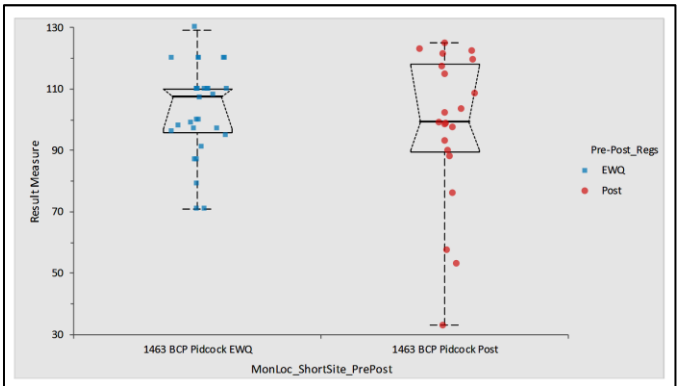
Hardness as CaCO3, Total mg/l

Existing Water Quality (Table 2X):

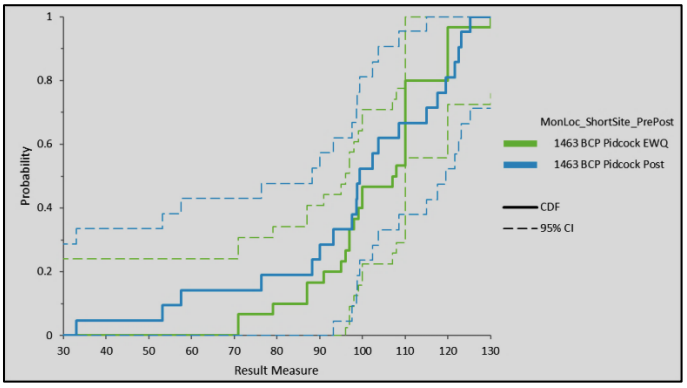
Median 108 mg/l
Lower 95% Confidence Interval 97 mg/l
Upper 95% Confidence Interval 110 mg/l
Defined in regulations as a flow-related parameter







N	51					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	71.0	95.9	107.5	110.0	130.0	14.1
1463 BCP Pidcock Post	33.0	89.4	99.4	118.3	125.2	28.9



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	14.7	0.49
1463 BCP Pidcock Post	21	21.0	1.00

H statistic	0.16
X^2 approximation	0.16
DF	1
p-value	0.6870 [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.

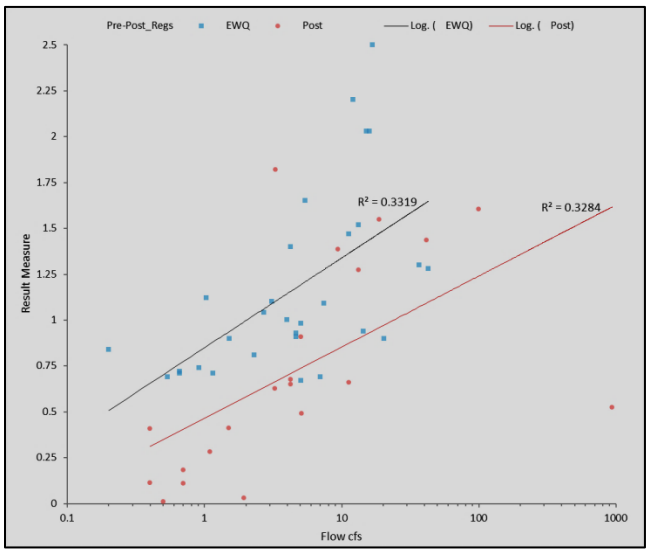
No water quality degradation is evident. Hardness did not measurably change between the EWQ and post-EWQ periods. Sources of analytical uncertainty included potential laboratory artifacts and insufficient post-EWQ sampling (n=21). Hardness is inversely related to flow. Post-EWQ median hardness fell within the EWQ 95% confidence intervals. The unusually low values observed in the post-EWQ period were sampled during high-flow or flood events. Note that flows are plotted on a logarithmic scale.

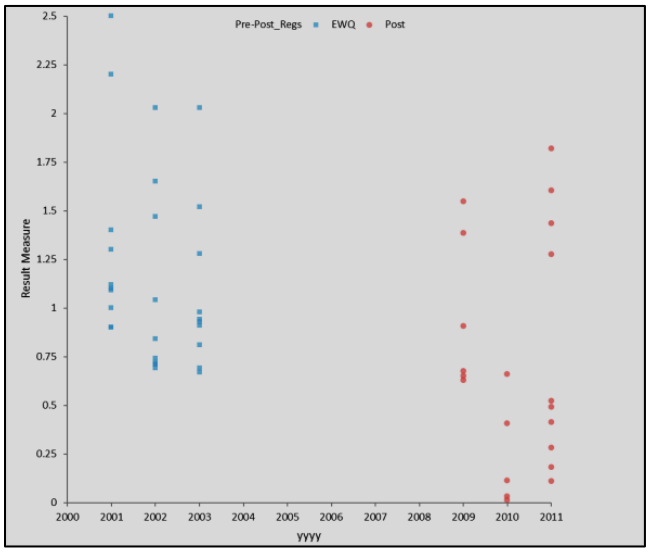
Chapter 3: 1463 BCP
Pidcock Creek, PA

Nitrate + Nitrite as N, Total mg/l

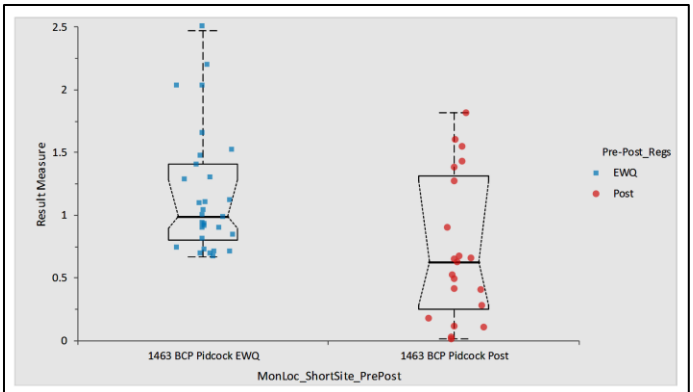
Existing Water Quality (Table 2X):

Median 0.99 mg/l
Lower 95% Confidence Interval 0.90 mg/l
Upper 95% Confidence Interval 1.28 mg/l



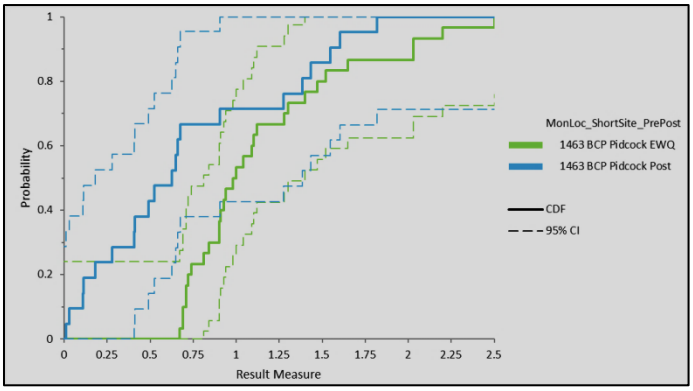


No water quality degradation is evident. Nitrate concentrations apparently declined between the EWQ and post-EWQ periods. However, there are potential laboratory artifacts and detection limit differences that introduce uncertainty in the conclusion. Nitrate is positively but weakly related to flow.



N 51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	0.670	0.804	0.990	1.406	2.500	0.602
1463 BCP Pidcock Post	0.012	0.248	0.627	1.311	1.819	1.063



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	874.8	29.16
1463 BCP Pidcock Post	21	1249.7	59.51

H statistic	9.61
X^2 approximation	9.61
DF	1
p-value	0.0019 [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.

