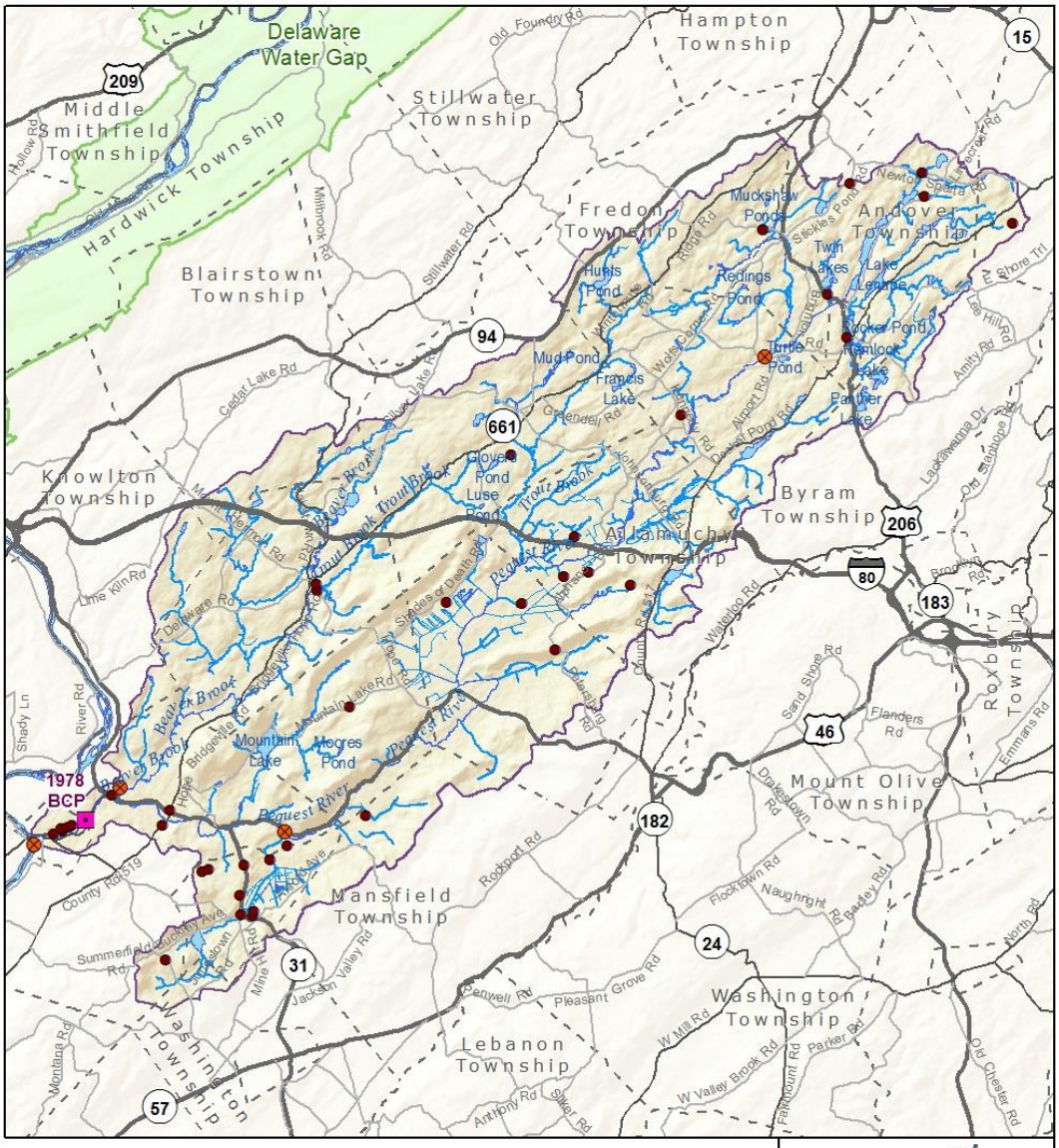
Chapter 21: 1978 BCP Pequest River, Warren & Sussex Counties, NJ



Pequest River

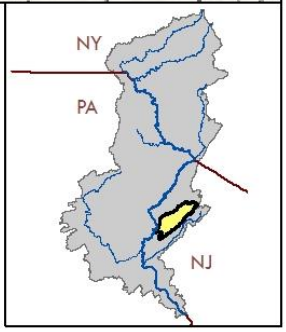
Drainage Area = 157.01 mi²

- Sampling Location
- NPDES
- Stream Gage
- Drainage Area
- NPS Boundary

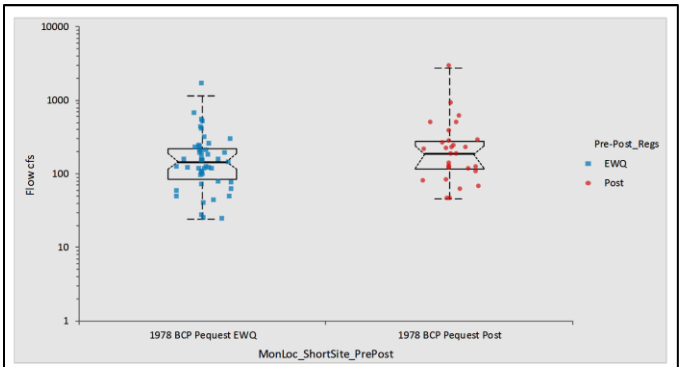
N

0 1 2 3 4 5 6 7 8

Miles



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



N	78

Flow cfs by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	24	85	146	221	1697	136
1978 BCP Pequest Post	46	115	185	281	2918	166

Median post-EWQ flow was 44 cfs higher than EWQ median flow, though this difference did not affect water quality analyses except those at extreme low flow conditions. The range of flow conditions sampled was also roughly equal, but the post-EWQ data are under-represented by values less than 46 cfs. This is taken into account in each water quality analysis, particularly for flow-related parameters.

Kruskal-Wallis test

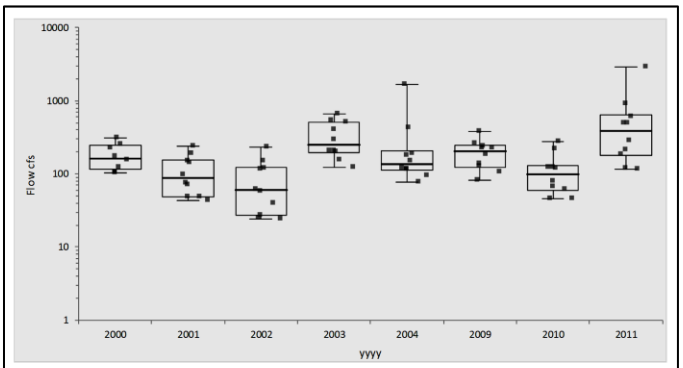
Flow cfs by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	48	344.0	7.17
1978 BCP Pequest Post	30	550.4	18.35

H statistic	1.74
X^2 approximation	1.74
DF	1
p-value	0.1868[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 Pequest River is a good-quality cold-water creek possessing naturally reproducing trout populations. The watershed was about 93% glaciated, there is some agriculture, and small towns comprise 4.5% of the watershed area. Overall watershed area is about 157 square miles, and it is about 58% forested. 93% of the watershed is underlain by carbonate bedrock, and limestone has a major effect upon water quality.

Upstream ICP: Delaware River at Belvidere 1978 ICP
Downstream ICP: Delaware River at Easton 1838 ICP



N	78

Flow cfs by yyyy	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
2000	104	115	164	244	308	129
2001	43	49	88	154	237	105
2002	24	27	60	124	230	97
2003	123	196	250	513	667	317
2004	77	114	135	210	1697	95
2009	81	124	204	245	379	120
2010	46	60	99	131	281	71
2011	116	182	392	640	2918	459

There are a few major dischargers in the Pequest watershed. There are NJDEP and USGS data available for comparison with DRBC results at this site. There is USGS gage 01446400 located upstream of the Orchard Road sampling site, and the gage is used for flow estimation by drainage area weighting.

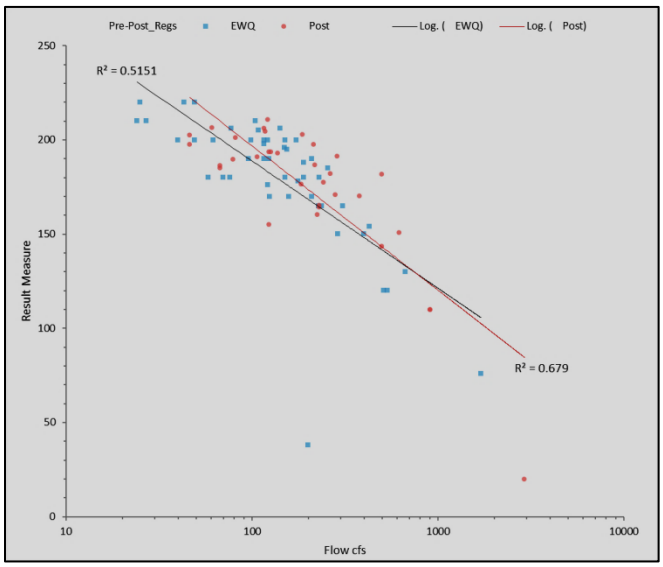
Annual May to September flow statistics associated with water quality measurements are plotted above. These are measurements or estimates associated with the time of each water quality sample. Mean annual flow is about 268 cfs; and harmonic mean flow is about 209 cfs (USGS Stream Stats retrieval, Feb. 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 harmonic mean flow conditions.

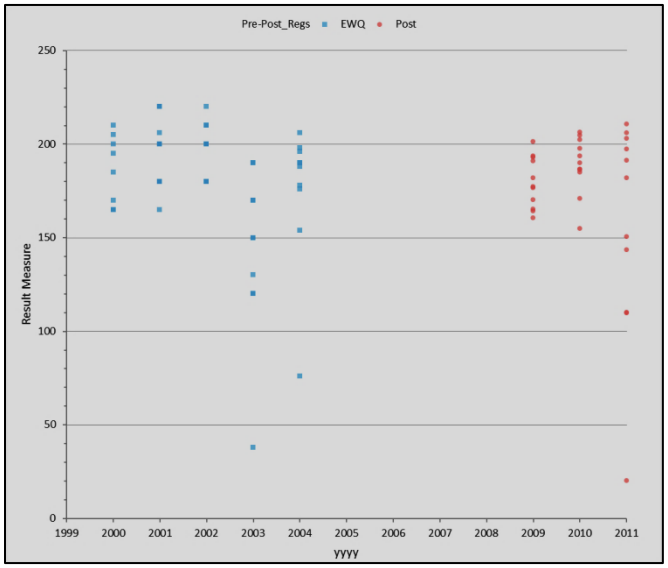
Chapter 21: 1978 BCP Pequest River, NJ

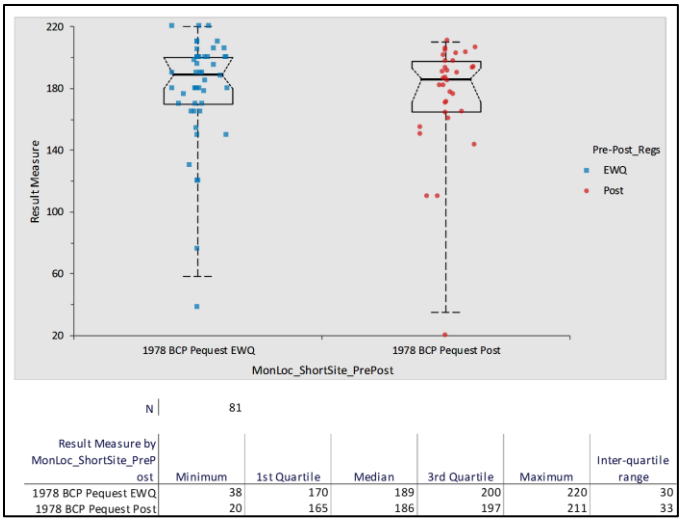
Alkalinity as CaCO3, Total mg/l

Existing Water Quality (Table 2F):

Median 189 mg/l
Lower 95% Confidence Interval 180 mg/l
Upper 95% Confidence Interval 200 mg/l
Defined in regulations as a flow-related parameter

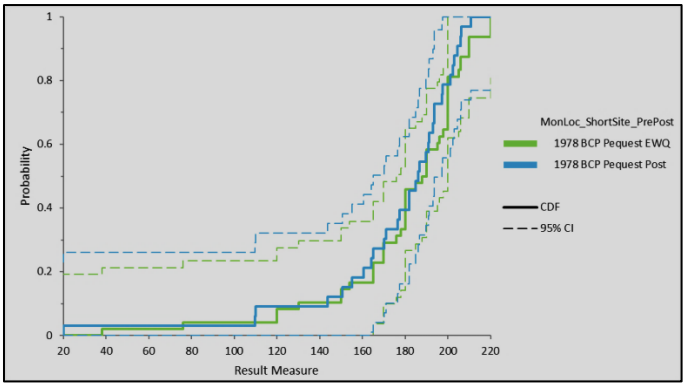






N	81

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	38	170	189	200	220	30
1978 BCP Pequest Post	20	165	186	197	211	33



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	48	81.4	1.70
1978 BCP Pequest Post	33	118.4	3.59

H statistic	0.36
X^2 approximation	0.36
DF	1
p-value	0.5477 [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.

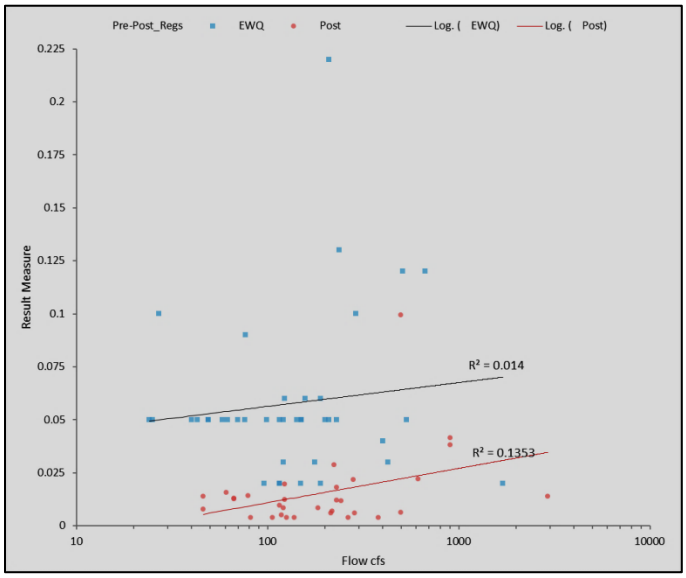
No water quality degradation is evident here. Alkalinity apparently did not measurably change between the EWQ and post-EWQ periods. However, sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions. Alkalinity is inversely related to flow in both data sets. Post-EWQ median alkalinity was within the EWQ 95% confidence intervals. Flow is plotted on a logarithmic scale.

