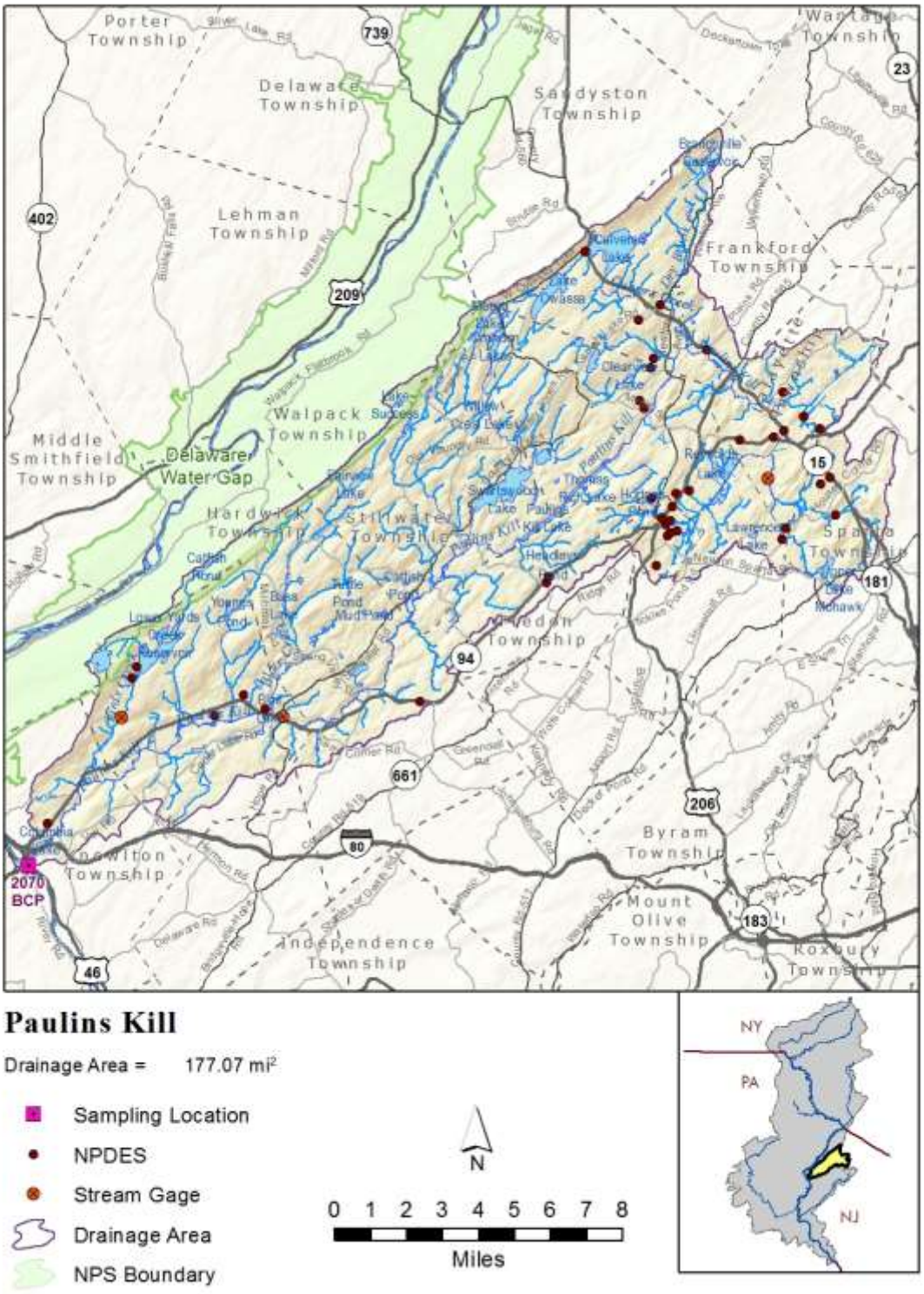
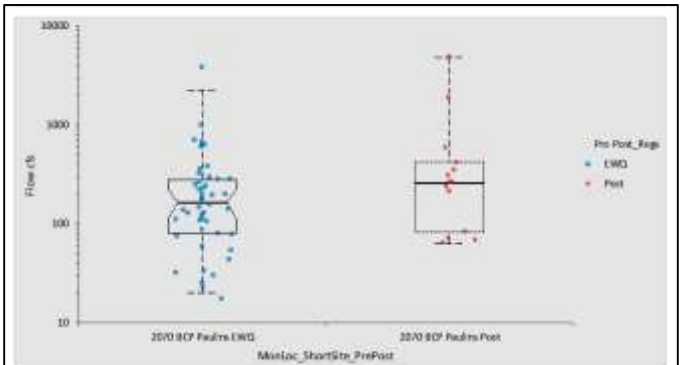
## Chapter 23: 2070 BCP Paulins Kill River, Warren & Sussex Counties, NJ