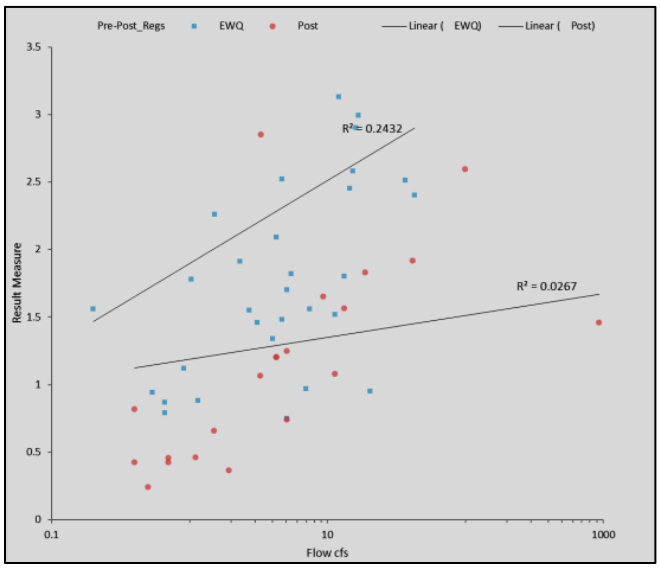
On the annual plot, 2002-2003 EWQ nitrates appear to match well with post-EWQ nitrate + nitrite for 2009. Nitrate + Nitrite concentrations are assumed to be equivalent for comparison with EWQ nitrate concentrations, since EWQ nitrite concentrations were never detected. Note that flows are plotted on a logarithmic scale. Independent data were not available for validation of the apparent decline. Post-EWQ median nitrate + nitrite concentrations fell below the EWQ lower 95% confidence interval.

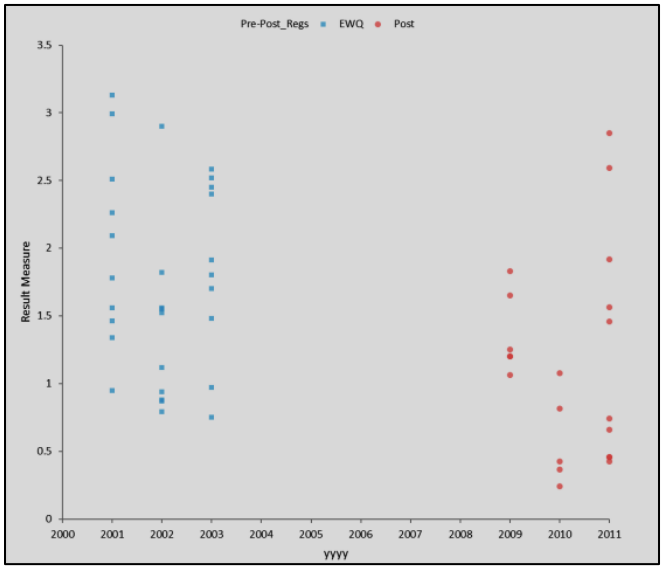
Chapter 3: 1463 BCP
Pidcock Creek, PA

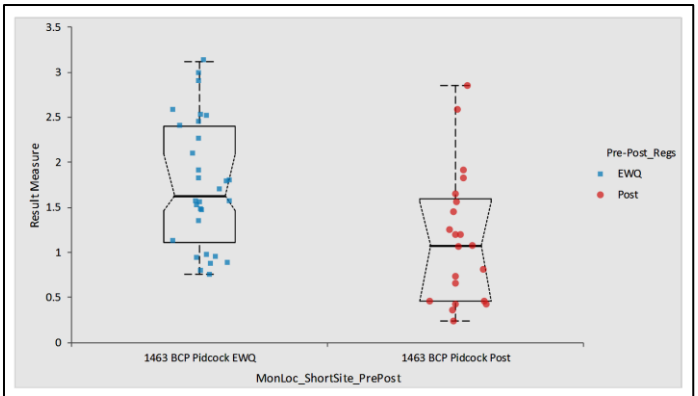
Nitrogen as N, Total (TN) mg/l

Existing Water Quality (Table 2X):

Median 1.63 mg/l
Lower 95% Confidence Interval 1.46 mg/l
Upper 95% Confidence Interval 2.09 mg/l

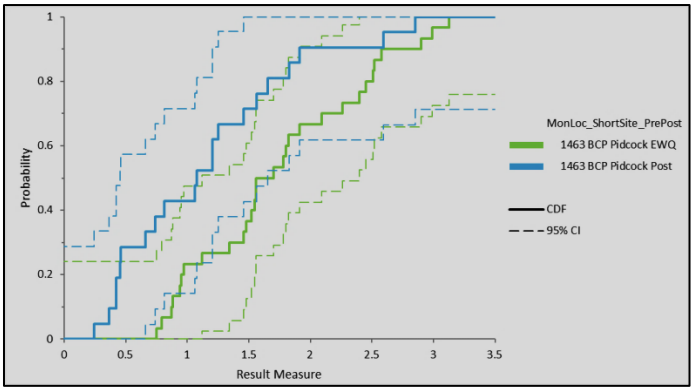






N	51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	0.750	1.108	1.630	2.404	3.130	1.297
1463 BCP Pidcock Post	0.242	0.458	1.076	1.593	2.850	1.135



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	681.6	22.72
1463 BCP Pidcock Post	21	973.8	46.37

H statistic	7.49
X^2 approximation	7.49
DF	1
p-value	0.0062 [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.

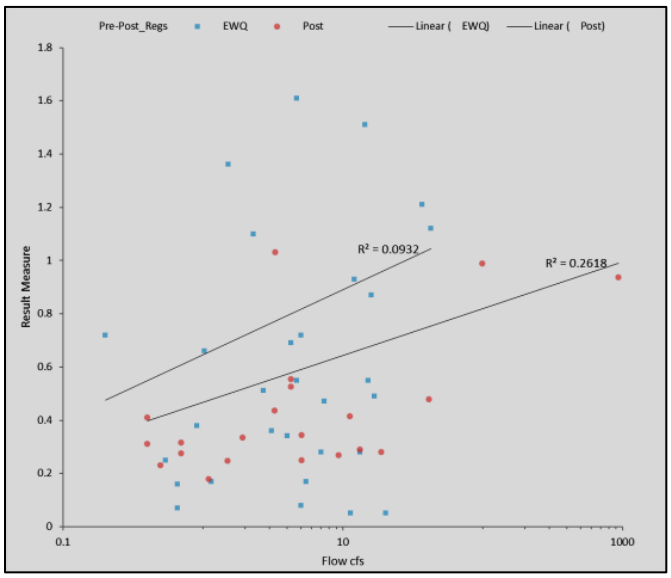
No water quality degradation is evident. Total Nitrogen concentrations apparently declined between the EWQ and post-EWQ periods. However, differences in detection limits and laboratory artifacts introduced uncertainty in such a conclusion. TN is weakly related to flow in the EWQ period, but unrelated to flow in the post-EWQ period. Note that flows are plotted on a logarithmic scale. DRBC results could not be independently validated. Post-EWQ median TN concentrations fell below the EWQ lower 95% confidence interval.