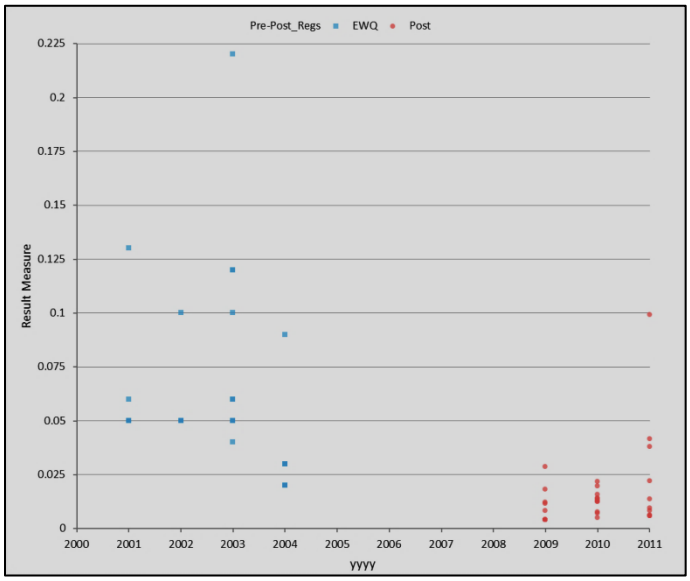
Chapter 21: 1978 BCP Pequest River, NJ

Ammonia Nitrogen as N, Total mg/l

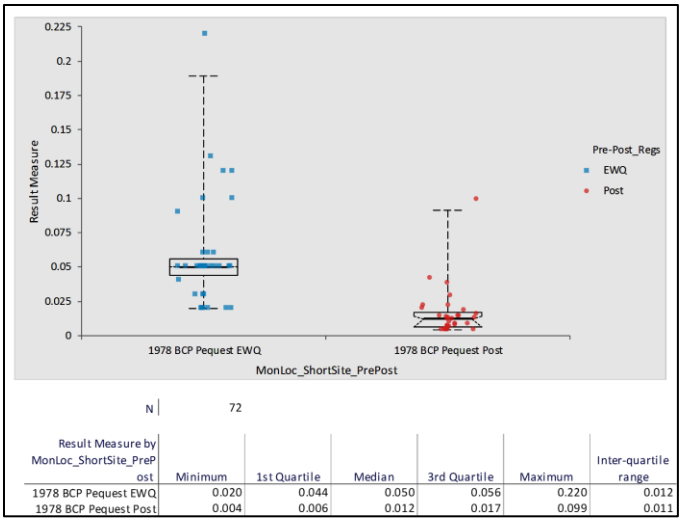
Existing Water Quality (Table 2F):

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



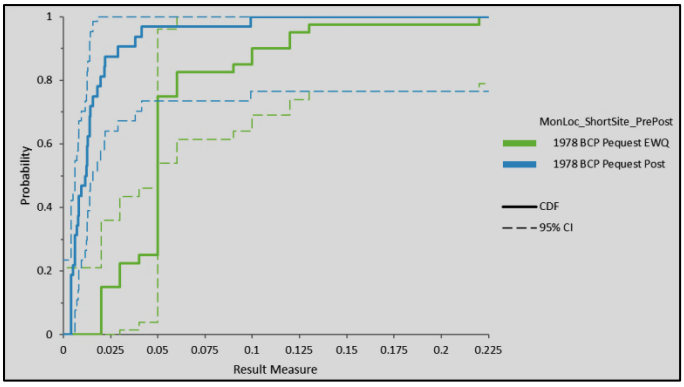


No water quality degradation is evident here. Ammonia concentrations appear to have declined. However, sources of analytical uncertainty included potential laboratory artifacts, detection limit differences, and under-representation of extreme low flow conditions. Post-EWQ median ammonia concentration was below the EWQ lower 95% confidence interval.



N	72

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	0.020	0.044	0.050	0.056	0.220	0.012
1978 BCP Pequest Post	0.004	0.006	0.012	0.017	0.099	0.011



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	40	8094.0	202.35
1978 BCP Pequest Post	32	10117.5	316.17

H statistic	42.54
X^2 approximation	42.54
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.

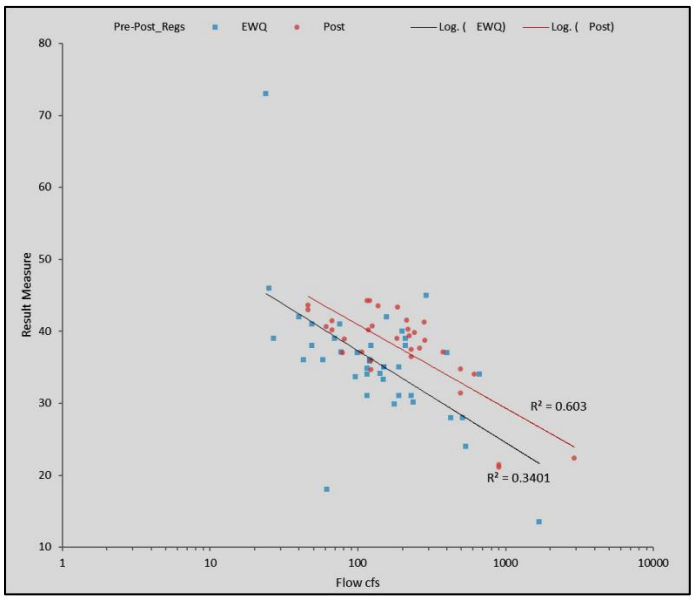
Ammonia is unrelated to flow in both data sets. Flow is plotted on logarithmic scale. EWQ data contained 27/40 undetected results, which interfered with calculation of the median. Because of this EWQ was defined at "less than 0.05 mg/l" in DRBC rules. EWQ results above the detection limit were variable. Under 2009-2011 lower detection levels there were still 9/32 undetected results, and no interference with the median. Post-EWQ results above detection levels were less variable and only one result was higher than 0.04 mg/l. Ambient concentrations appear to have improved (unless this is a laboratory artifact), but true ammonia concentrations are now better known in the Pequest River. USGS/NJ post-EWQ data were comparable with results.

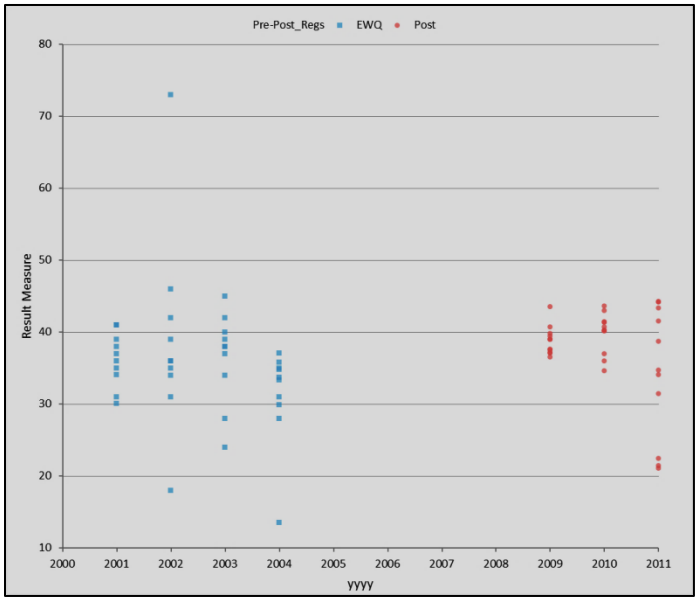
Chapter 21: 1978 BCP Pequest River, NJ

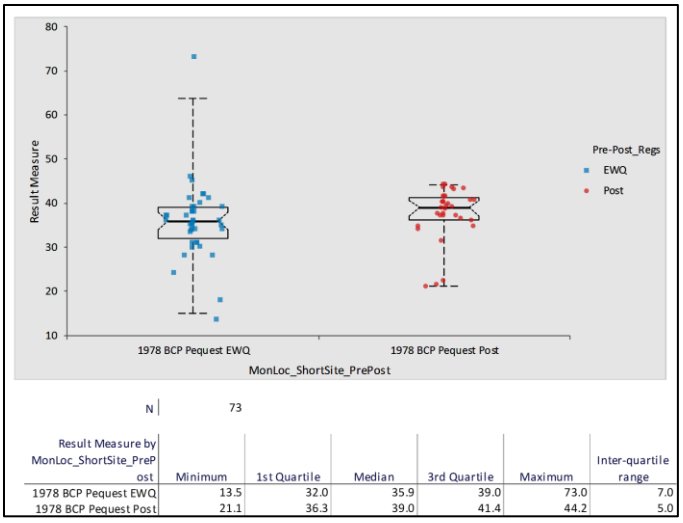
Chloride, Total mg/l

Existing Water Quality (Table 2F):

Median 35.9 mg/l
Lower 95% Confidence Interval 34.0 mg/l
Upper 95% Confidence Interval 38.0 mg/l
Defined in regulations as a flow-related parameter

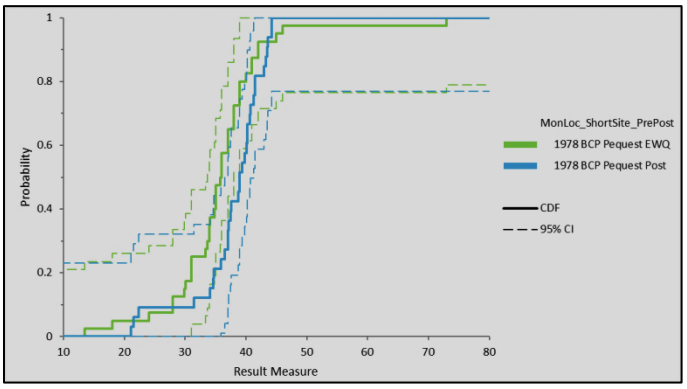






N	73

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	13.5	32.0	35.9	39.0	73.0	7.0
1978 BCP Pequest Post	21.1	36.3	39.0	41.4	44.2	5.0



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	40	1155.6	28.89
1978 BCP Pequest Post	33	1400.8	42.45

H statistic	5.68
X^2 approximation	5.68
DF	1
p-value	0.0171 [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.

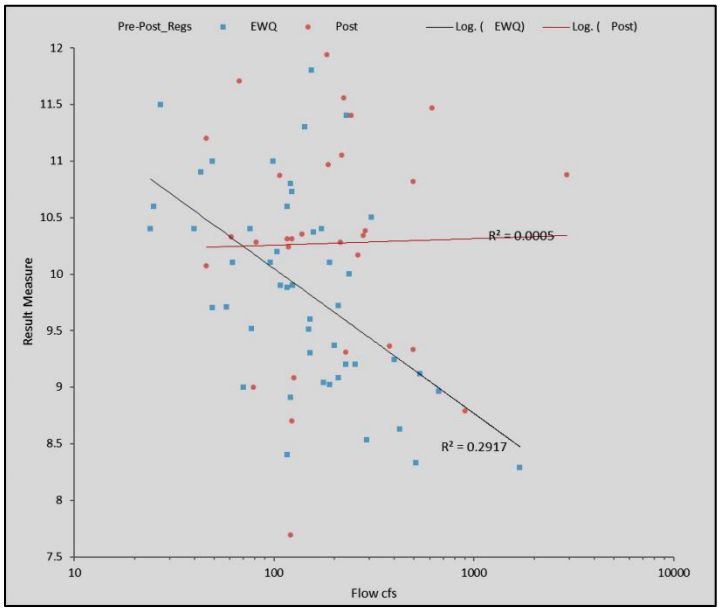
Water quality degradation is evident here. Chloride concentrations apparently rose by about 3 mg/l between the two periods. However, sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions. Post-EWQ median concentration rose above the EWQ upper 95% confidence interval. Chloride concentration is inversely related to flow in both data sets. Flow is plotted on a logarithmic scale. USGS measured dissolved chloride while DRBC measured total chloride. Even so, there were insufficient data to show any change in USGS dissolved chloride concentrations.

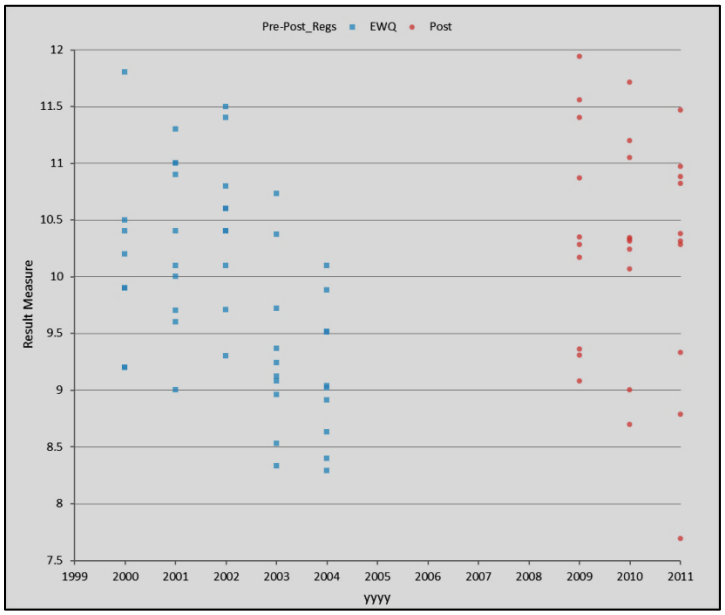
Chapter 21: 1978 BCP Pequest River, NJ

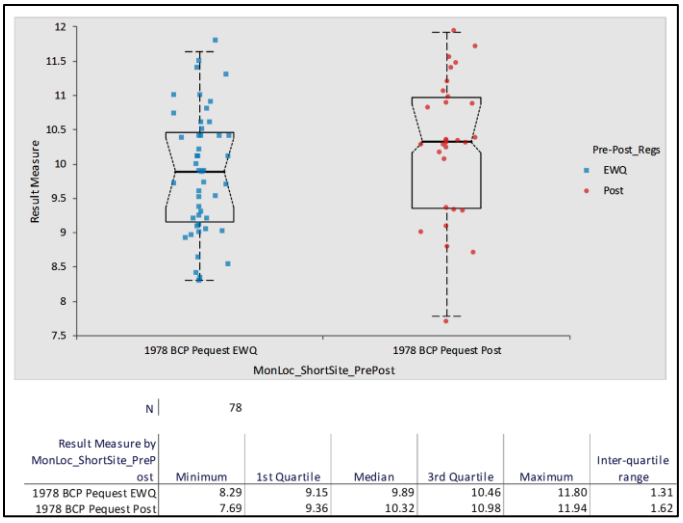
Dissolved Oxygen (DO) mg/l

Existing Water Quality (Table 2F):

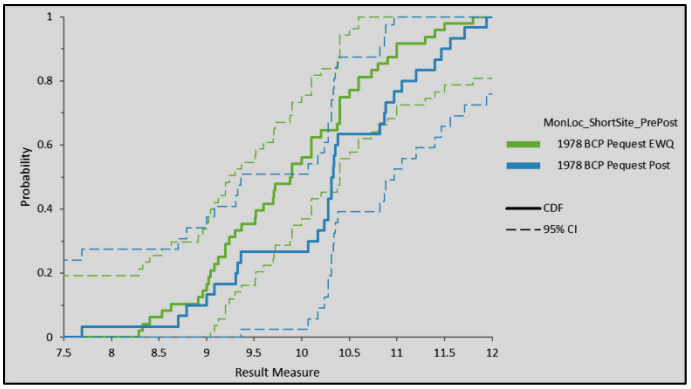
Median 9.89 mg/l
Lower 95% Confidence Interval 9.37 mg/l
Upper 95% Confidence Interval 10.37 mg/l







N	78					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	8.29	9.15	9.89	10.46	11.80	1.31
1978 BCP Pequest Post	7.69	9.36	10.32	10.98	11.94	1.62



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	48	671.3	13.98
1978 BCP Pequest Post	30	1074.0	35.80

H statistic	3.40
X^2 approximation	3.40
DF	1
p-value	0.0652 [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.