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




| N | 62 | | | | | |
|---|---|---|---|---|---|---|
| Flow cfs by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
| 2070 BCP Paulins EWQ | 17 | 81 | 165 | 280 | 5778 | 199 |
| 2070 BCP Paulins Post | 63 | 82 | 261 | 426 | 4846 | 344 |

Post-EWQ median flow of the Paulins Kill was about 96 cfs higher than EWQ median flow. Too few samples were collected in the post-EWQ period (n=14). Sampling of the middle to upper range of flow conditions was about the same, but low-flow conditions were not well-represented in post-EWQ data. As a result it is possible that water quality differences can be falsely interpreted as significant when they really are not. This point is closely considered in each analysis to follow.

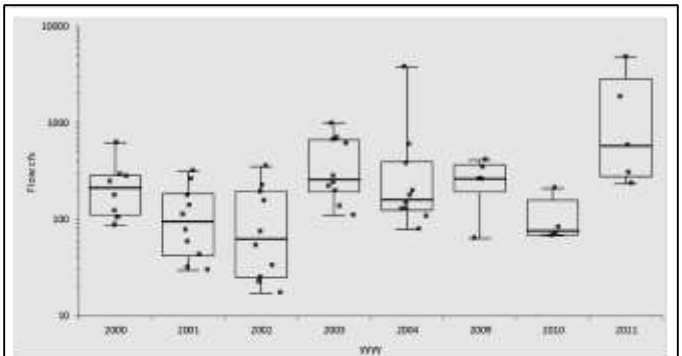
Kruskal-Wallis test

| Flow cfs by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 48 | 165.0 | 3.44 |
| 2070 BCP Paulins Post | 14 | 565.8 | 40.41 |

| | |
|---|---|
| H statistic | 2.25 |
| $X^2$ approximation | 2.25 |
| DF | 1 |
| p-value | 0.1340[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.

Watershed facts derived from USGS StreamStats website (accessed February 2014): The Paulins Kill watershed is about 62% forested; was entirely glaciated; about 5.9% urban land, 7.8% covered by lakes and ponds (including two hydroelectric dams); and is about 29% underlain by carbonate bedrock. The carbonate bedrock percentage is sufficient to produce limestone stream water quality effects, such as high alkalinity, conductivity, hardness, and well-buffered pH. There are numerous dischargers in the watershed.




| N | 62 | | | | | |
|---|---|---|---|---|---|---|
| Flow cfs by yyyy | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
| 2000 | 86 | 112 | 211 | 285 | 623 | 173 |
| 2001 | 30 | 42 | 94 | 184 | 317 | 143 |
| 2002 | 17 | 25 | 63 | 196 | 351 | 171 |
| 2003 | 110 | 102 | 259 | 665 | 976 | 474 |
| 2004 | 78 | 125 | 160 | 396 | 3778 | 271 |
| 2009 | 63 | 155 | 263 | 570 | 412 | 177 |
| 2010 | 67 | 69 | 77 | 158 | 212 | 90 |
| 2011 | 232 | 280 | 579 | 2861 | 4846 | 2581 |

Annual May to September flow statistics associated with water quality measurements are plotted above. Mean annual flow at this location is about 295 cfs; harmonic mean flow is 164 cfs; and average May to September flow is about 147 cfs, which is most typical of summer flow conditions. Though a wide range of flows were sampled by DRBC, the EWQ data are most representative of summer flow conditions, while low flow conditions are not well represented in post-EWQ data. Flows estimates were obtained using instantaneous water discharge data from the USGS gage No. 01443500 on the Paulins Kill at Blairstown. Estimation of stream flow is complicated by the presence of the Columbia Lake hydroelectric generating station that discharges just upstream of the monitoring location. This alters natural flow of the Paulins Kill, so DRBC relates gage height measurements to upstream Blairstown flows then converts Blairstown flow with drainage area weighting to estimate flow at Rt. 46. If the hydropower plant remains operational we recommend that a stream gage be installed upon the next renewal of the power plant's FERC license. At 177 square miles, the Paulins Kill is a major tributary to the Delaware River, and its hydropower impacts upon the Delaware River should be known and accounted.