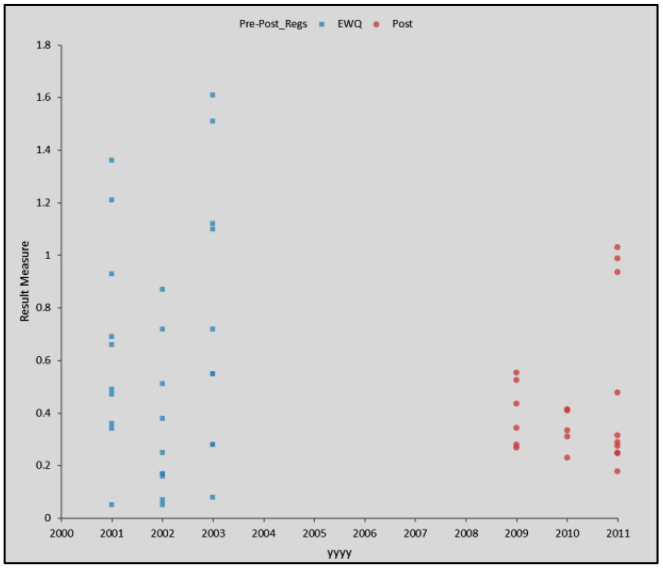
Chapter 3: 1463 BCP
Pidcock Creek, PA

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

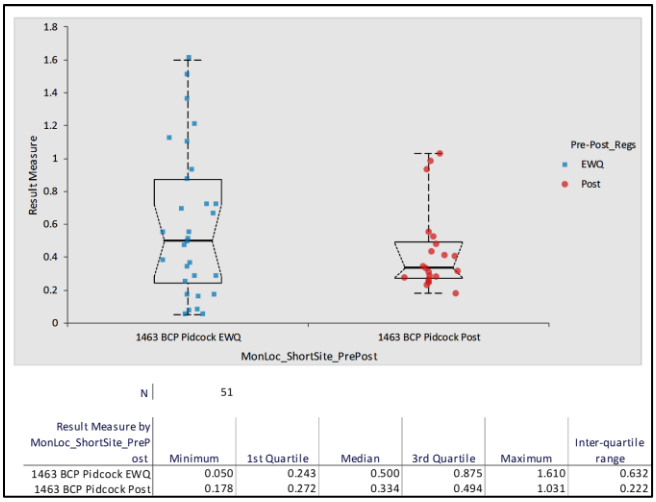
Existing Water Quality (Table 2X):

Median 0.50 mg/l
Lower 95% Confidence Interval 0.28 mg/l
Upper 95% Confidence Interval 0.72 mg/l



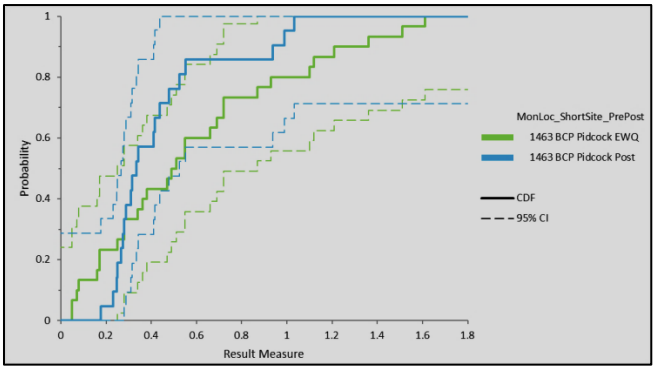


No water quality degradation is evident. No measurable change occurred in TKN concentrations between the EWQ and post-EWQ periods. However, potential laboratory artifacts and insufficient post-EWQ sampling (n=21) introduced analytical uncertainty.



N	51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	0.050	0.243	0.500	0.875	1.610	0.632
1463 BCP Pidcock Post	0.178	0.272	0.334	0.494	1.031	0.222



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	93.6	3.12
1463 BCP Pidcock Post	21	133.8	6.37

H statistic	1.03
X^2 approximation	1.03
DF	1
p-value	0.3104 [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.

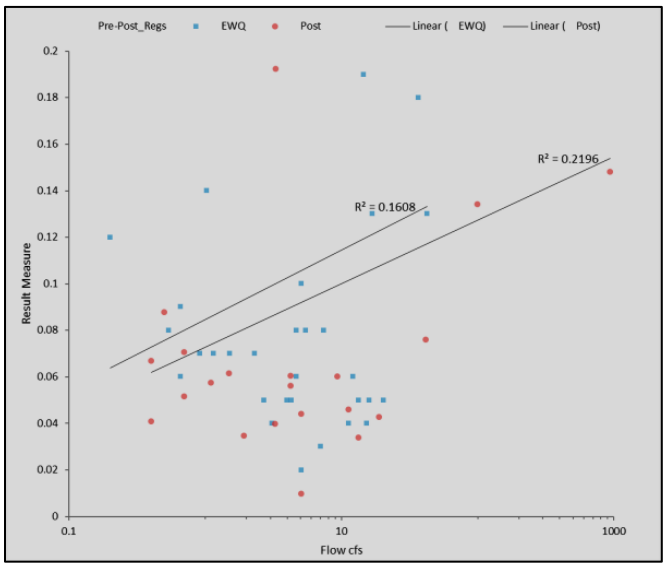
TKN concentration is unrelated to flow in the EWQ data sets, and weakly related in the post-EWQ data set. TKN ranges less widely in the post-EWQ data set. Note that flows are plotted on a logarithmic scale. Post-EWQ median TKN fell within EWQ 95% confidence intervals, but very near the lower 95% confidence interval. Though there was no statistical difference between EWQ and post-EWQ TKN, concentrations appeared to fall somewhat and were far more stable. Unlike nitrate + nitrite and other parameters, the TKN data sets are more directly comparable since there are no discrepancies in detection limits throughout the two periods, and the flow regime is well represented in both periods.

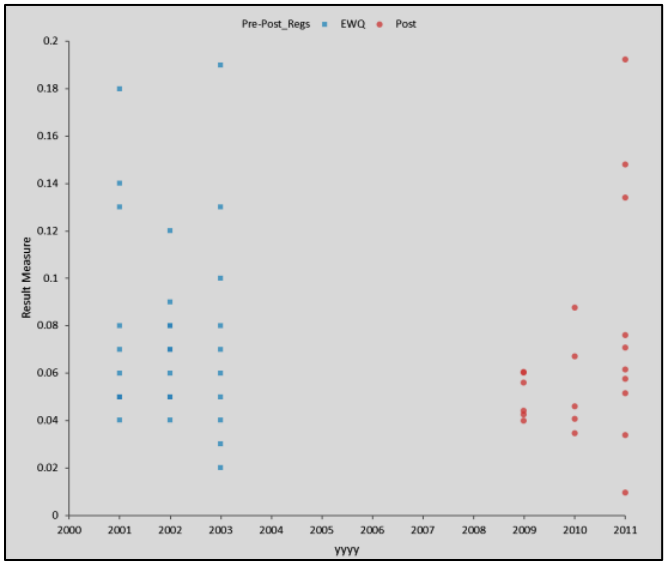
Chapter 3: 1463 BCP
Pidcock Creek, PA

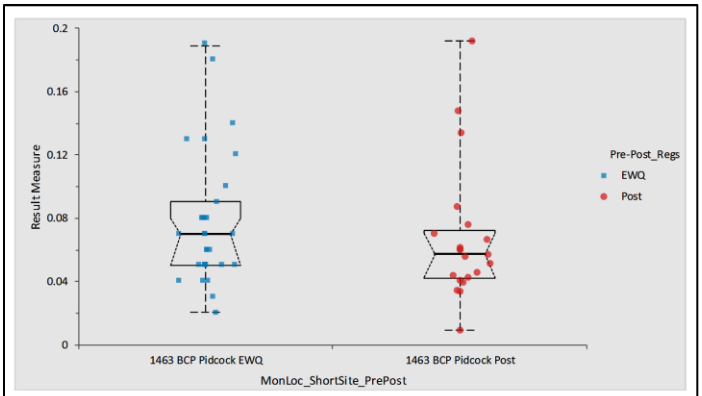
Orthophosphate as P, Total mg/l

Existing Water Quality (Table 2X):

Median 0.07 mg/l
Lower 95% Confidence Interval 0.05 mg/l
Upper 95% Confidence Interval 0.08 mg/l

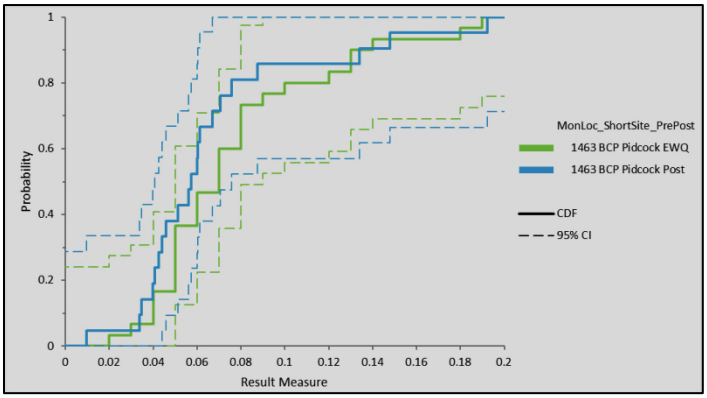






N	51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	0.020	0.050	0.070	0.091	0.190	0.041
1463 BCP Pidcock Post	0.010	0.042	0.057	0.072	0.192	0.030



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	108.3	3.61
1463 BCP Pidcock Post	21	154.7	7.37

H statistic	1.19
X^2 approximation	1.19
DF	1
p-value	0.2746[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.