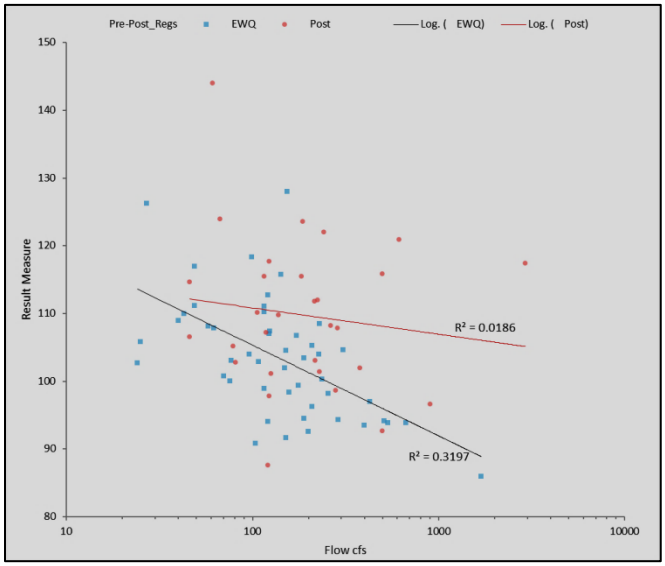
No water quality degradation is evident here. Dissolved oxygen concentrations increased slightly between the EWQ and Post-EWQ periods, but not significantly. There were no known sources of analytical uncertainty in these data. Post-EWQ median DO concentration was near the upper EWQ 95% confidence interval. DO concentration is unrelated to flow in both data sets. Flow is plotted on a logarithmic scale. USGS data, though less numerous (n=10 EWQ, n=11 post-EWQ), indicated a similar increase and were comparable to DRBC results. Both data sets are mid-day grab sample measurements, so they represent maximum daily DO concentrations.

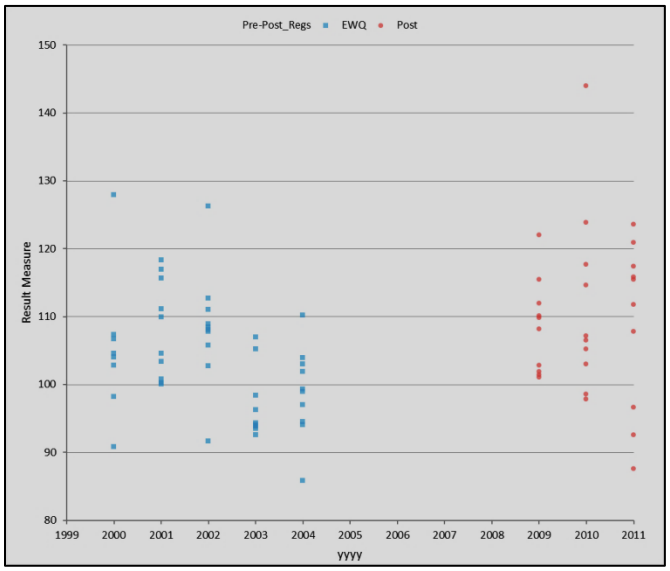
Chapter 21: 1978 BCP Pequest River, NJ

Dissolved Oxygen Saturation %

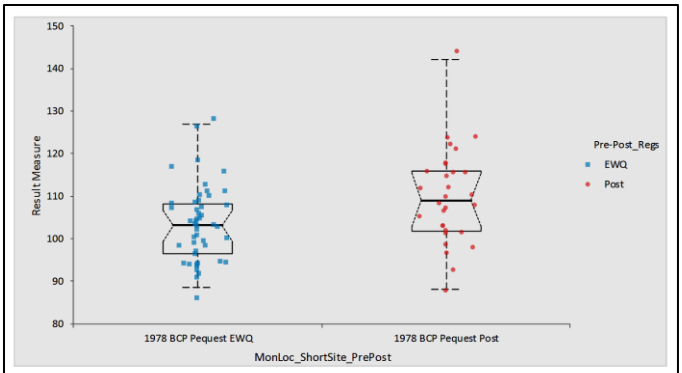
Existing Water Quality (Table 2F):

Median 103%
Lower 95% Confidence Interval 99%
Upper 95% Confidence Interval 107%



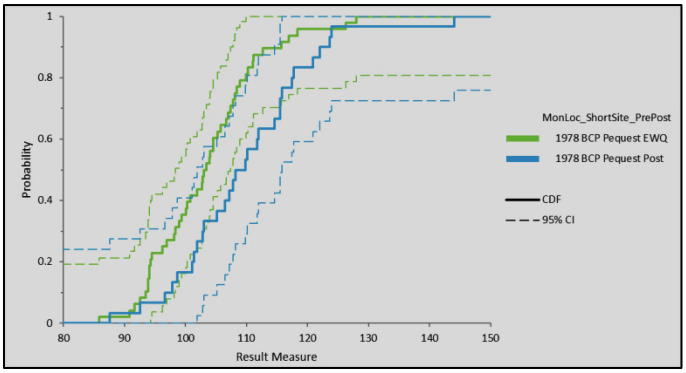


No water quality degradation is evident here. DO saturation increased. There were no known sources of analytical uncertainty in these data. Post-EWQ median DO saturation rose above the upper EWQ 95% confidence interval. DO saturation is not usually flow-related, but there is a weakly inverse relationship in the EWQ data not shown in post-EWQ data.



N	78

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	86	97	103	108	128	12
1978 BCP Pequest Post	88	102	109	116	144	14



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	48	1302.1	27.13
1978 BCP Pequest Post	30	2083.3	69.44

H statistic	6.59
X^2 approximation	6.59
DF	1
p-value	0.0102[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.

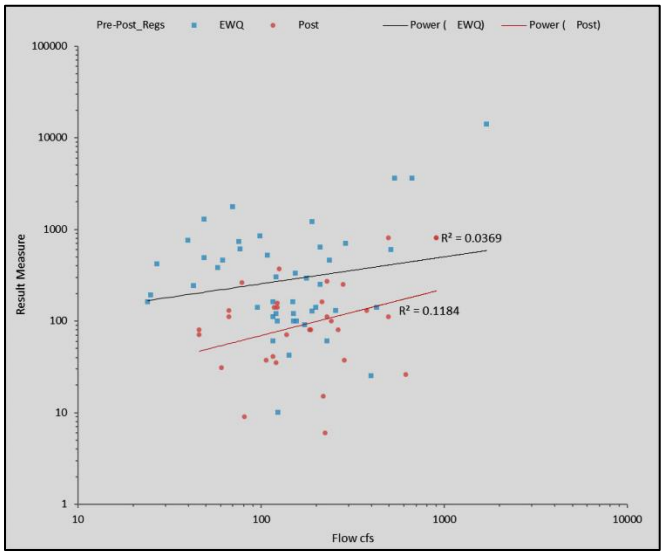
Two possibilities can explain the difference: less organic pollution (less oxygen demand) or increased algal and aquatic plant activity at this site. There were no measurements below 80%, so no concern about excess oxygen-reducing material. However, several values over 120% indicated super-saturation conditions associated with high algal production. As a rule of thumb, 80-120% is considered "normal"; in that range a balance exists between oxygen demand and supply. This location on the Pequest River is a shallow, wide channel that receives abundant sunlight, and abundant algae and aquatic plants. Perhaps there were more aquatic plants in the post-EWQ period, or less storms to scour away plant growth. USGS data were available and corroborated DRBC results.

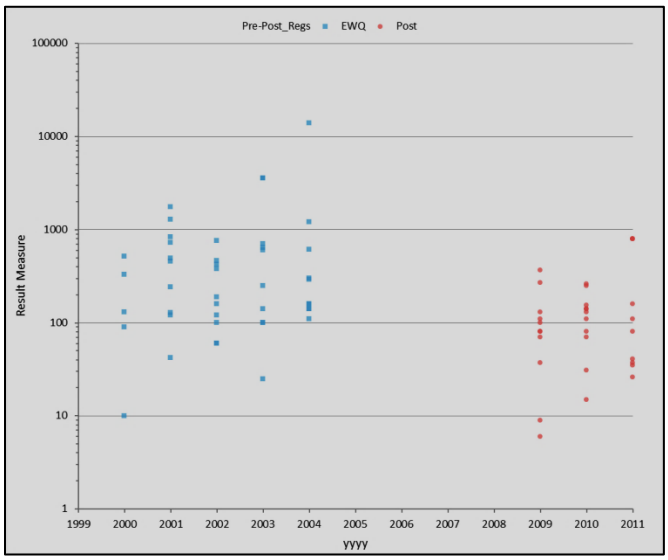
Chapter 21: 1978 BCP Pequest River, NJ

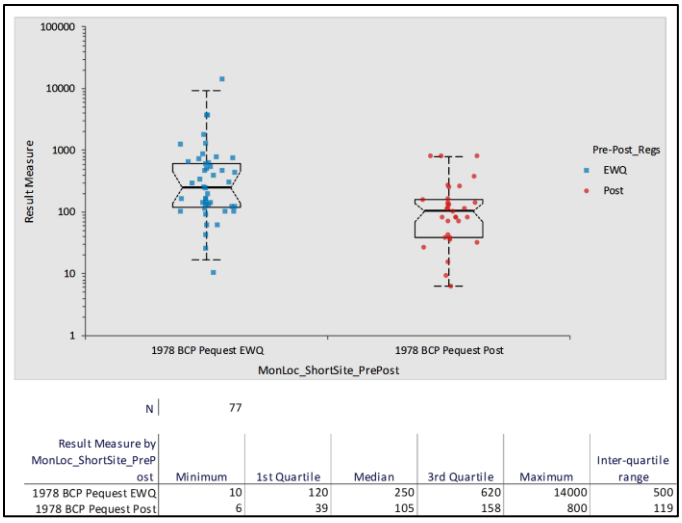
Enterococcus colonies/100 ml

Existing Water Quality (Table 2F):

Median 250/100 ml
Lower 95% Confidence Interval 140/100 ml
Upper 95% Confidence Interval 460/100 ml

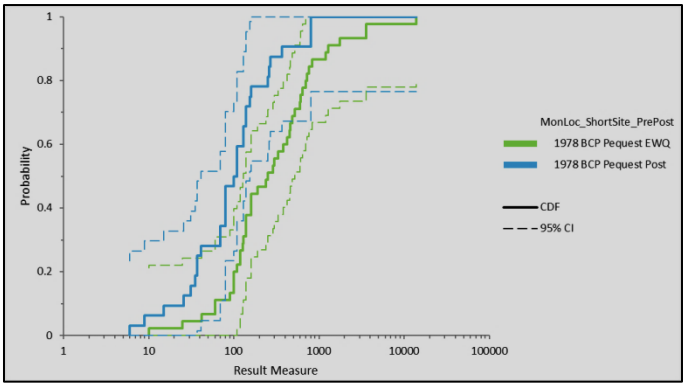






N	77

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	10	120	250	620	14000	500
1978 BCP Pequest Post	6	39	105	158	800	119



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	45	2553.8	56.75
1978 BCP Pequest Post	32	3591.3	112.23

H statistic	12.29
X^2 approximation	12.29
DF	1
p-value	0.0005 [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.

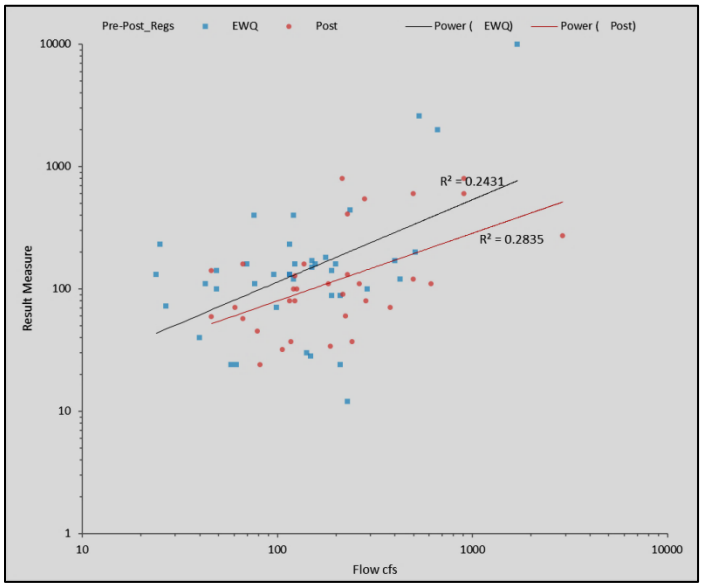
No water quality degradation is evident here. Enterococci apparently declined between the two periods. However, sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions. Enterococcus concentrations are unrelated to flow in both data sets. Concentrations and flows are plotted on logarithmic scale, and regressions are power relationships. Post-EWQ median enterococcus concentrations fell below the lower EWQ 95% confidence interval. USGS and NJDEP data were available for comparison with DRBC results. Most of the USGS/NJDEP data were taken during the EWQ period, and compared well with DRBC results.

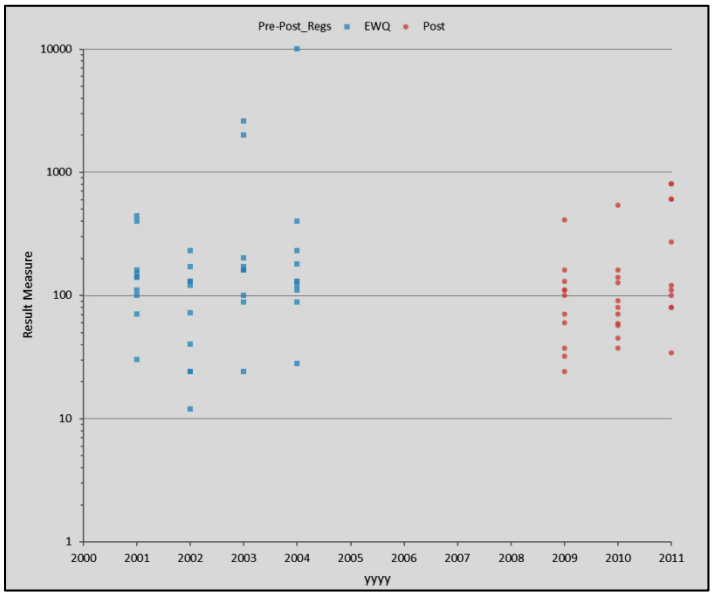
Chapter 21: 1978 BCP Pequest River, NJ

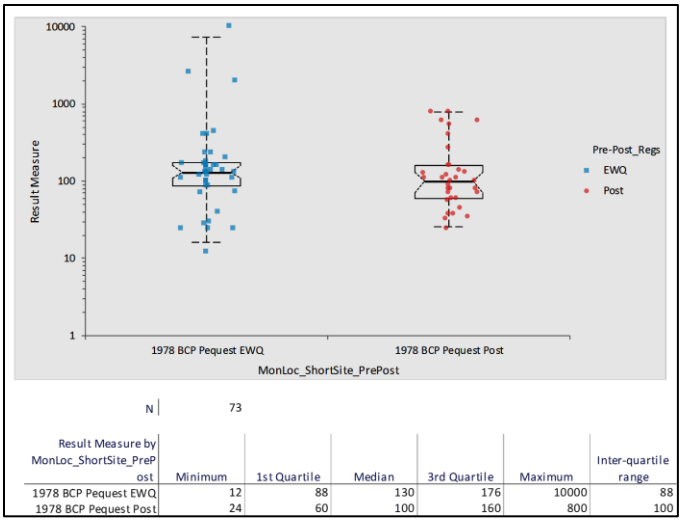
Escherichia coli colonies/100 ml

Existing Water Quality (Table 2F):

Median 130/100 ml
Lower 95% Confidence Interval 110/100 ml
Upper 95% Confidence Interval 160/100 ml

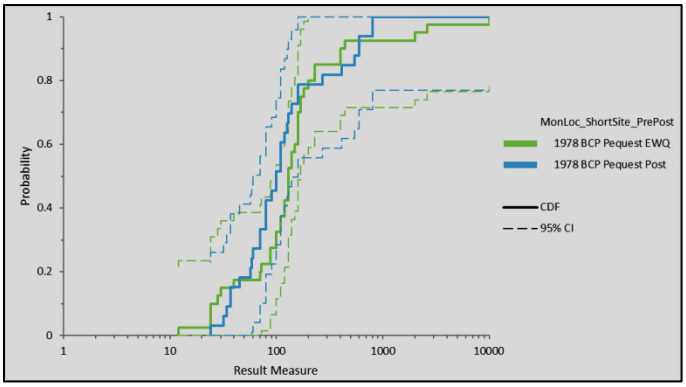






N	73

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	12	88	130	176	10000	88
1978 BCP Pequest Post	24	60	100	160	800	100



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	40	278.3	6.96
1978 BCP Pequest Post	33	337.3	10.22

H statistic	1.37
X^2 approximation	1.37
DF	1
p-value	0.2418[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.