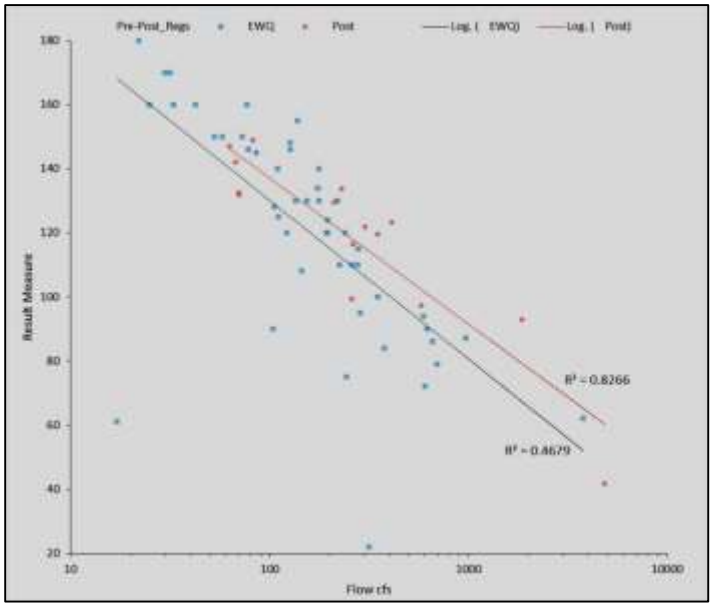
Upstream ICP: Delaware River at Portland 2070 ICP
Downstream ICP: Delaware River at Belvidere 1978 ICP

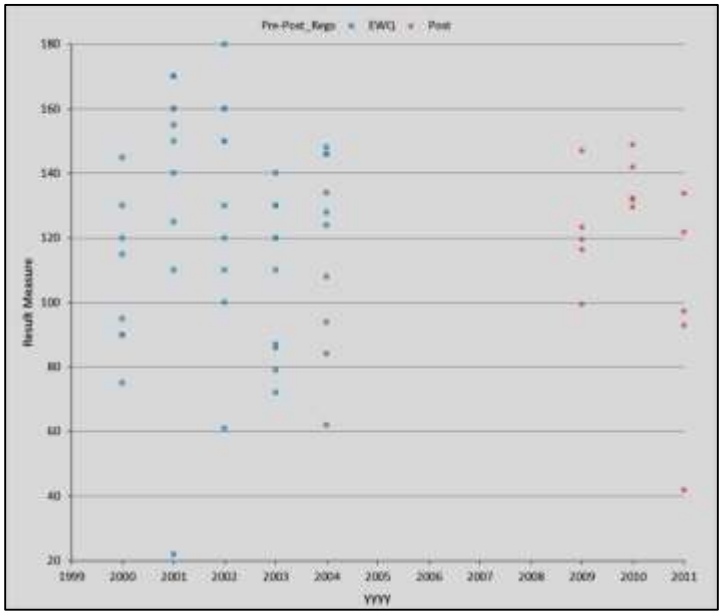
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