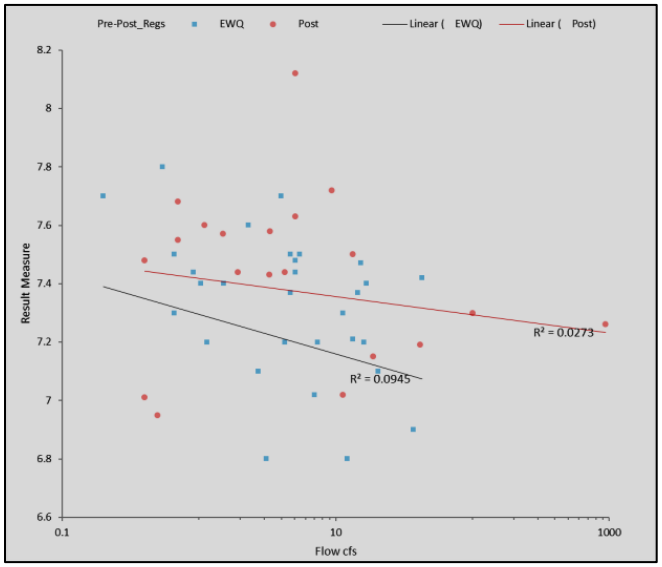
No water quality degradation is evident. Orthophosphate concentrations did not measurably change between the EWQ and post-EWQ periods. However, potential laboratory artifacts and insufficient post-EWQ sampling (n=21) introduced analytical uncertainty. Orthophosphate is very weakly related to flow in both data sets. Note that flows are plotted on a logarithmic scale. Post-EWQ median orthophosphate fell within EWQ 95% confidence intervals, but very near the lower 95% confidence interval. There were no independent data to confirm DRBC results. DRBC detection limits improved between the two periods, but there were no undetected results in either data set.

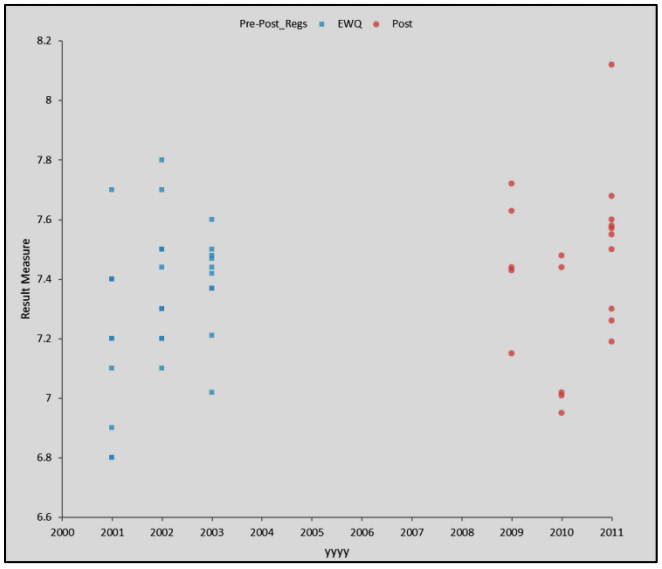
Chapter 3: 1463 BCP
Pidcock Creek, PA

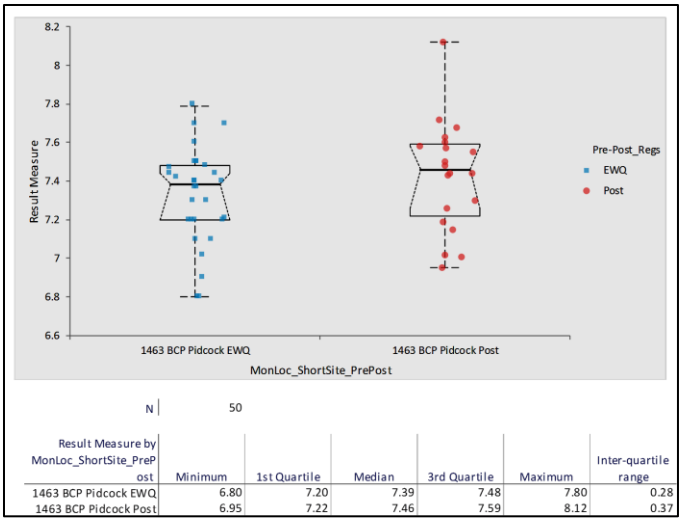
pH, units

Existing Water Quality (Table 2X):

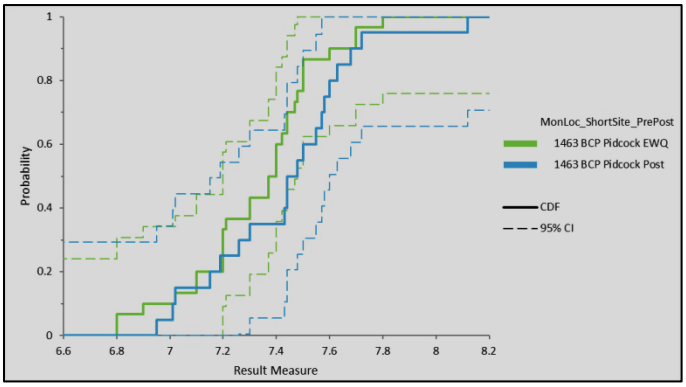
Median 7.39 standard units
Lower 95% Confidence Interval 7.20 standard units
Upper 95% Confidence Interval 7.44 standard units







N	50					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	6.80	7.20	7.39	7.48	7.80	0.28
1463 BCP Pidcock Post	6.95	7.22	7.46	7.59	8.12	0.37



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	154.1	5.14
1463 BCP Pidcock Post	20	231.2	11.56

H statistic	1.82
X^2 approximation	1.82
DF	1
p-value	0.1776 [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.

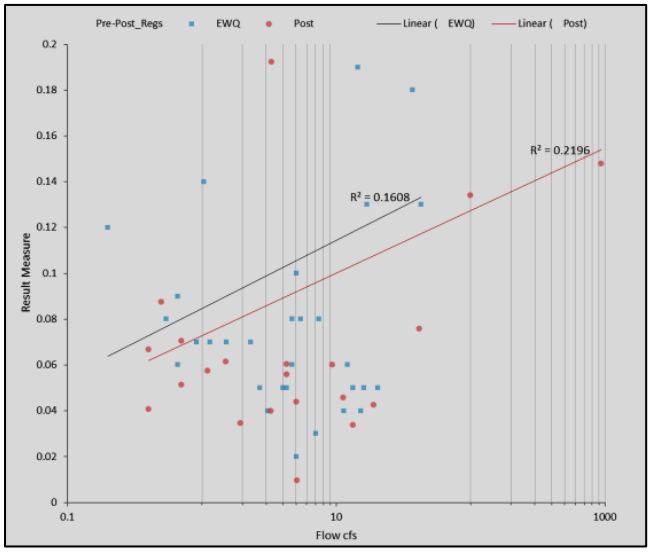
No water quality degradation is indicated. pH did not measurably change between the EWQ and post-EWQ periods. Under higher flow conditions, pH tends toward neutral, though pH is unrelated to flow in both data sets. Post-EWQ median pH fell within the EWQ 95% confidence intervals. Note that flows are plotted on a logarithmic scale.