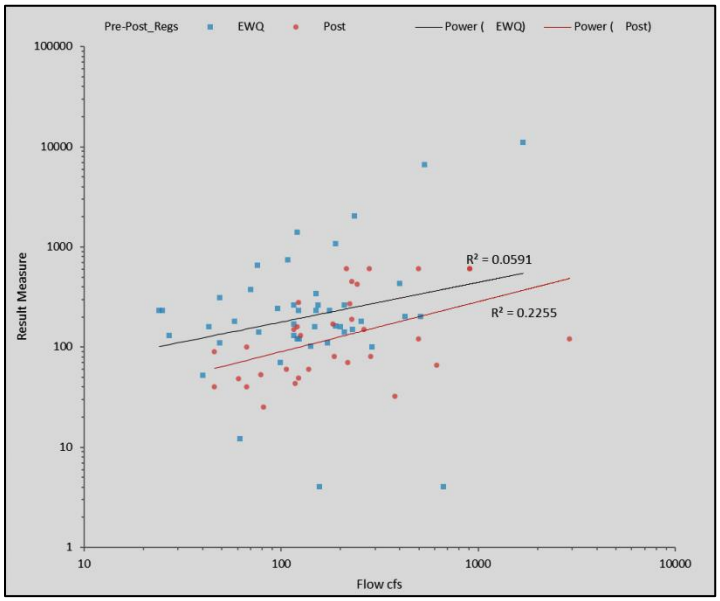
No water quality degradation is evident here. E. coli concentrations did not measurably change between the two periods. However, sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions. Four high values were laboratory truncated to upper quantification limits, but did not affect the comparison. Post-EWQ median E. coli fell below the lower EWQ 95% confidence interval, but not significantly. Concentrations and flows are plotted on logarithmic scale, and regressions are power relationships. E. coli concentrations are weakly related to flow in both data sets.

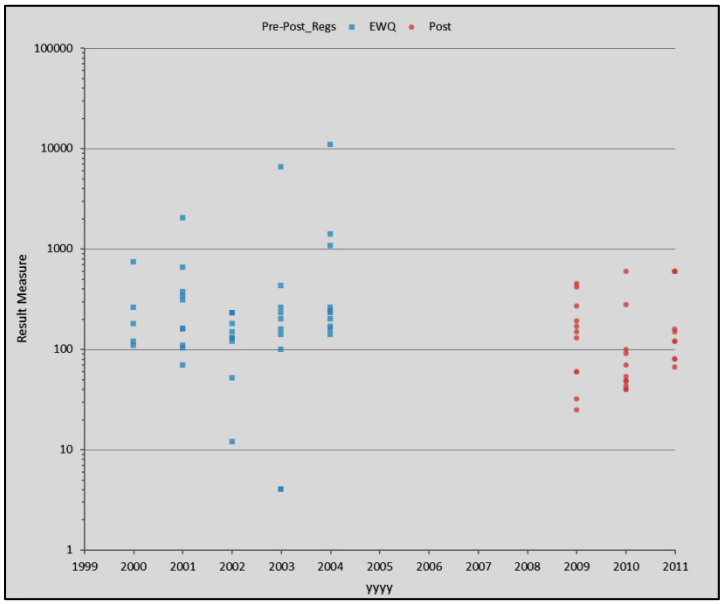
Chapter 21: 1978 BCP Pequest River, NJ

Fecal coliform colonies/100 ml

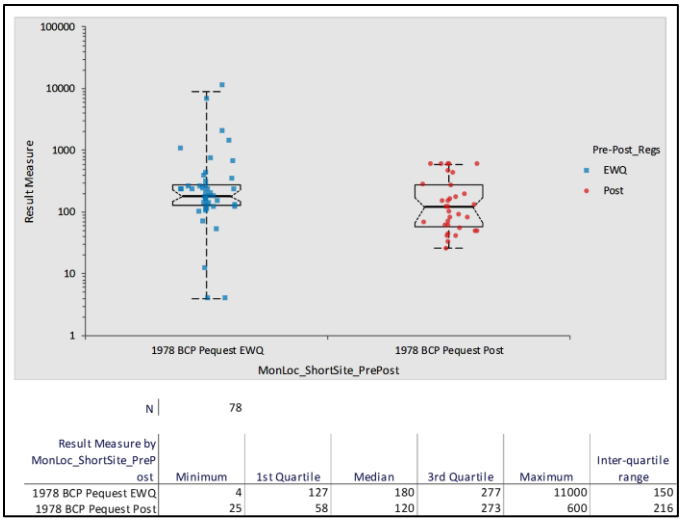
Existing Water Quality (Table 2F):

Median 180/100 ml
Lower 95% Confidence Interval 150/100 ml
Upper 95% Confidence Interval 230/100 ml



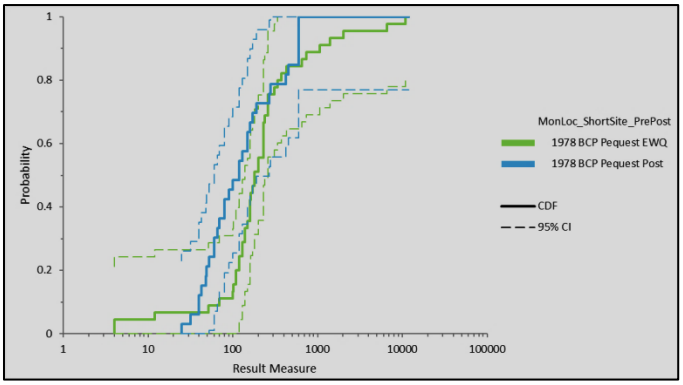


No water quality degradation is evident here. Fecal coliform concentrations apparently declined between the two periods. However, sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions.



N	78

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	4	127	180	277	11000	150
1978 BCP Pequest Post	25	58	120	273	600	216



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	45	1110.1	24.67
1978 BCP Pequest Post	33	1513.7	45.87

H statistic	5.11
X^2 approximation	5.11
DF	1
p-value	0.0237 [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.

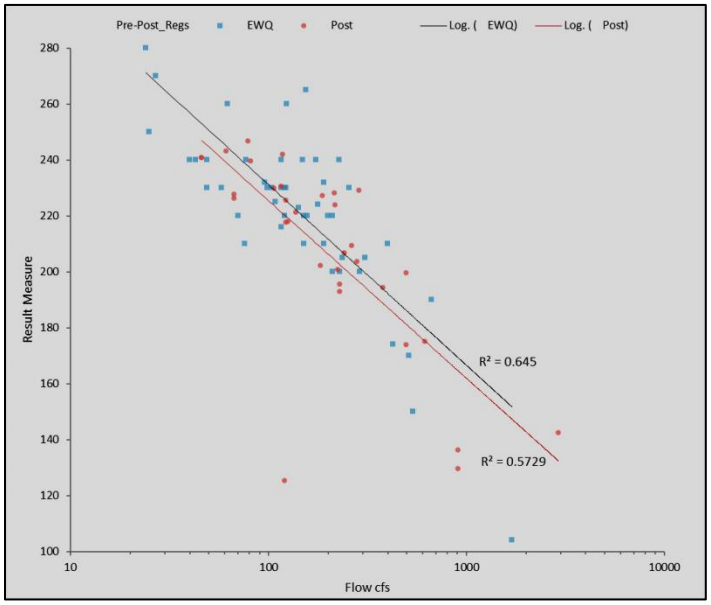
Five high values were laboratory truncated to upper quantification limits, but did not affect the comparison above the 85th percentile. Fecal coliform concentrations are unrelated to flow in the EWQ data set, but weakly related to flow in the post-EWQ data set. Post-EWQ median concentrations fell below the lower EWQ 95% confidence interval. Concentrations and flows are plotted on logarithmic scale, and regressions are power relationships. NJDEP and USGS results verify those of DRBC.

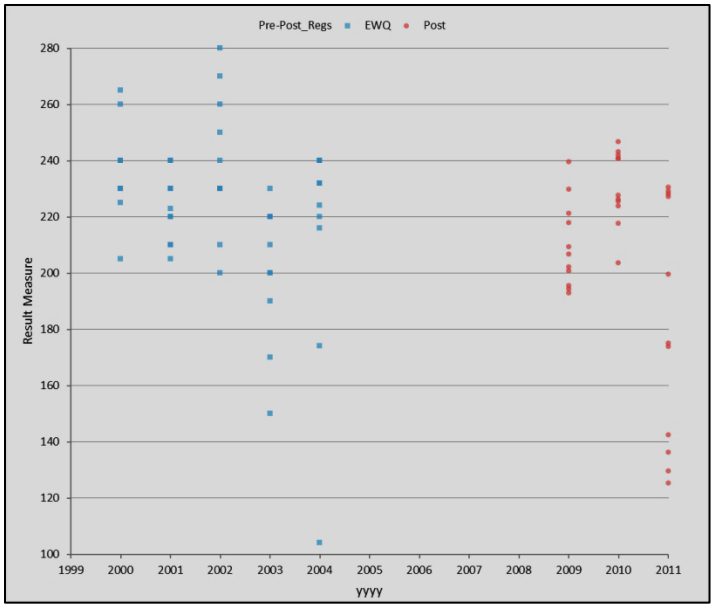
Chapter 21: 1978 BCP Pequest River, NJ

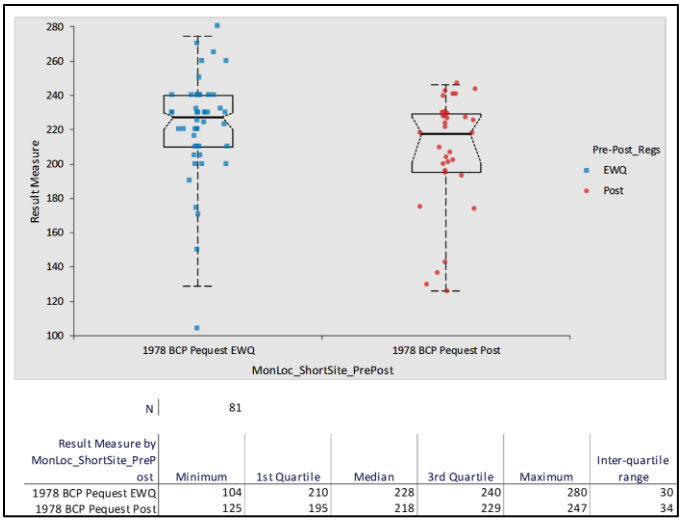
Hardness as CaCO3, Total mg/l

Existing Water Quality (Table 2F):

Median 228 mg/l
Lower 95% Confidence Interval 220 mg/l
Upper 95% Confidence Interval 230 mg/l
Defined in regulations as a flow-related parameter

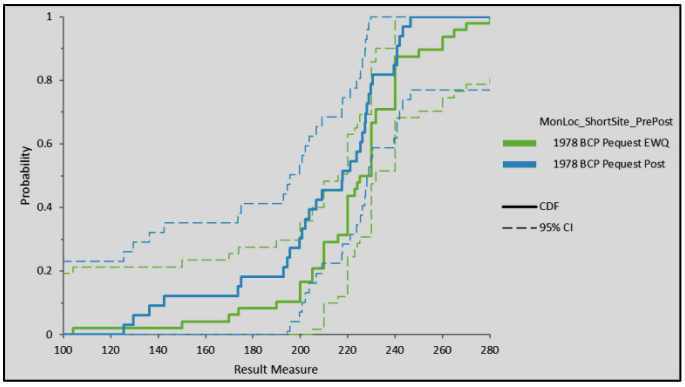






N	81

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	104	210	228	240	280	30
1978 BCP Pequest Post	125	195	218	229	247	34



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	48	833.3	17.36
1978 BCP Pequest Post	33	1212.1	36.73

H statistic	3.70
X^2 approximation	3.70
DF	1
p-value	0.0543 [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.

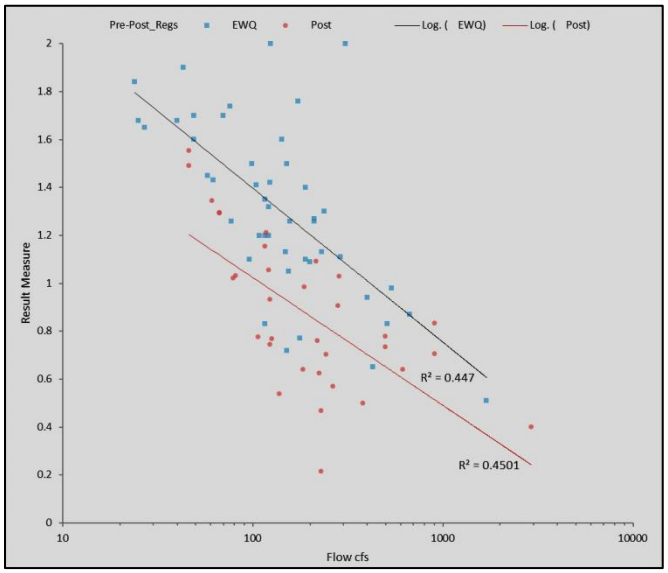
No water quality degradation is evident here. Hardness apparently did not measurably change between the EWQ and post-EWQ periods. However, sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions. Hardness is inversely related to flow in both data sets. Post-EWQ median hardness fell below the lower EWQ 95% confidence intervals, but not significantly and the differences were in low flow conditions. Flow is plotted on a logarithmic scale. USGS data were comparable with DRBC results.