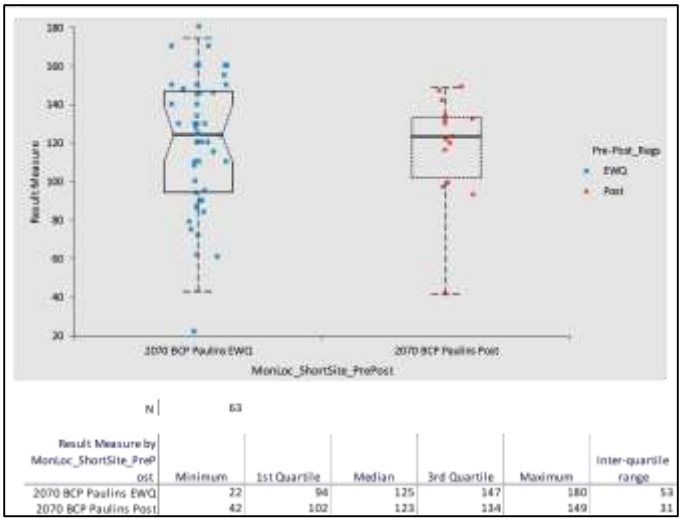
Alkalinity as CaCO3, Total mg/l

Existing Water Quality (Table 2D):

Median 125 mg/l
Lower 95% Confidence Interval 110 mg/l
Upper 95% Confidence Interval 140 mg/l
Defined in regulations as a flow-related parameter

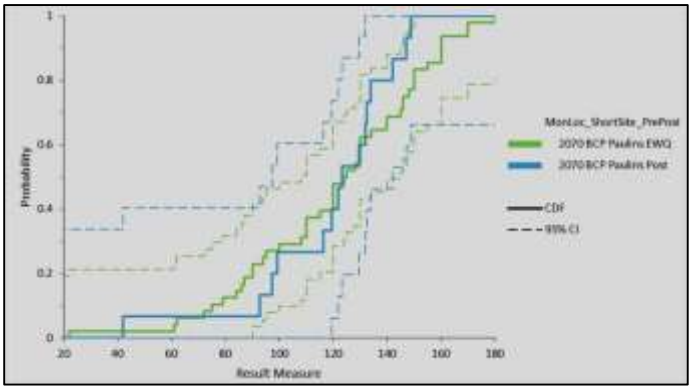



| | |
|---|---|
| N | 63 |

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 22 | 94 | 125 | 147 | 180 | 53 |
| 2070 BCP Paulins Post | 42 | 102 | 123 | 134 | 149 | 31 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 48 | 5.3 | 0.11 |
| 2070 BCP Paulins Post | 15 | 17.1 | 1.14 |

| | |
|---|---|
| H statistic | 0.07 |
| $X^2$ approximation | 0.07 |
| DF | 1 |
| p-value | 0.7962 [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.

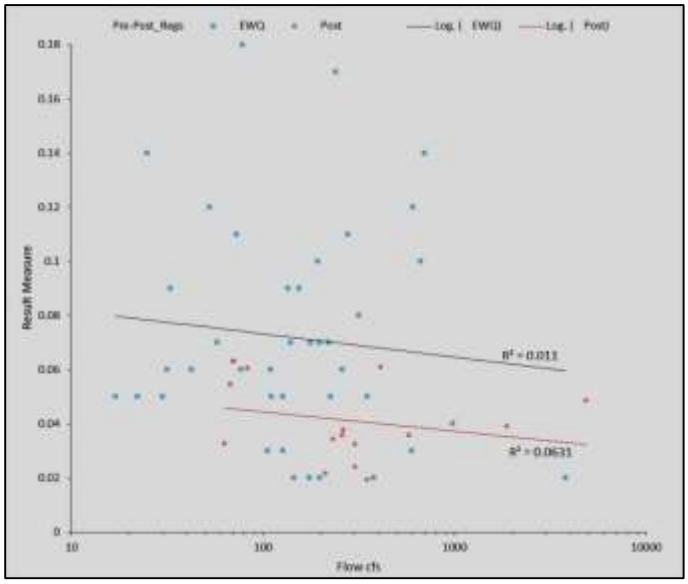
No water quality degradation is evident here. Alkalinity apparently did not measurably change between the EWQ and post-EWQ periods. However, analytical uncertainty was introduced by potential laboratory artifacts, insufficient post-EWQ sampling rate, and low flow differences. Alkalinity is inversely related to flow in both data sets. Median alkalinity over 100 mg/l generally indicates that the stream is influenced by limestone geology. Post-EWQ median alkalinity fell within EWQ 95% confidence intervals. Flow is plotted on logarithmic scale. There were too few samples in the post-EWQ data set. No independent samples were available for comparison with DRBC results.