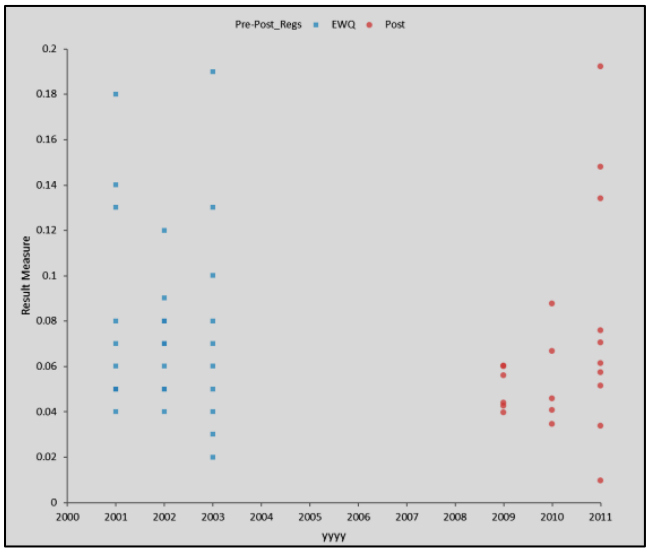
Chapter 3: 1463 BCP
Pidcock Creek, PA

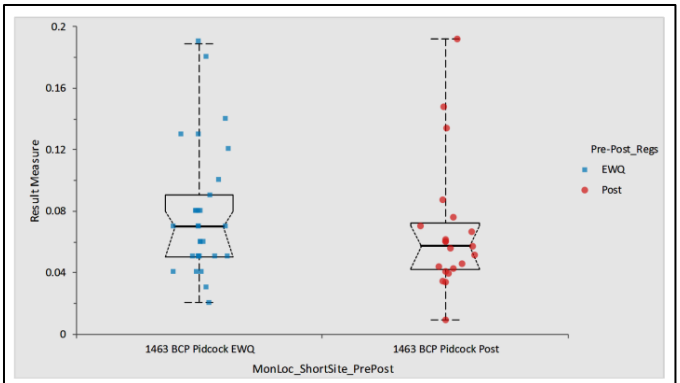
Phosphorus as P, Total (TP) mg/l

Existing Water Quality (Table 2X):

Median 0.10 mg/l
Lower 95% Confidence Interval 0.08 mg/l
Upper 95% Confidence Interval 0.12 mg/l

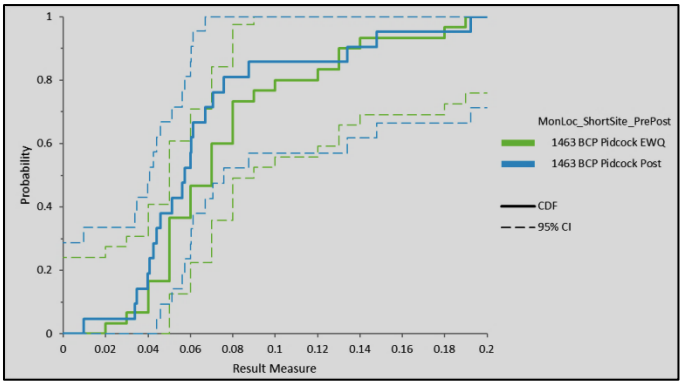






N 51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	0.020	0.050	0.070	0.091	0.190	0.041
1463 BCP Pidcock Post	0.010	0.042	0.057	0.072	0.192	0.030



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	108.3	3.61
1463 BCP Pidcock Post	21	154.7	7.37

H statistic	1.19
X^2 approximation	1.19
DF	1
p-value	0.2746[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.

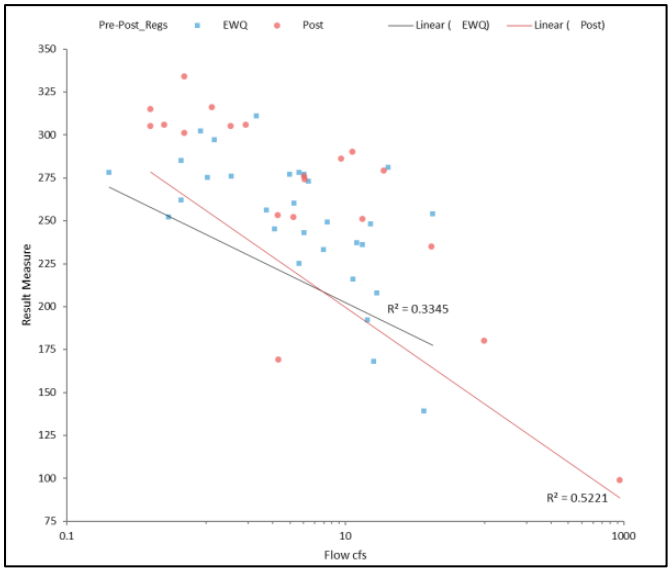
No water quality degradation is indicated. Total Phosphorus (TP) concentrations did not measurably change between the EWQ and post-EWQ periods. However, potential laboratory artifacts and insufficient post-EWQ sampling (n=21) introduced analytical uncertainty. Post-EWQ median total phosphorus fell below the EWQ lower 95% confidence interval, but there were insufficient data for a statistically significant decline. TP is unrelated to flow in both data sets. Note that flows are plotted on a logarithmic scale. No independent data were available to confirm these results.

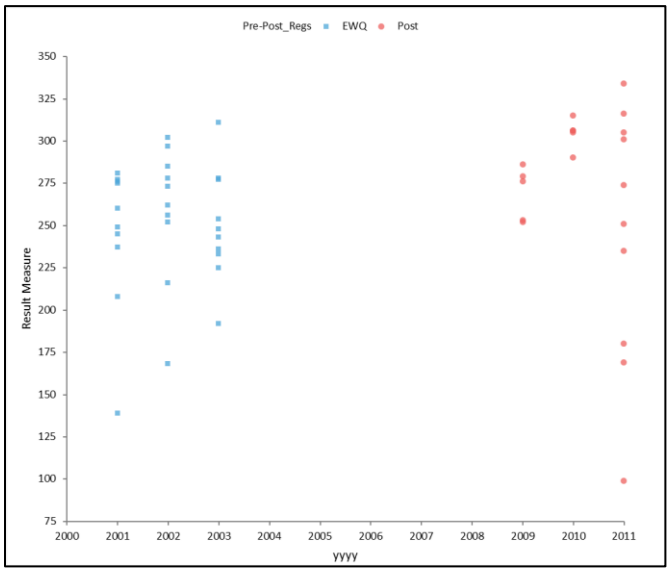
Chapter 3: 1463 BCP
Pidcock Creek, PA

Specific Conductance µmho/cm

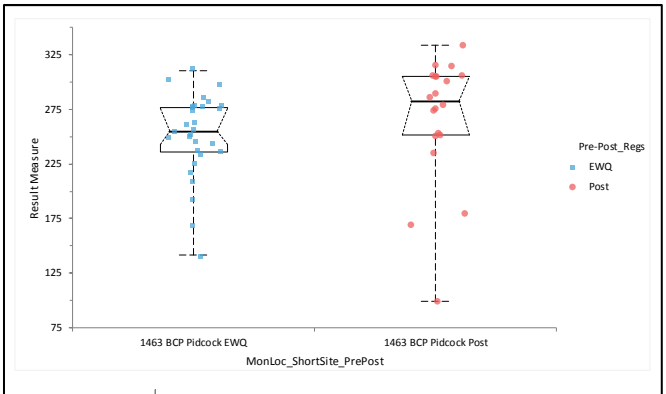
Existing Water Quality (Table 2X):

Median 255 µmho/cm
Lower 95% Confidence Interval 243 µmho/cm
Upper 95% Confidence Interval 276 µmho/cm
Defined in regulations as a flow-related parameter

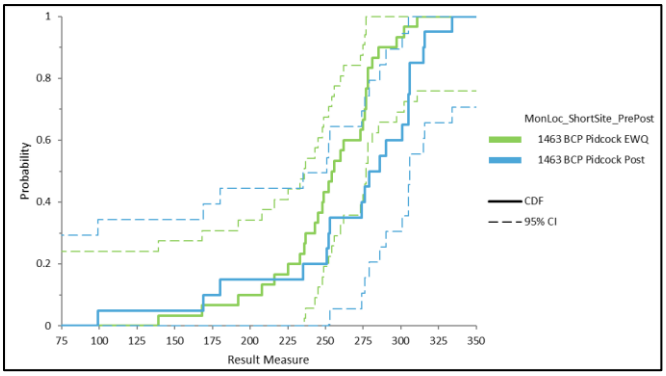




Evidence of water quality degradation is indicated. Specific conductance rose by about 27 µmho/cm, which is above the EWQ upper 95% confidence interval. In both data sets, specific conductance is inversely related to flow.