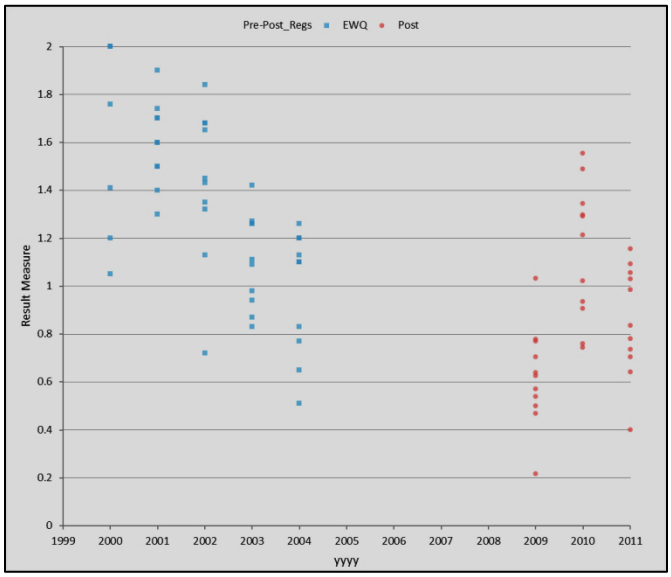
Chapter 21: 1978 BCP Pequest River, NJ

Nitrate + Nitrite as N, Total mg/l

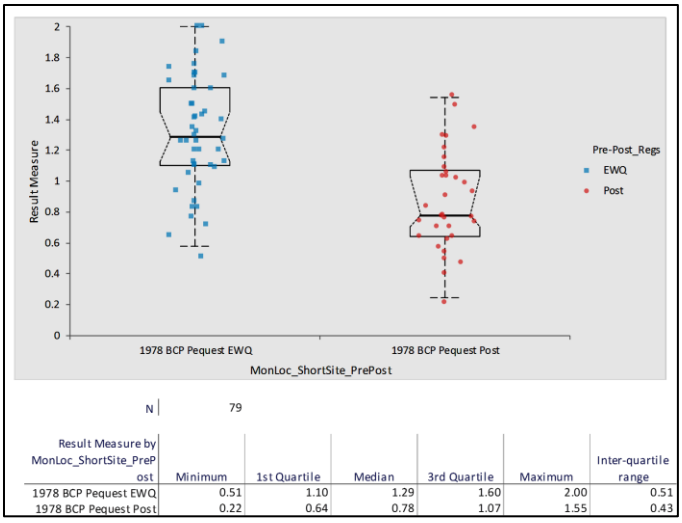
Existing Water Quality (Table 2F, as Nitrate only):

Median 1.29 mg/l
Lower 95% Confidence Interval 1.13 mg/l
Upper 95% Confidence Interval 1.45 mg/l



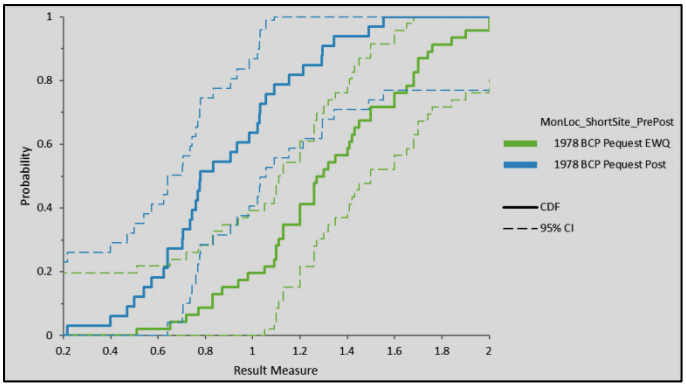


No water quality degradation is evident here. Nitrate concentrations apparently declined between the EWQ and post-EWQ periods. However, sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions. Nitrate is inversely related to flow in both data sets, and should have been designated as such in DRBC rules.



N	79

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	0.51	1.10	1.29	1.60	2.00	0.51
1978 BCP Pequest Post	0.22	0.64	0.78	1.07	1.55	0.43



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	46	5071.5	110.25
1978 BCP Pequest Post	33	7069.4	214.22

H statistic	23.06
X^2 approximation	23.06
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.

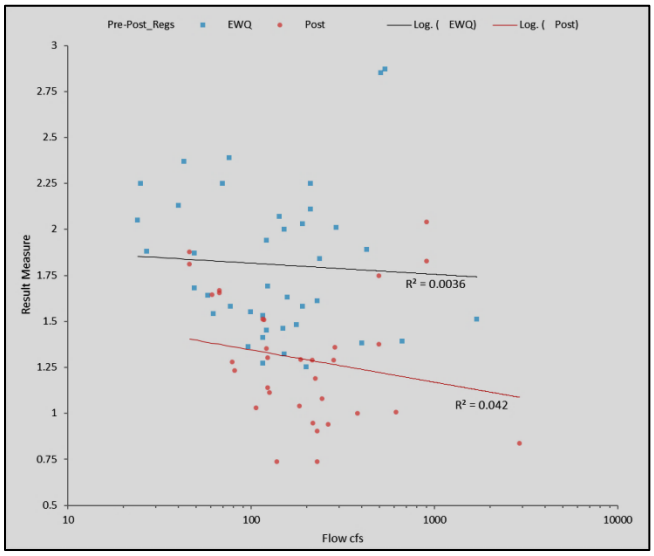
Post-EWQ median concentrations fell below the lower EWQ 95% confidence interval. Post-EWQ nitrate + nitrite concentrations were assumed equivalent with EWQ nitrate concentrations since EWQ nitrite concentrations were never detected. USGS data compared with results, with a similar decline. With no undetected results in either data set, concentrations are sufficiently high in the Pequest River that detection limit differences did not interfere with data analysis.

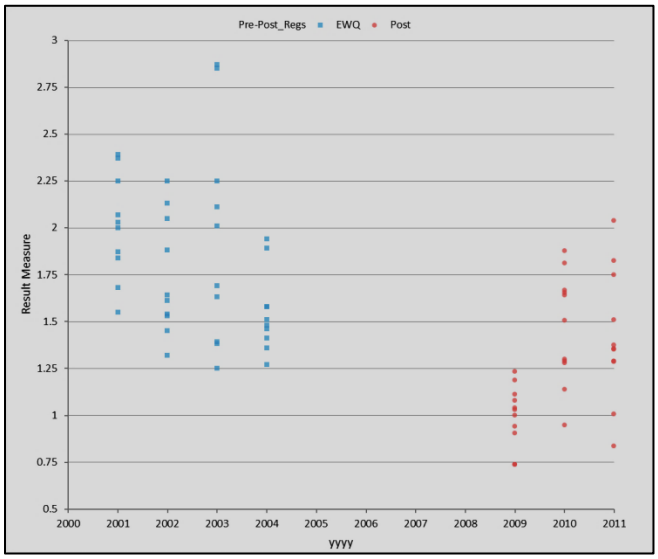
Chapter 21: 1978 BCP Pequest River, NJ

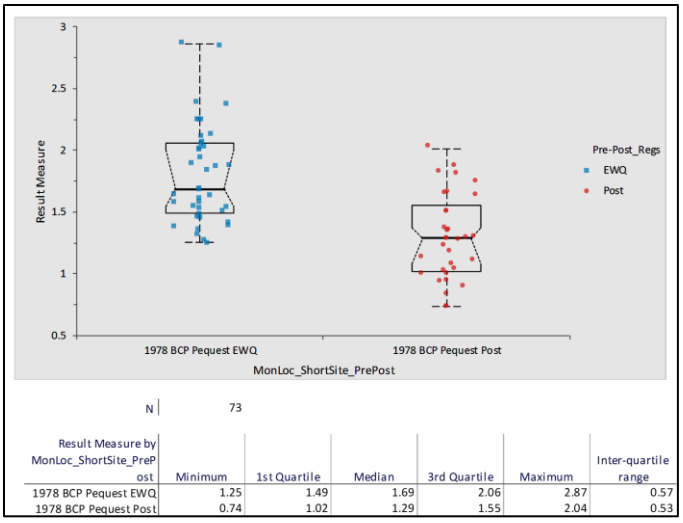
Nitrogen as N, Total (TN) mg/l

Existing Water Quality (Table 2F):

Median 1.69 mg/l
Lower 95% Confidence Interval 1.54 mg/l
Upper 95% Confidence Interval 2.00 mg/l

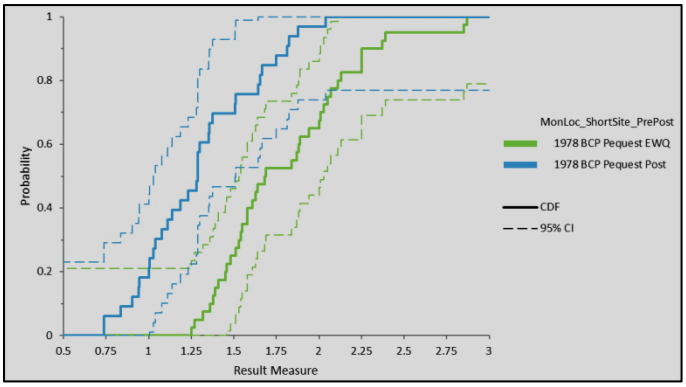






N	73

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	1.25	1.49	1.69	2.06	2.87	0.57
1978 BCP Pequest Post	0.74	1.02	1.29	1.55	2.04	0.53



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	40	5006.4	125.16
1978 BCP Pequest Post	33	6068.4	183.89

H statistic	24.60
X^2 approximation	24.60
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.

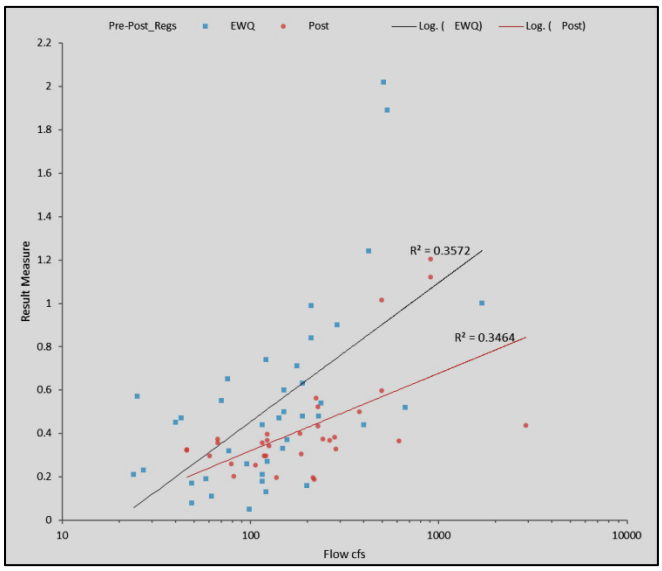
No water quality degradation is evident here. Total Nitrogen concentrations apparently declined between the EWQ and post-EWQ periods. However, sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions. TN is unrelated to flow in both data sets. USGS data confirmed and were very similar to DRBC results. Post-EWQ median TN concentration fell below the lower EWQ 95% confidence interval.

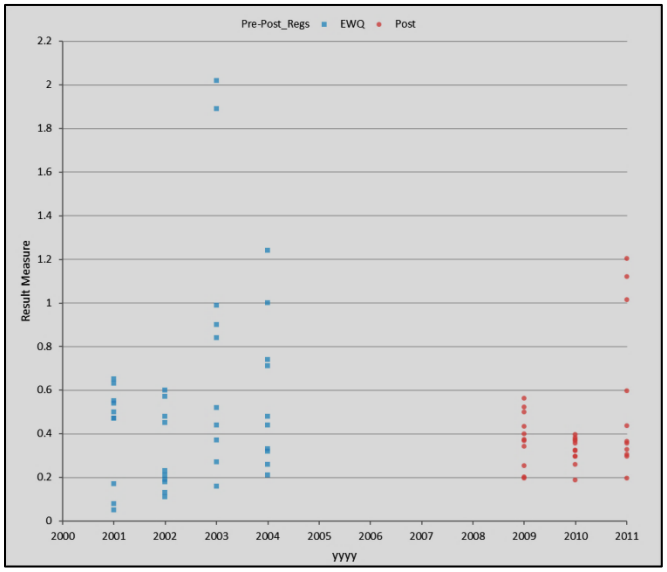
Chapter 21: 1978 BCP Pequest River, NJ

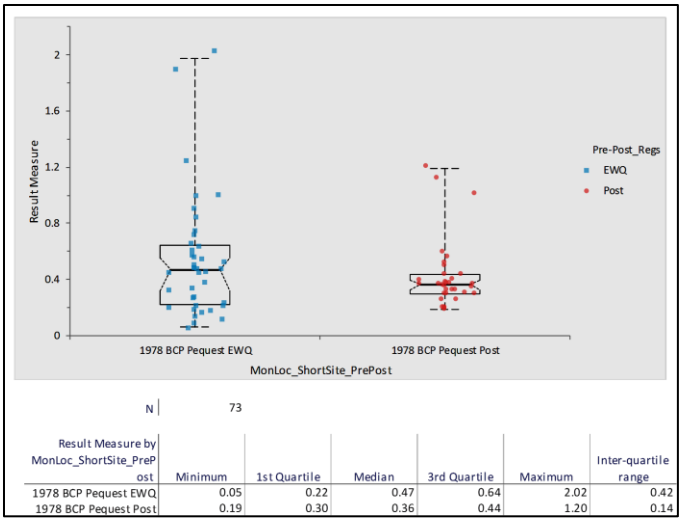
Nitrogen, Kjeldahl as N, Total (TKN) mg/l

Existing Water Quality (Table 2F):

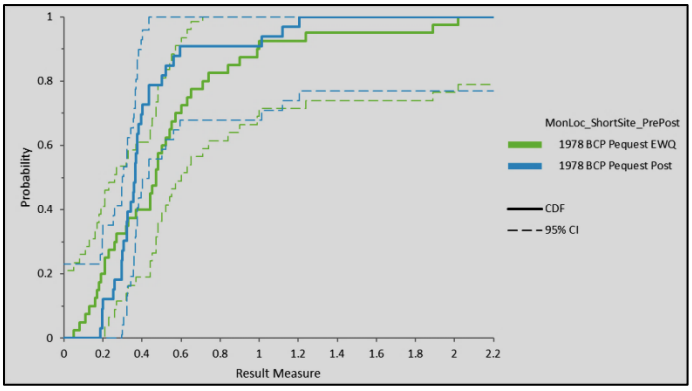
Median 0.47 mg/l
Lower 95% Confidence Interval 0.32 mg/l
Upper 95% Confidence Interval 0.55 mg/l
Defined in regulations as a flow-related parameter







N	73					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	0.05	0.22	0.47	0.64	2.02	0.42
1978 BCP Pequest Post	0.19	0.30	0.36	0.44	1.20	0.14



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	40	230.4	5.76
1978 BCP Pequest Post	33	279.3	8.46

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.

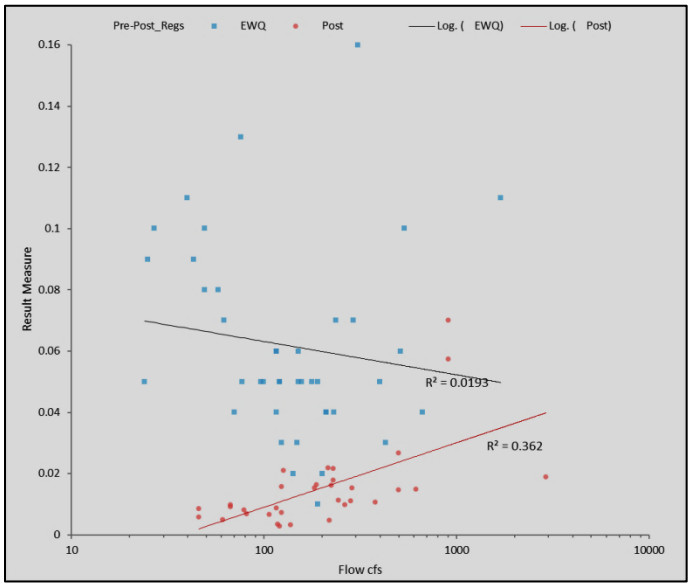
No water quality degradation is evident here. TKN concentrations apparently declined between the EWQ and post-EWQ periods, but not significantly. Sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions. The post-EWQ range of values was narrower. TKN concentration is weakly related to flow in both data sets. Post-EWQ median TKN fell near the lower EWQ 95% confidence interval. There were too few USGS data to confirm DRBC results.