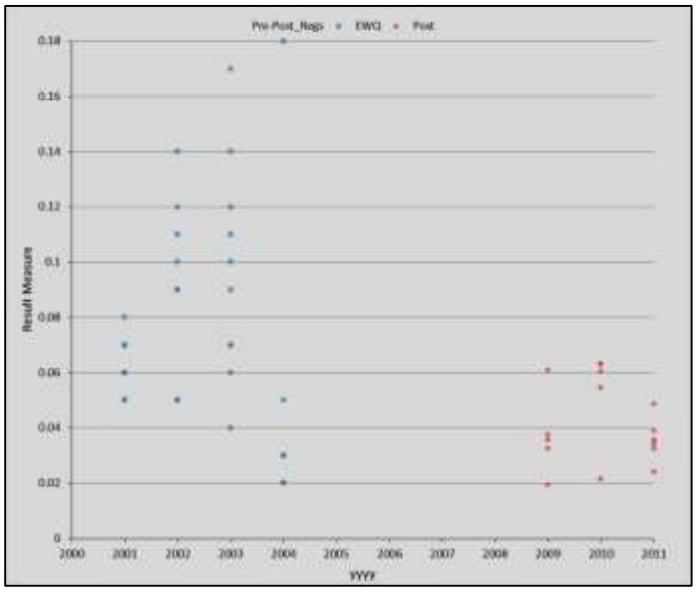
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

Ammonia Nitrogen as N, Total mg/l

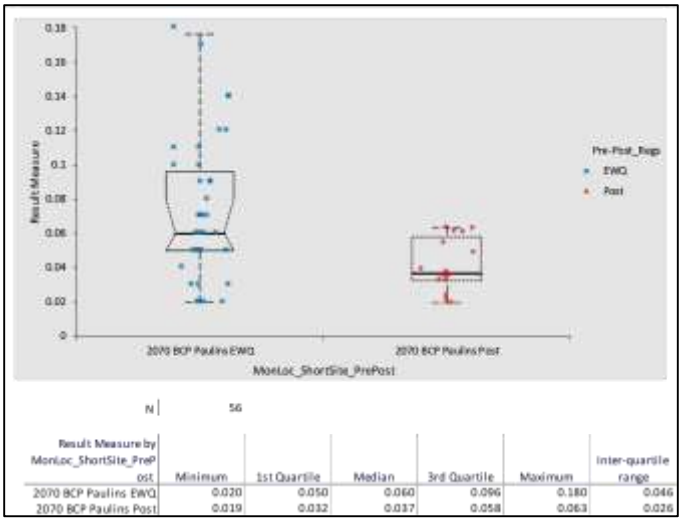
Existing Water Quality (Table 2D):

Median 0.06 mg/l
Lower 95% Confidence Interval 0.05* mg/l
Upper 95% Confidence Interval 0.08 mg/l
*corrected value – rules showed 0.04 mg/l



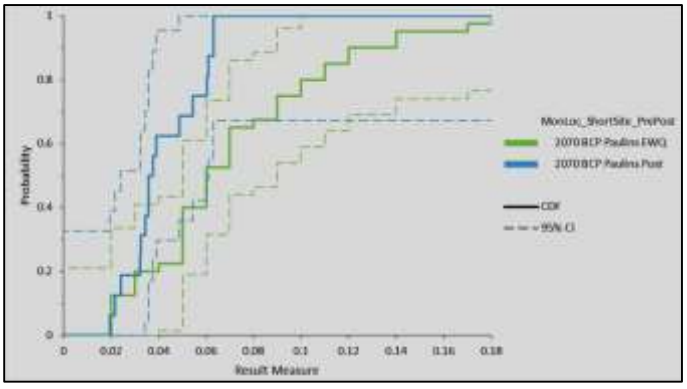




No water quality degradation is evident here. Ammonia concentrations apparently declined. However, analytical uncertainty included potential laboratory artifacts and insufficient post-EWQ sampling rate.




N 56

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 0.020 | 0.050 | 0.060 | 0.096 | 0.180 | 0.046 |
| 2070 BCP Paulins Post | 0.019 | 0.032 | 0.037 | 0.058 | 0.063 | 0.026 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 40 | 525.6 | 13.14 |
| 2070 BCP Paulins Post | 16 | 1314.1 | 82.13 |

| | |
|---|---|
| H statistic | 6.95 |
| $X^2$ approximation | 6.95 |
| DF | 1 |
| p-value | 0.0084 [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.