	N	50				
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	139	235.8	255.0	277.1	311	41.3
1463 BCP Pidcock Post	99	251.4	282.5	305.6	334	54.2



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	360.5	12.02
1463 BCP Pidcock Post	20	540.8	27.04

H statistic	4.24
X^2 approximation	4.24
DF	1
p-value	0.0394 [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.

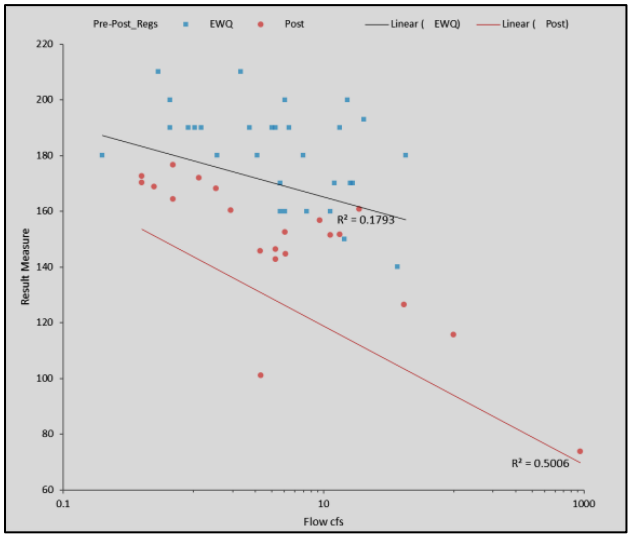
In the post-EWQ data, a single outlier drives the regression, but the flow relationship remains strong even so. The outlier was a sample taken during flood conditions. Note that flows are plotted on a logarithmic scale. The rise in specific conductance may be attributable to the concurrent rise in chloride concentrations. No new dischargers are present in the watershed. Specific conductance has risen from a median of 255 µmho/cm, which was around the upper limit of typical concentration for a relatively undeveloped Piedmont stream. It is now 282 µmho/cm, which is a significant increase in a short time.

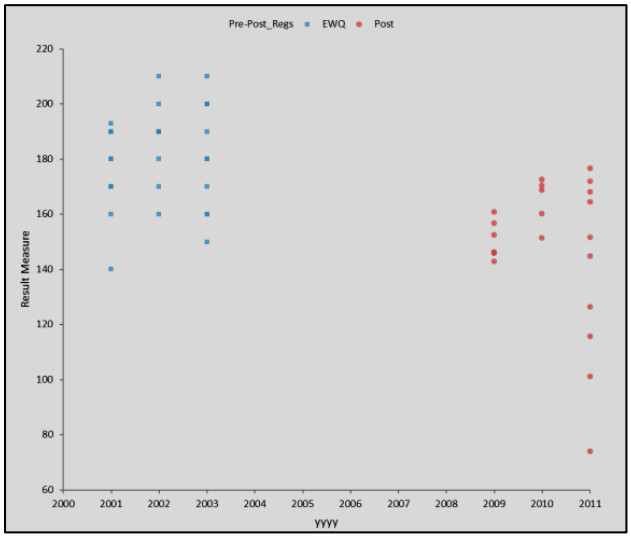
Chapter 3: 1463 BCP
Pidcock Creek, PA

Total Dissolved Solids (TDS) mg/l

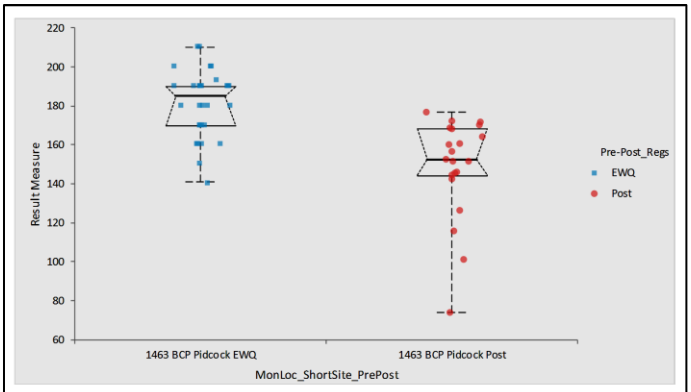
Existing Water Quality (Table 2X):

Median 185 mg/l
Lower 95% Confidence Interval 170 mg/l
Upper 95% Confidence Interval 190 mg/l
Defined in regulations as a flow-related parameter



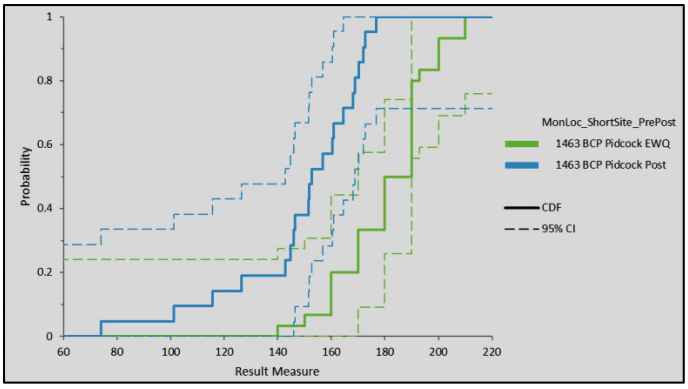


No water quality degradation is evident. TDS apparently declined between the EWQ and post-EWQ periods. However, potential laboratory artifacts introduced uncertainty in this conclusion.



N 51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	140.0	170.0	185.0	190.0	210.0	20.0
1463 BCP Pidcock Post	73.9	144.1	152.6	168.3	176.6	24.2



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	1809.6	60.32
1463 BCP Pidcock Post	21	2585.2	123.10

H statistic	20.04
X^2 approximation	20.04
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.

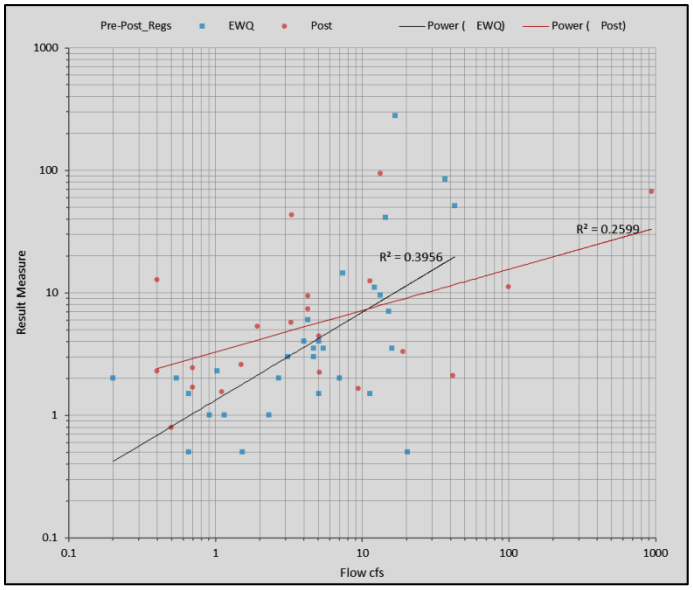
TDS is inversely related to flow, though weakly in the EWQ data set. Stream flows were not significantly different between the two periods. Post-EWQ median TDS was well below the EWQ 95% lower confidence interval. Post-EWQ detection limits were lower than EWQ detection limits, though there were no non-detect results at any time. Unusually low TDS values in the post-EWQ data are all high flow or flood samples, though TDS was generally lower in the post-EWQ data throughout the entire data distribution. Note that flows are plotted on a logarithmic scale.