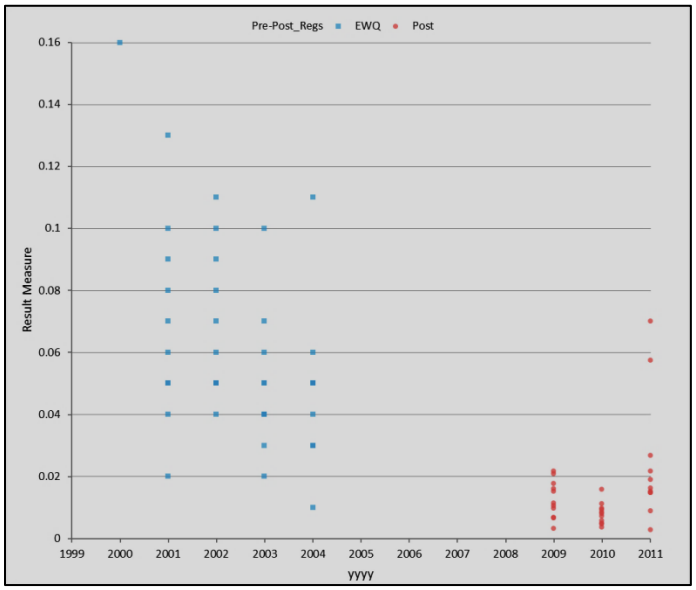
Chapter 21: 1978 BCP Pequest River, NJ

Orthophosphate as P, Total mg/l (OP)

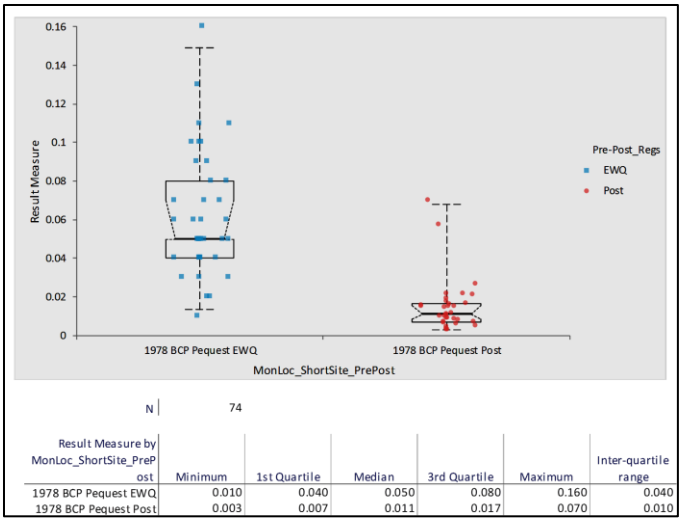
Existing Water Quality (Table 2F):

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



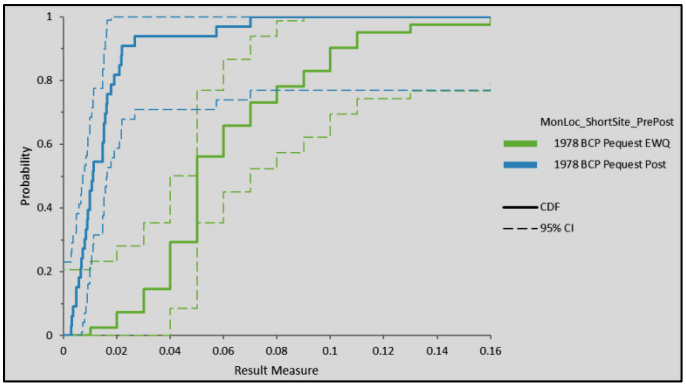


No water quality degradation is evident here. OP concentrations apparently declined between the EWQ and post-EWQ periods. However, sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions.



N	74

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	0.010	0.040	0.050	0.080	0.160	0.040
1978 BCP Pequest Post	0.003	0.007	0.011	0.017	0.070	0.010



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	41	8765.9	213.80
1978 BCP Pequest Post	33	10890.9	330.03

H statistic	42.68
X^2 approximation	42.68
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.

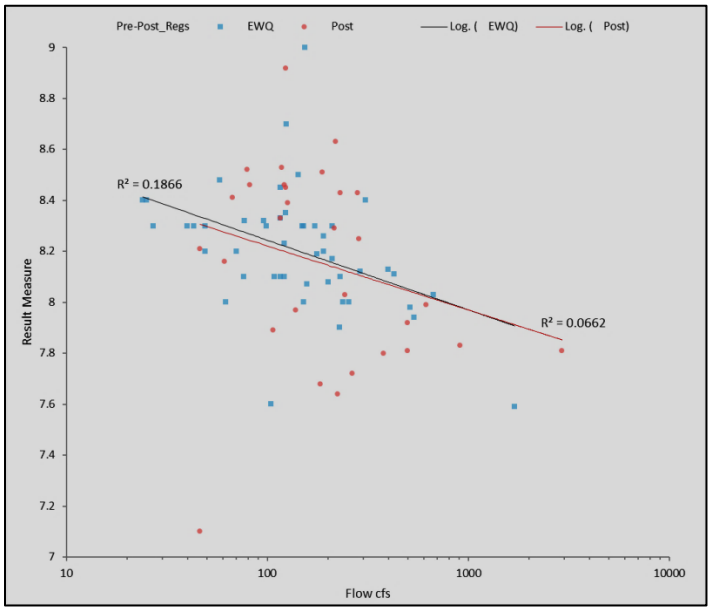
Orthophosphate is unrelated to flow in both data sets. Post-EWQ median orthophosphate fell below the lower EWQ 95% confidence interval. There was no interference by detection limits in either data set, as only a single result was below detection levels. USGS measures dissolved orthophosphate while DRBC measures total orthophosphate, but results were comparable. USGS data were most similar to DRBC post-EWQ results. DRBC EWQ data were more variable, wider-ranging, and generally higher in concentration.

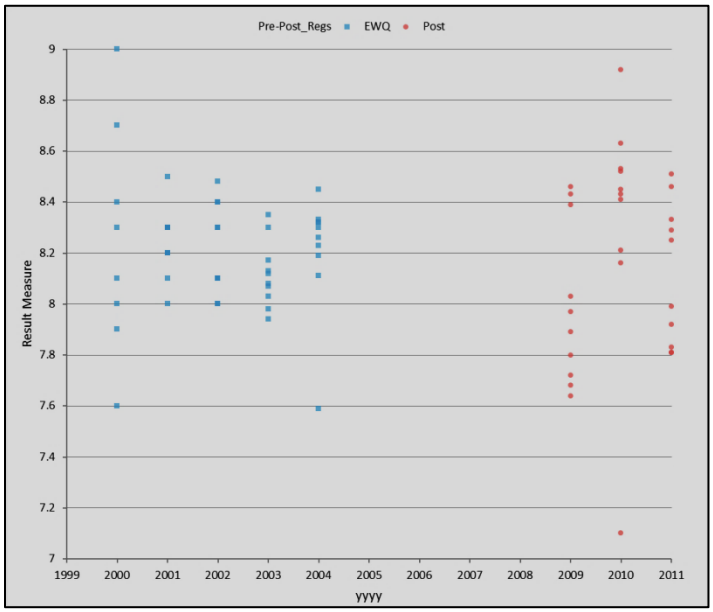
Chapter 21: 1978 BCP Pequest River, NJ

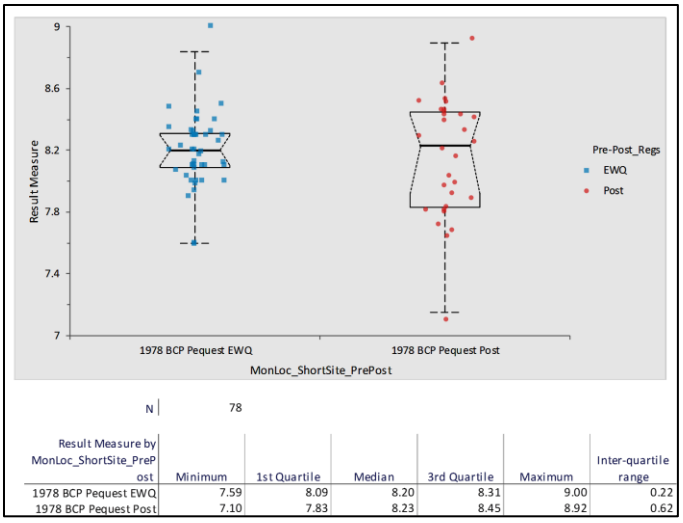
pH

Existing Water Quality (Table 2F):

Median 8.20 standard units
Lower 95% Confidence Interval 8.10 standard units
Upper 95% Confidence Interval 8.30 standard units

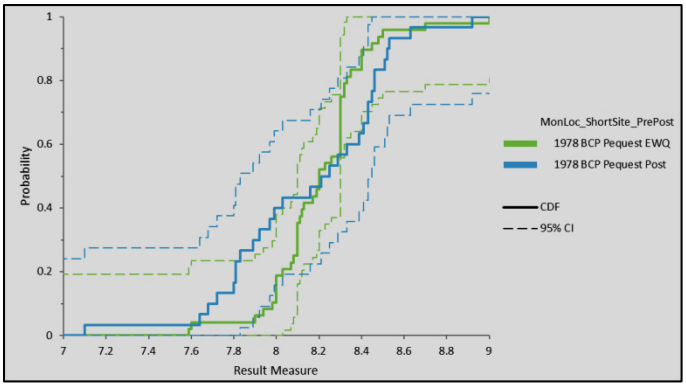






N	78

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	7.59	8.09	8.20	8.31	9.00	0.22
1978 BCP Pequest Post	7.10	7.83	8.23	8.45	8.92	0.62



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	48	4.4	0.09
1978 BCP Pequest Post	30	7.0	0.23

H statistic	0.02
X^2 approximation	0.02
DF	1
p-value	0.8815 [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.

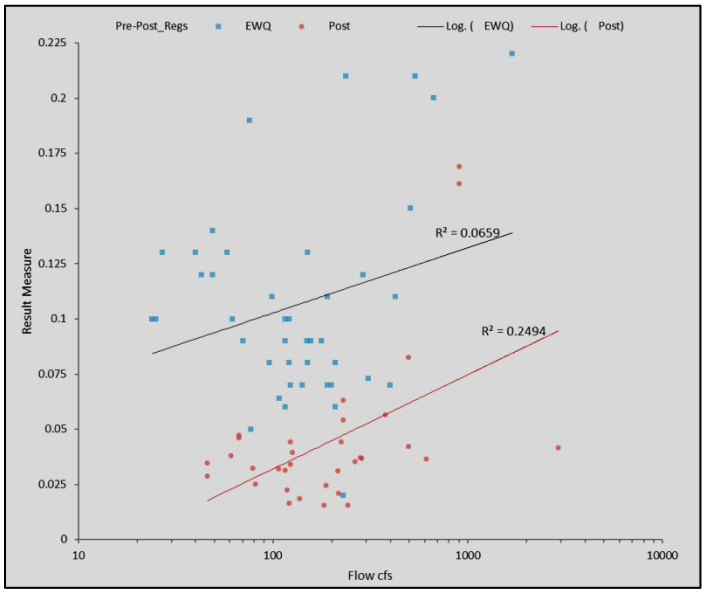
No water quality degradation is evident here. pH did not measurably change between the EWQ and post-EWQ periods. There were no known sources of analytical uncertainty in these data. pH is unrelated to flow in both data sets. Post-EWQ median pH was within the EWQ 95% confidence intervals. The result below pH 7.2 taken in 2010 was probably a probe malfunction. USGS data were less numerous but matched DRBC results.

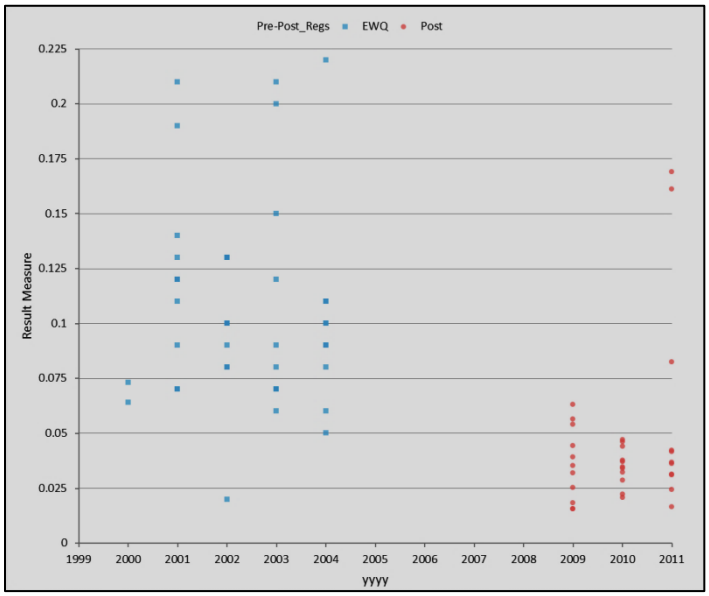
Chapter 21: 1978 BCP Pequest River, NJ

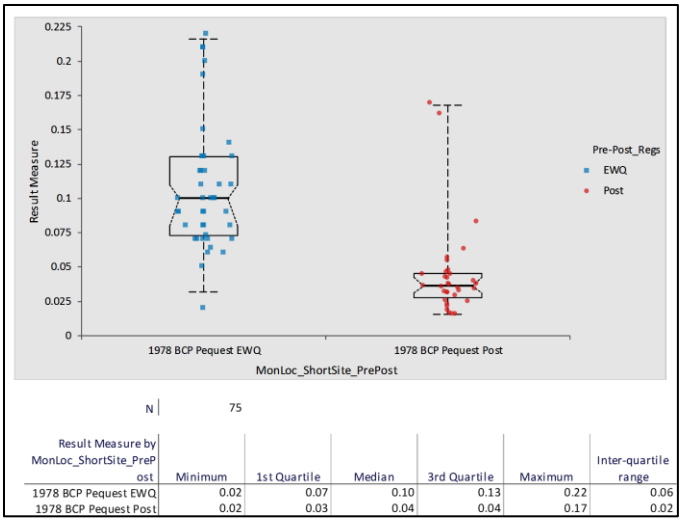
Phosphorus as P, Total (TP) mg/l

Existing Water Quality (Table 2F):

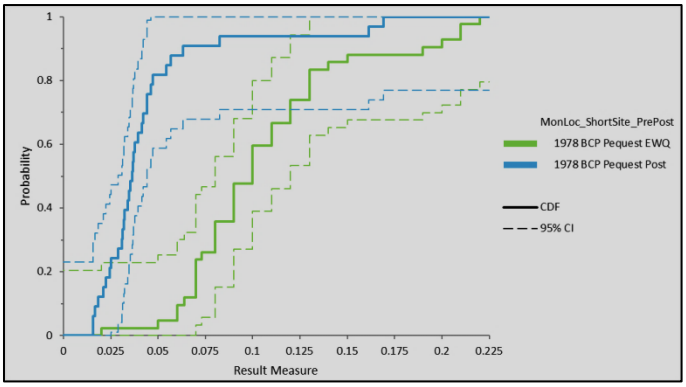
Median 0.10 mg/l
Lower 95% Confidence Interval 0.08 mg/l
Upper 95% Confidence Interval 0.11 mg/l







N	75					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	0.02	0.07	0.10	0.13	0.22	0.06
1978 BCP Pequest Post	0.02	0.03	0.04	0.04	0.17	0.02



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	42	7817.4	186.13
1978 BCP Pequest Post	33	9949.4	301.50

H statistic	37.45
X^2 approximation	37.45
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.