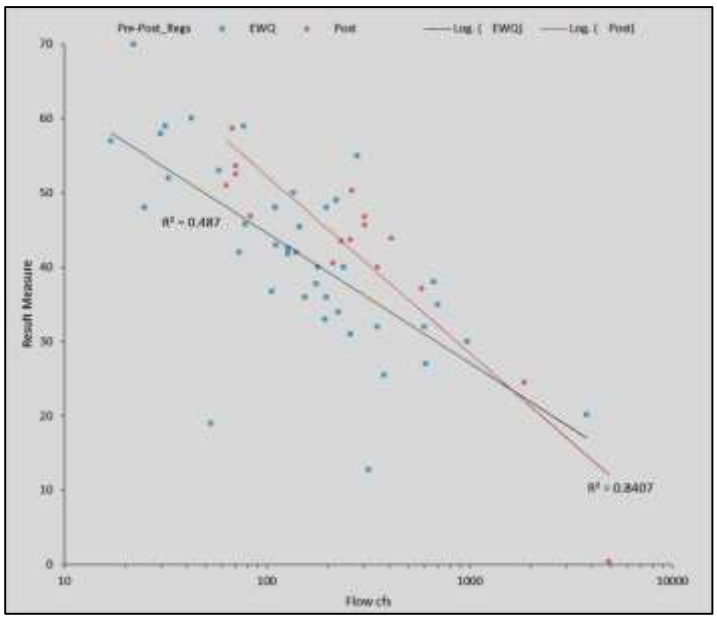
Post-EWQ median ammonia concentration was below the EWQ lower 95% confidence interval. Undetected results did not interfere with estimation of the median and its confidence intervals. EWQ data contained 12 undetected results out of 40 samples. Under 2009-2011 lower detection levels there were no undetected results out of 16 samples. Ammonia is unrelated to flow. Possible water quality improvement is indicated by post-EWQ concentrations no greater than 0.063 mg/l, though this result may be due to laboratory artifacts. There were no independent data available for comparison with DRBC results.

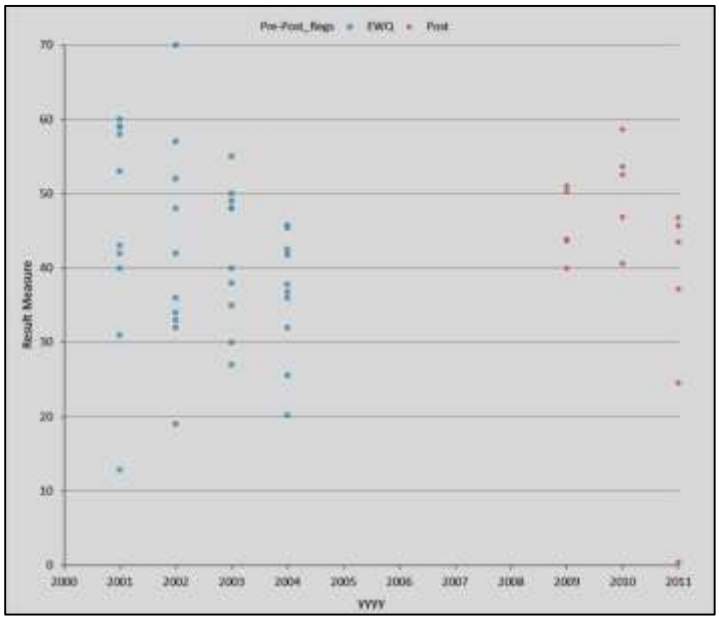
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