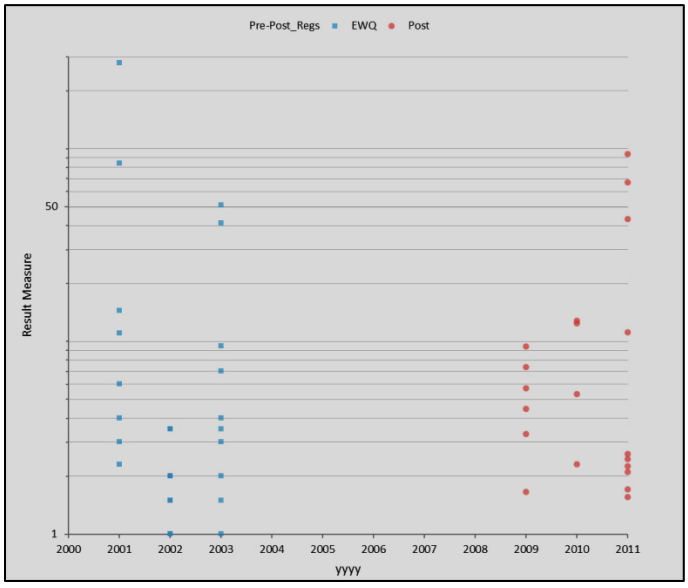
Chapter 3: 1463 BCP
Pidcock Creek, PA

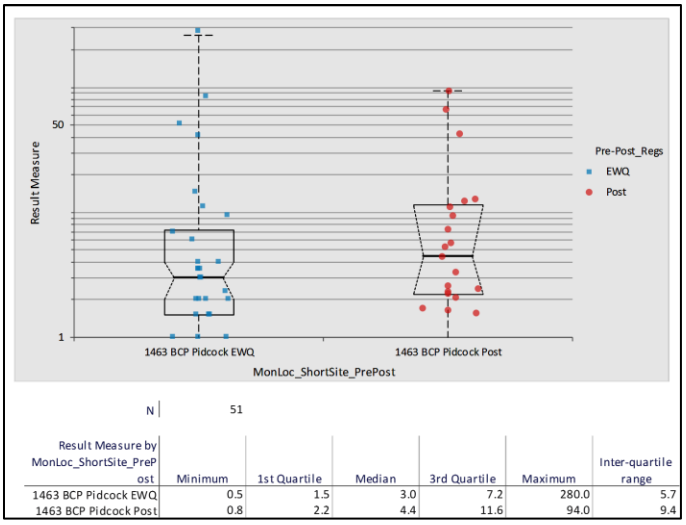
Total Suspended Solids (TSS) mg/l

Existing Water Quality (Table 2X):

Median 3.0 mg/l
Lower 95% Confidence Interval 2.0 mg/l
Upper 95% Confidence Interval 4.0 mg/l
Defined in regulations as a flow-related parameter

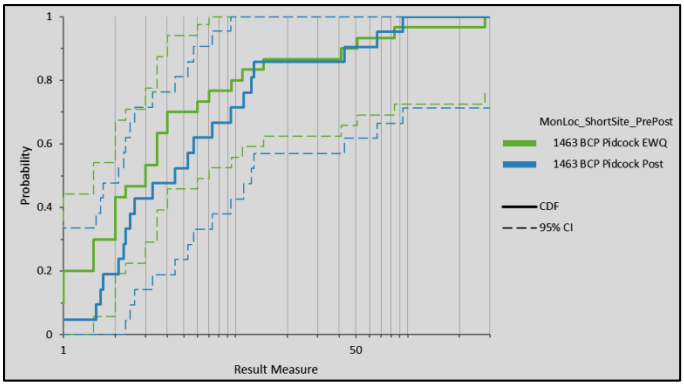






N	51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	0.5	1.5	3.0	7.2	280.0	5.7
1463 BCP Pidcock Post	0.8	2.2	4.4	11.6	94.0	9.4



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	149.6	4.99
1463 BCP Pidcock Post	21	213.8	10.18

H statistic	1.65
X^2 approximation	1.65
DF	1
p-value	0.1994 [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.

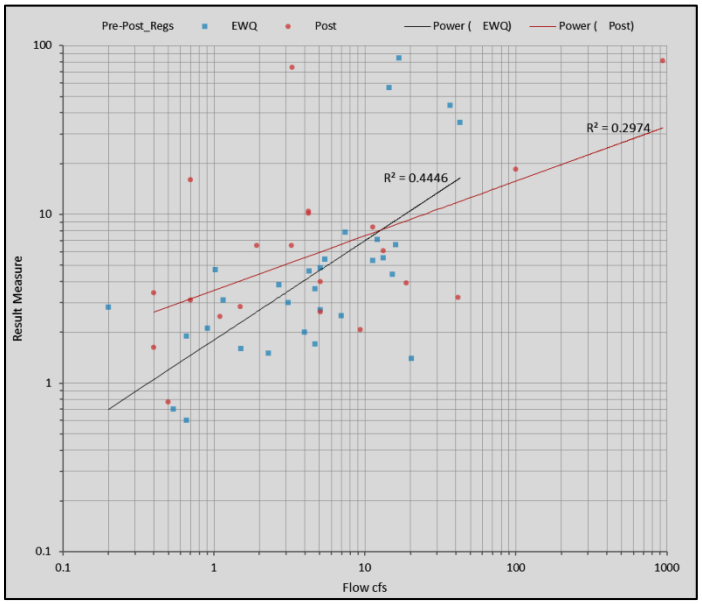
No water quality degradation is evident. TSS did not measurably change between the EWQ and post-EWQ periods. However, potential laboratory artifacts and insufficient post-EWQ sampling (n=21) introduced analytical uncertainty. TSS is positively though weakly related to flow in both data sets. Post-EWQ median TSS was slightly above the EWQ upper 95% confidence interval, but the difference was not statistically significant. Both distributions were similarly shaped. Note that both flow and concentration are plotted on a logarithmic scale.

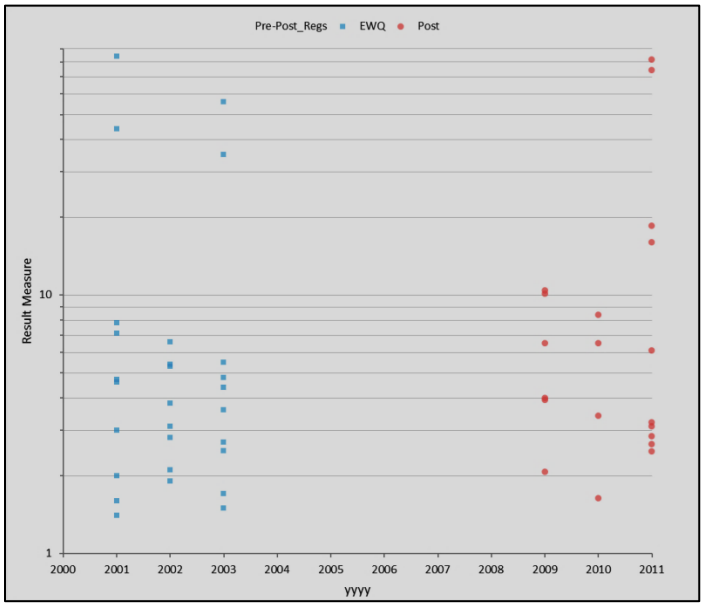
Chapter 3: 1463 BCP
Pidcock Creek, PA

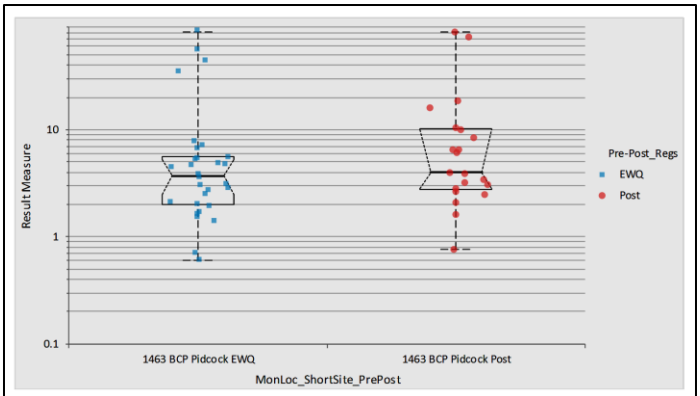
Turbidity NTU

Existing Water Quality (Table 2X):