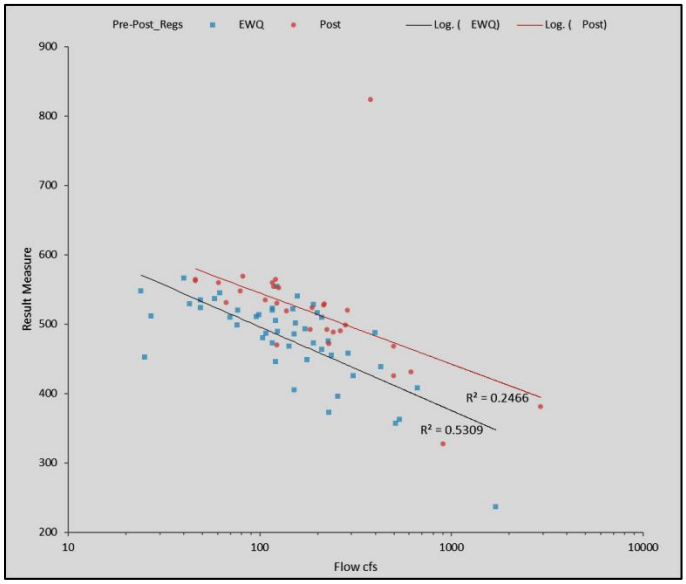
No water quality degradation is evident here. Total Phosphorus (TP) concentrations apparently declined between the EWQ and post-EWQ periods. However, sources of analytical uncertainty included potential laboratory artifacts, detection limit differences, and under-representation of extreme low flow conditions. Post-EWQ median total phosphorus fell below the EWQ lower 95% confidence interval. TP is unrelated to flow in both data sets. USGS data were less numerous but confirmed DRBC results. It appears that New Jersey Total Phosphorus criteria may no longer be exceeded at this location, unless the decline is simply a laboratory artifact.

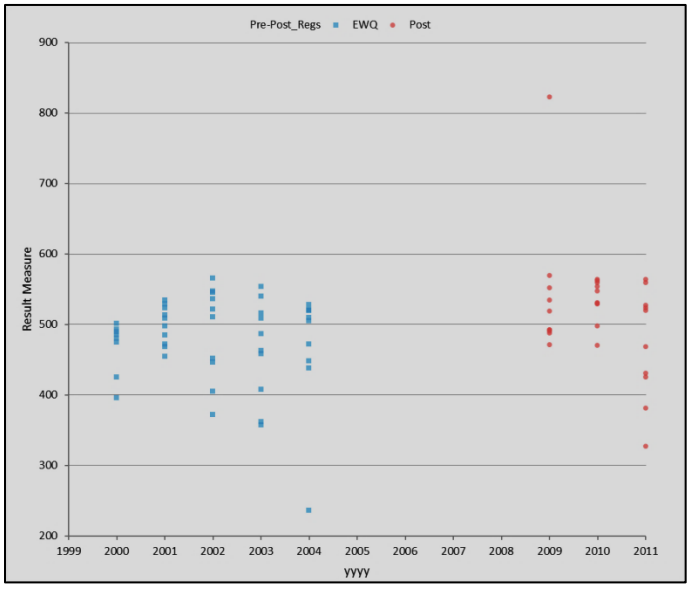
Chapter 21: 1978 BCP Pequest River, NJ

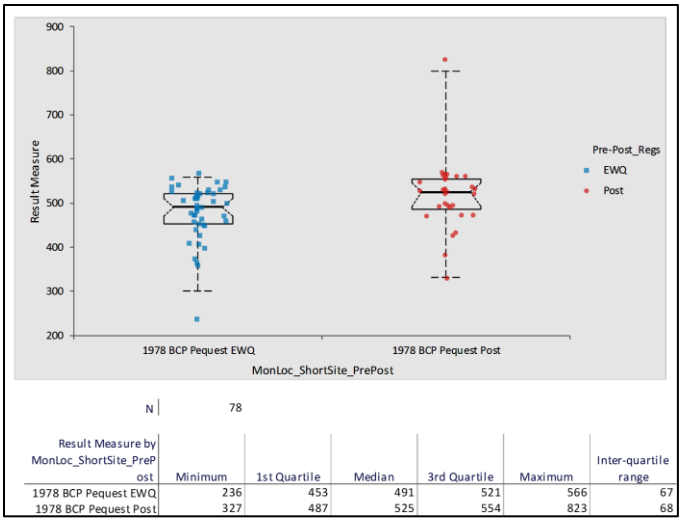
Specific Conductance µmho/cm

Existing Water Quality (Table 2F):

Median 491 µmho/cm
Lower 95% Confidence Interval 472 µmho/cm
Upper 95% Confidence Interval 511 µmho/cm
Defined in regulations as a flow-related parameter

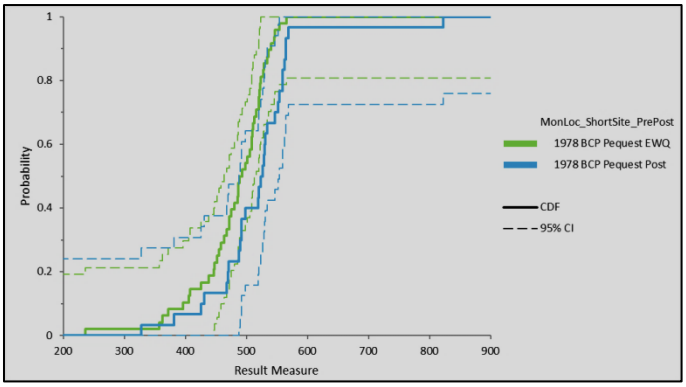






N	78

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	236	453	491	521	566	67
1978 BCP Pequest Post	327	487	525	554	823	68



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	48	1281.3	26.69
1978 BCP Pequest Post	30	2050.1	68.34

H statistic	6.49
X^2 approximation	6.49
DF	1
p-value	0.0109[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.

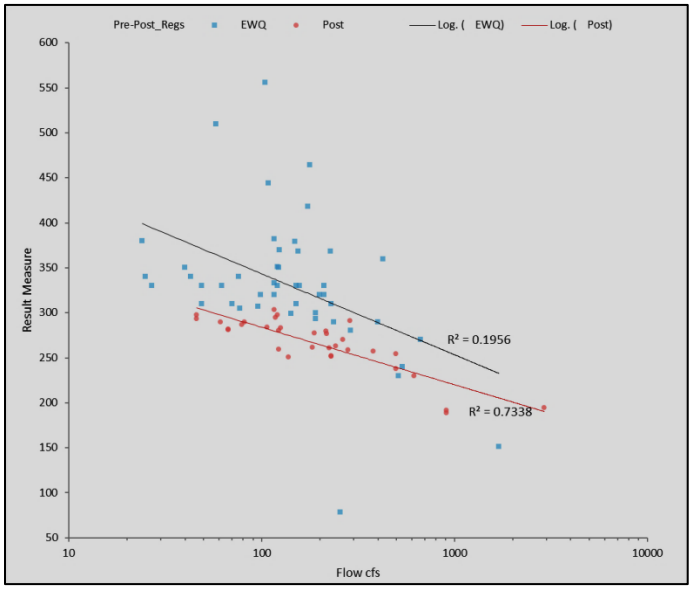
Water quality degradation is evident here. Specific conductance increased by 7%, or 34 µmho/cm, which is above the EWQ upper 95% confidence interval. There are no known sources of analytical uncertainty in these data. Specific conductance is inversely related to flow in both data sets. There was a single extremely high result (823 µmho/cm) taken in June 2009 in normal flow conditions; its cause was unknown. The rise in specific conductance may be partially attributable to the concurrent rise in chloride concentrations. USGS data were similar to DRBC results.

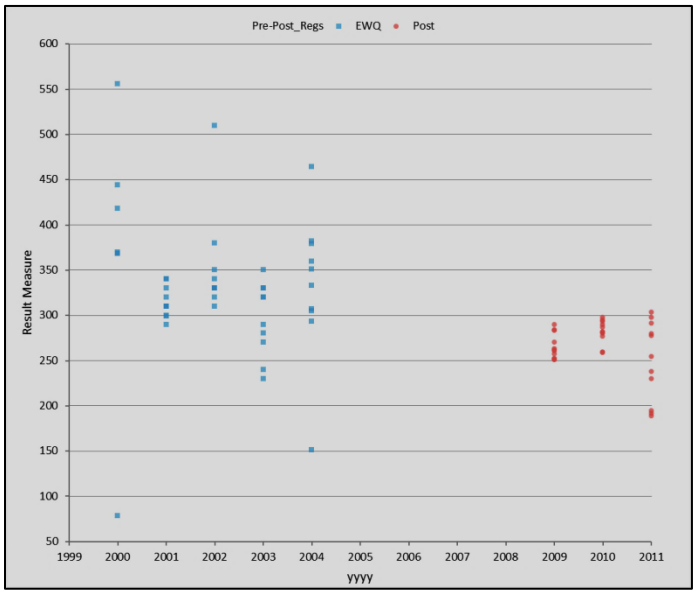
Chapter 21: 1978 BCP Pequest River, NJ

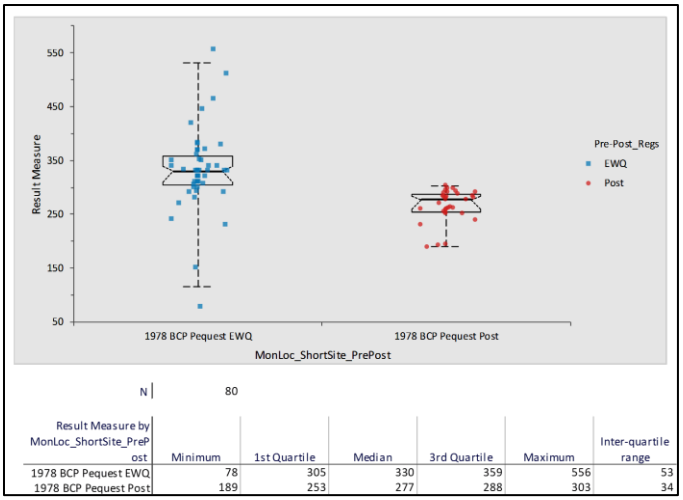
Total Dissolved Solids (TDS) mg/l

Existing Water Quality (Table 2F):

Median 330 mg/l
Lower 95% Confidence Interval 310 mg/l
Upper 95% Confidence Interval 340 mg/l
Defined in regulations as a flow-related parameter

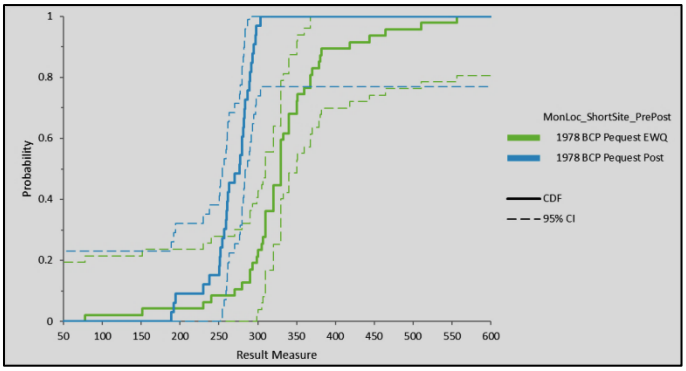






N	80

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	78	305	330	359	556	53
1978 BCP Pequest Post	189	253	277	288	303	34



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	47	7723.5	164.33
1978 BCP Pequest Post	33	11000.2	333.34

H statistic	34.71
X^2 approximation	34.71
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.

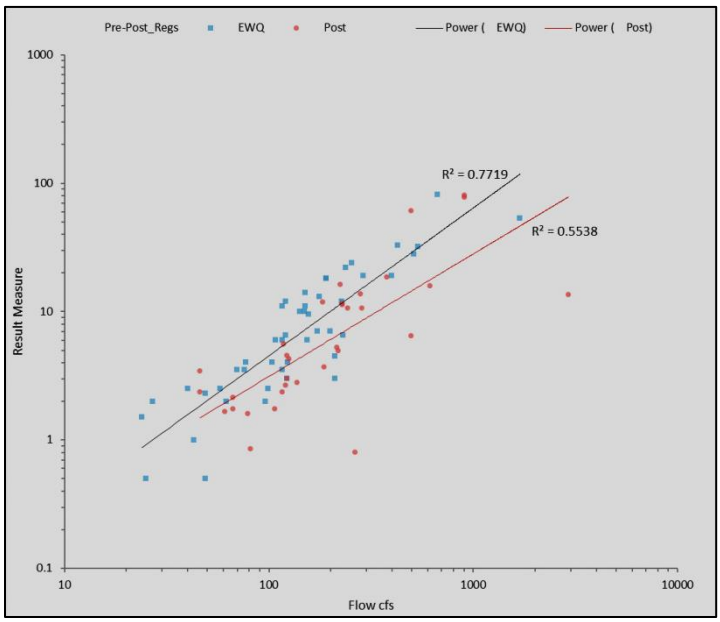
No water quality degradation is evident here. TDS apparently declined between the two periods. However, sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions. TDS is inversely related to flow in both data sets, though the relationship is weak in the EWQ data. Post-EWQ median TDS fell below the EWQ lower 95% lower confidence interval, and were less variable than the baseline samples as well. Post-EWQ detection limits were lower than EWQ detection limits, though there were no undetected results at any time. USGS data over the period show no decline, and compare best with DRBC post-EWQ data only. DRBC EWQ results were generally higher and more variable than USGS data of the time.