Chloride, Total mg/l

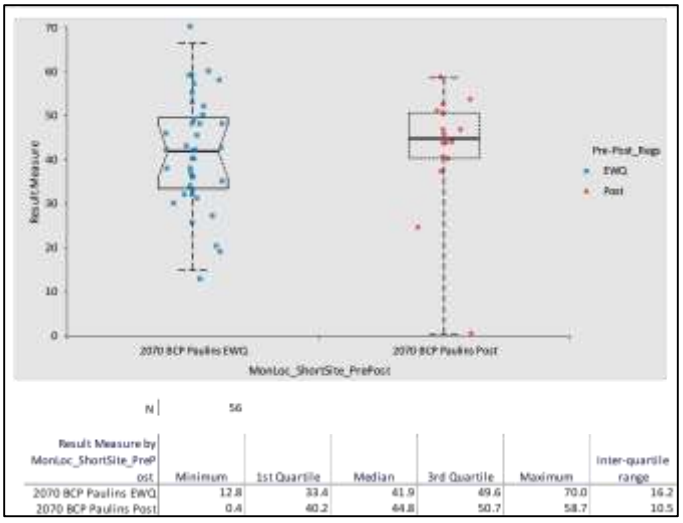
Existing Water Quality (Table 2D):

Median 42 mg/l
Lower 95% Confidence Interval 36 mg/l
Upper 95% Confidence Interval 48 mg/l
Defined in regulations as a flow-related parameter



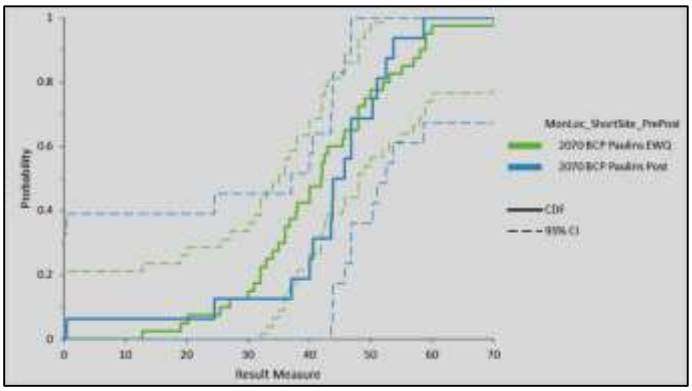




No water quality degradation is evident. Chloride apparently did not change between the two periods, though there were too few post-EWQ data for certainty.




| | |
|---|---|
| N | 56 |

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 12.8 | 33.4 | 41.9 | 49.6 | 70.0 | 16.2 |
| 2070 BCP Paulins Post | 0.4 | 40.2 | 44.8 | 50.7 | 58.7 | 10.5 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 40 | 55.2 | 1.38 |
| 2070 BCP Paulins Post | 16 | 138.1 | 8.63 |

| | |
|---|---|
| H statistic | 0.73 |
| $X^2$ approximation | 0.73 |
| DF | 1 |
| p-value | 0.3939 [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.

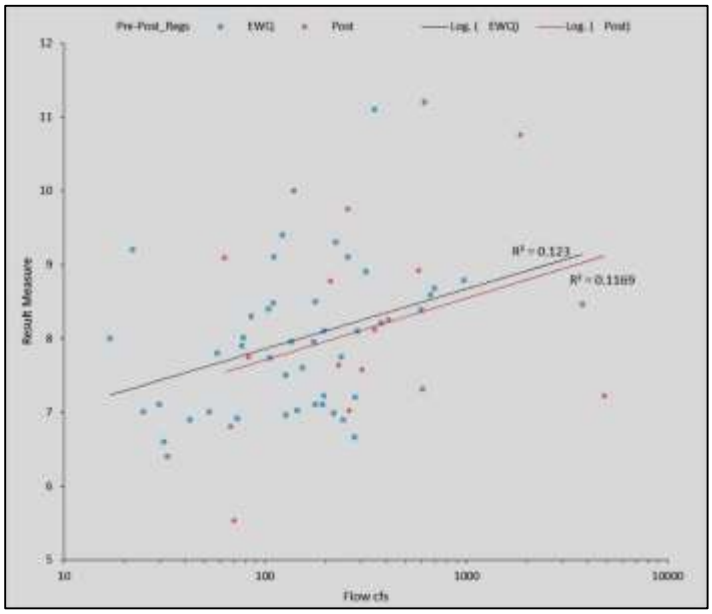
Analytical uncertainty was introduced by potential laboratory artifacts, insufficient post-EWQ sampling rate, and low flow differences. Post-EWQ median concentration fell within the EWQ 95% confidence intervals, rising 2.9 mg/l. Chloride concentration is inversely related to flow in both data sets. No independent data were available to validate results. Note a single extremely low result in 2011 – taken under the highest flow conditions sampled, when the Paulins Kill was running at nearly 5,000 cfs. Some chlorides may be sequestered by Columbia Lake, as the increase here was not as significant as in other watersheds.