Median 3.7 NTU
Lower 95% Confidence Interval 2.5 NTU
Upper 95% Confidence Interval 5.3 NTU
Defined in regulations as a flow-related parameter

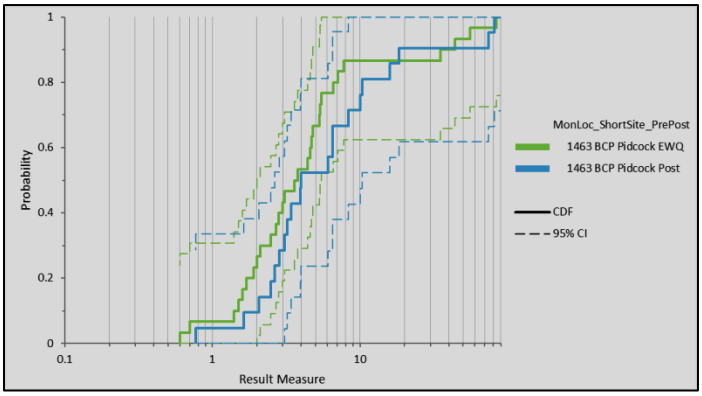






N	51

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	0.6	2.0	3.7	5.6	84.0	3.6
1463 BCP Pidcock Post	0.8	2.8	4.0	10.2	81.5	7.4



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	126.1	4.20
1463 BCP Pidcock Post	21	180.1	8.58

H statistic	1.39
X^2 approximation	1.39
DF	1
p-value	0.2392 [1]

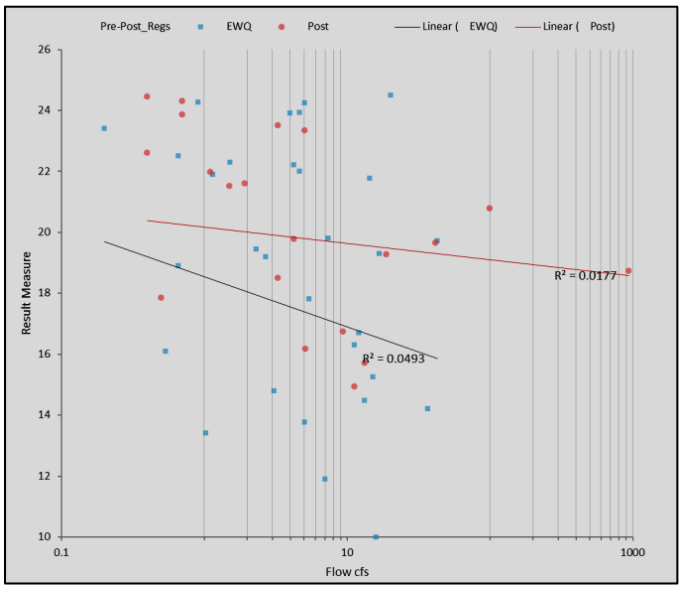
H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

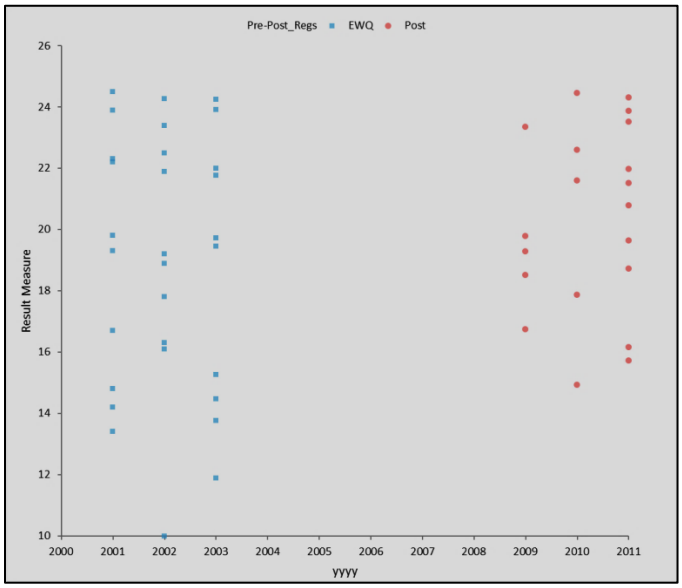
No water quality degradation is evident. Turbidity did not measurably change between the EWQ and post-EWQ periods. The post-EWQ median turbidity fell within the EWQ 95% confidence intervals of the median. In both data sets, the turbidity vs. flow relationship is positive, though the post-EWQ relationship is weak and driven by a single outlier sample taken during a major flood. Note that both concentration and flow is represented on logarithmic scales in all charts.

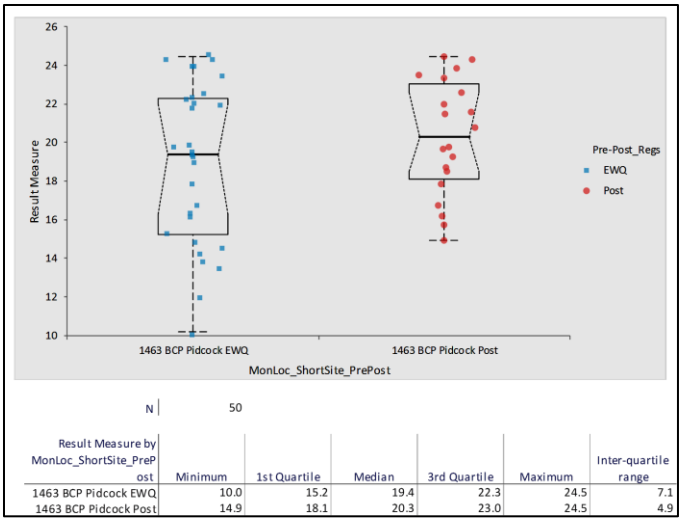
Chapter 3: 1463 BCP
Pidcock Creek, PA

Water Temperature, degrees C

Not included in DRBC Existing Water Quality rules

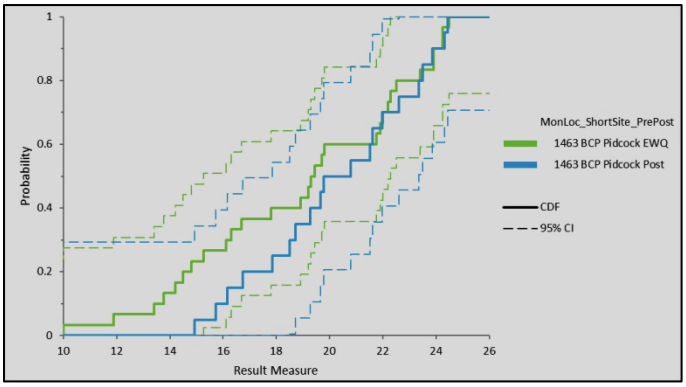






N	50

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1463 BCP Pidcock EWQ	10.0	15.2	19.4	22.3	24.5	7.1
1463 BCP Pidcock Post	14.9	18.1	20.3	23.0	24.5	4.9



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1463 BCP Pidcock EWQ	30	76.8	2.56
1463 BCP Pidcock Post	20	115.2	5.76

H statistic	0.90
X² approximation	0.90
DF	1
p-value	0.3418 [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 not related to flow in either data set. There were less cool temperatures in the post-EWQ data set. Note that flows are plotted on a logarithmic scale.