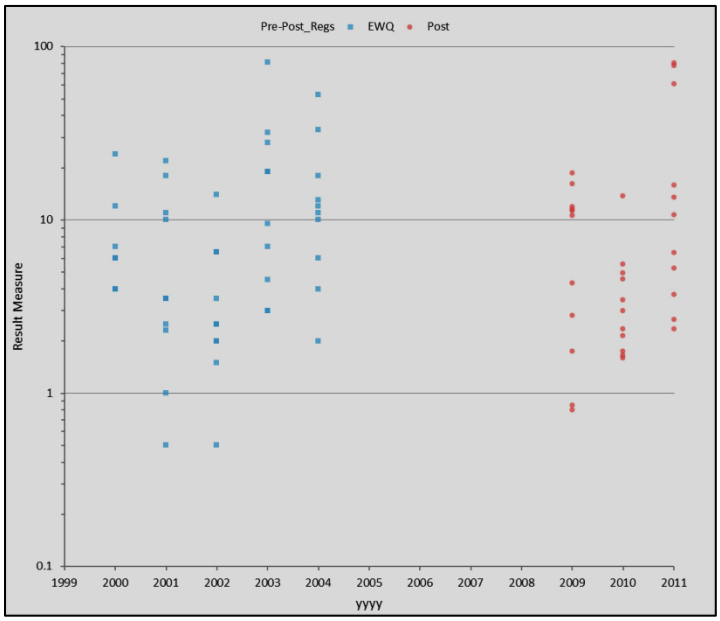
Chapter 21: 1978 BCP Pequest River, NJ

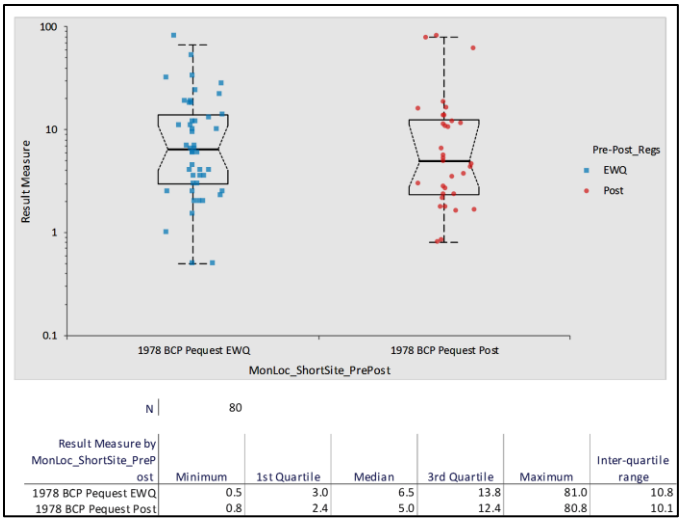
Total Suspended Solids (TSS) mg/l

Existing Water Quality (Table 2F):

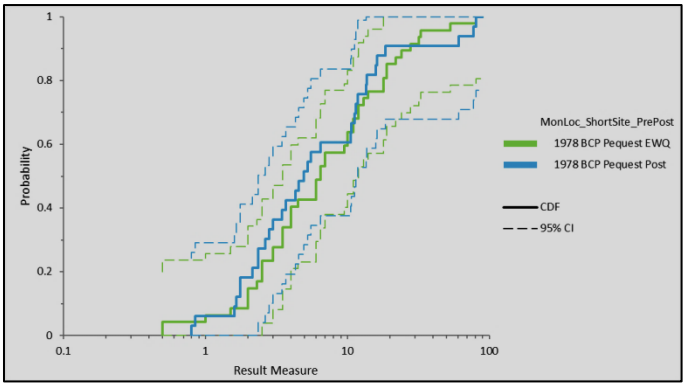
Median 6.5 mg/l
Lower 95% Confidence Interval 4.0 mg/l
Upper 95% Confidence Interval 11.0 mg/l
<u>Should have been designated in rules as flow-related</u>







N	80					
Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	0.5	3.0	6.5	13.8	81.0	10.8
1978 BCP Pequest Post	0.8	2.4	5.0	12.4	80.8	10.1



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	47	111.8	2.38
1978 BCP Pequest Post	33	159.3	4.83

H statistic	0.50
X² approximation	0.50
DF	1
p-value	0.4785 [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.

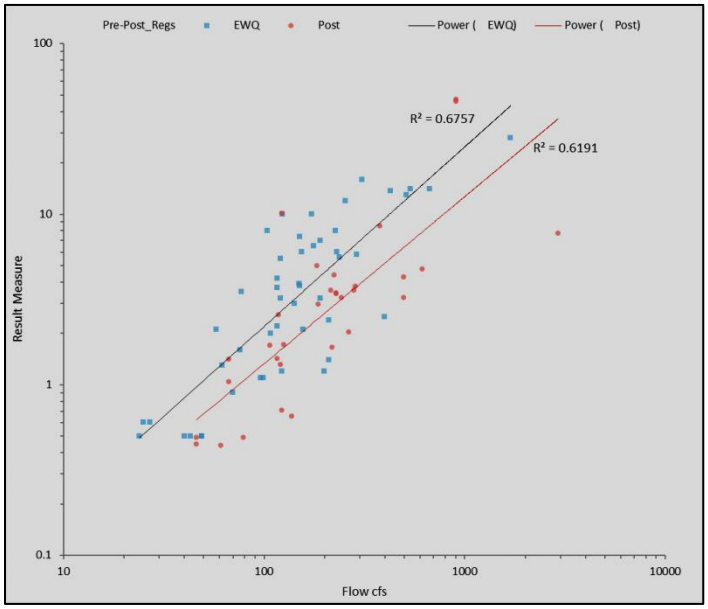
No water quality degradation is evident here. TSS concentrations apparently did not measurably change between the EWQ and post-EWQ periods. However, sources of analytical uncertainty included potential laboratory artifacts and under-representation of extreme low flow conditions. TSS is positively related to flow in both data sets, and should have been designated as flow-related in DRBC water quality rules. Post-EWQ median TSS fell within the EWQ 95% confidence intervals. Flows and concentrations are plotted on logarithmic scale, and regressions are power relationships. USGS data were comparable with DRBC results.

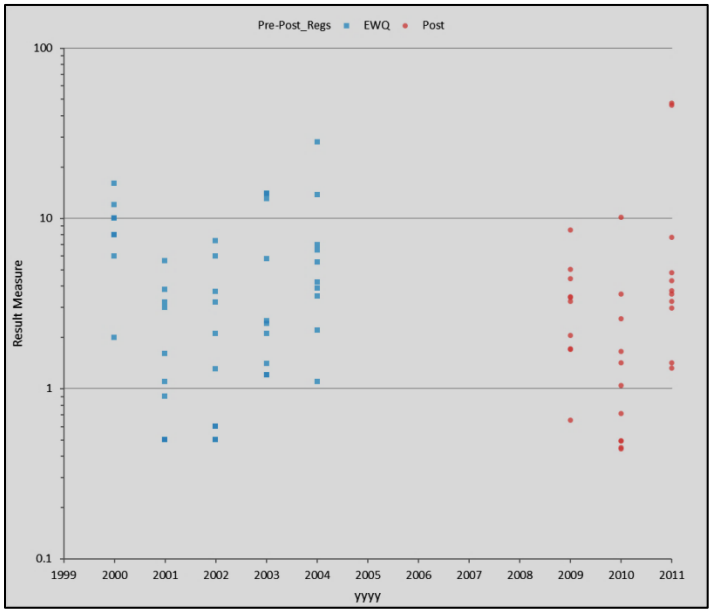
Chapter 21: 1978 BCP Pequest River, NJ

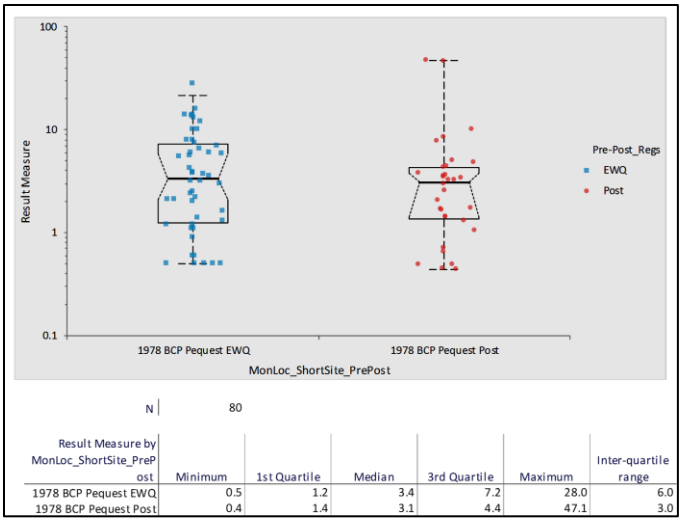
Turbidity NTU

Existing Water Quality (Table 2F):

Median 3.4 NTU
Lower 95% Confidence Interval 2.1 NTU
Upper 95% Confidence Interval 5.8 NTU
Defined in regulations as a flow-related parameter

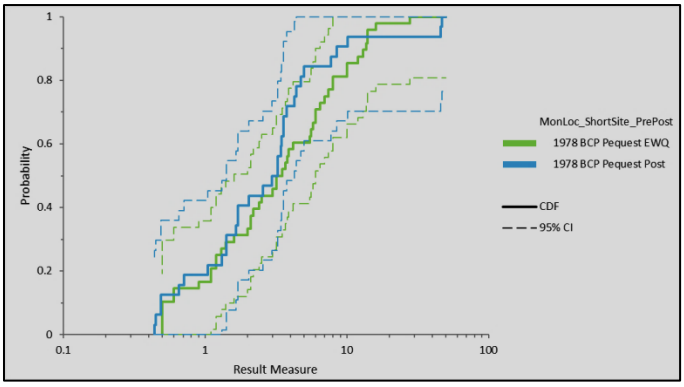






N	80

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	0.5	1.2	3.4	7.2	28.0	6.0
1978 BCP Pequest Post	0.4	1.4	3.1	4.4	47.1	3.0



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	48	212.5	4.43
1978 BCP Pequest Post	32	318.8	9.96

H statistic	0.98
X^2 approximation	0.98
DF	1
p-value	0.3212[1]

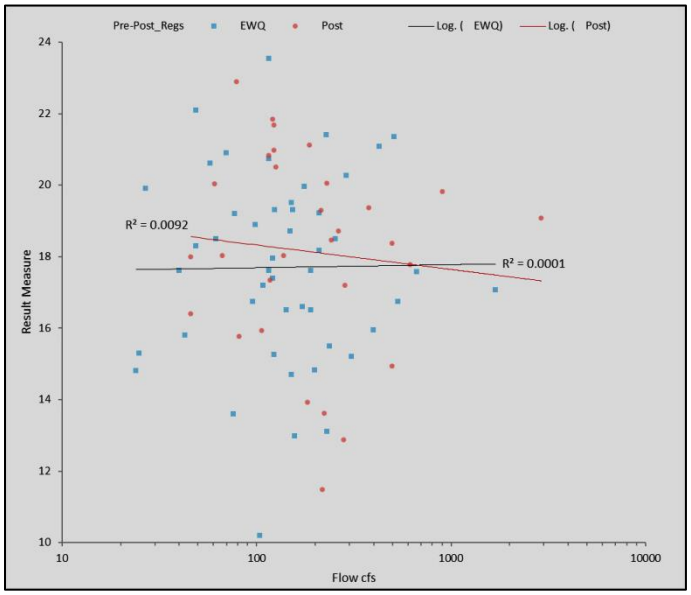
$H0: \theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
$H1: \theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

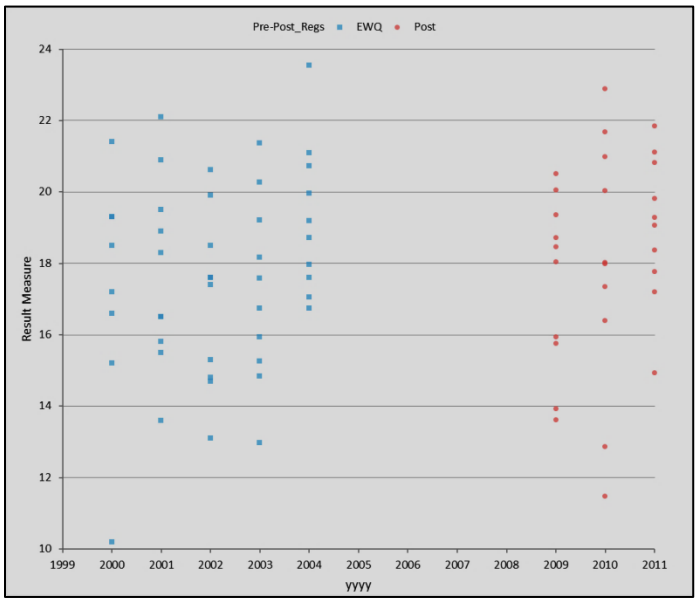
No water quality degradation is evident here. Turbidity did not measurably change between the EWQ and post-EWQ periods. There were no known sources of analytical uncertainty in these data. The post-EWQ median turbidity fell within the EWQ 95% confidence intervals. Turbidity is positively related to flow in both data sets. Concentrations and flows are represented on logarithmic scale, and regressions are power relationships. There were too few USGS data (n=8) available for comparison with DRBC results, but concentrations were in the same range.

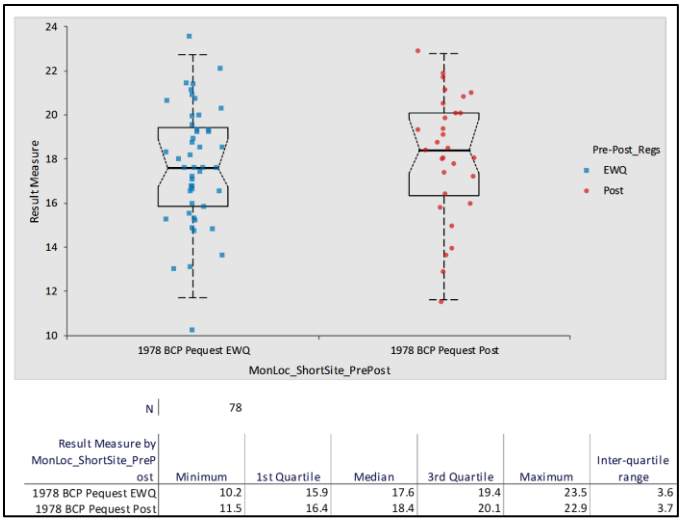
Chapter 21: 1978 BCP Pequest River, NJ

Water Temperature, degrees C

Not included in DRBC Existing Water Quality rules

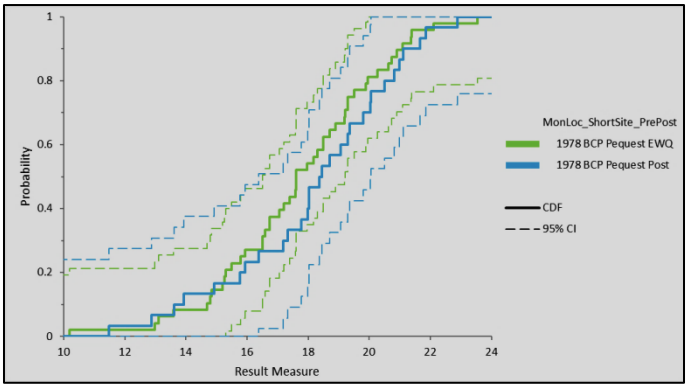






N	78

Result Measure by MonLoc_ShortSite_PrePost	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Inter-quartile range
1978 BCP Pequest EWQ	10.2	15.9	17.6	19.4	23.5	3.6
1978 BCP Pequest Post	11.5	16.4	18.4	20.1	22.9	3.7



Kruskal-Wallis test

Result Measure by MonLoc_ShortSite_PrePost	n	Rank sum	Mean rank
1978 BCP Pequest EWQ	48	155.9	3.25
1978 BCP Pequest Post	30	249.4	8.31

H statistic	0.79
X² approximation	0.79
DF	1
p-value	0.3743 [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 was not significantly different between the EWQ and post-EWQ periods, but there was about a 1 degree C increase throughout the post-EWQ data distribution. There were no known sources of analytical uncertainty in these data. Since warmer water holds less oxygen, the dissolved oxygen saturation increase noted earlier is verifiably not due to temperature differences between the data sets. Water temperature is unrelated to flow in both data sets. Note that flows are plotted on a logarithmic scale. NJDEP and USGS data were comparable with DRBC results.