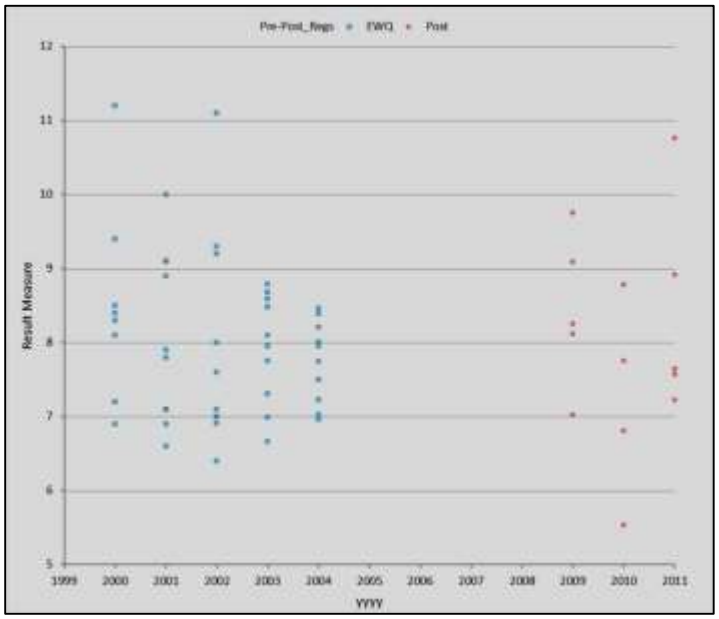
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

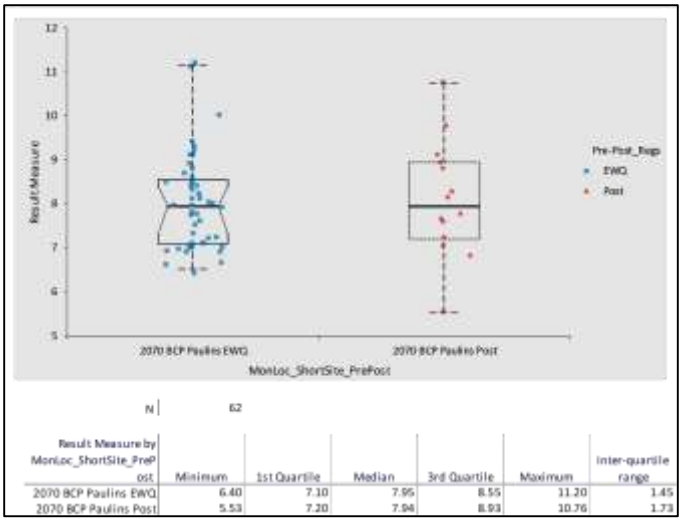
Dissolved Oxygen (DO) mg/l

Existing Water Quality (Table 2D):

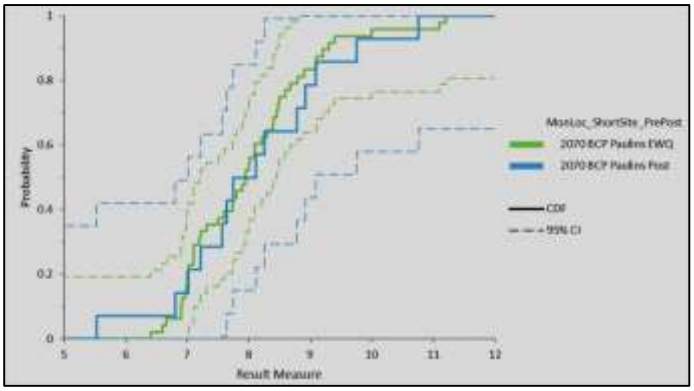
Median 7.95 mg/l
Lower 95% Confidence Interval 7.31 mg/l
Upper 95% Confidence Interval 8.39 mg/l




| N | 62 | | | | | |
|---|---|---|---|---|---|---|
| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
| 2070 BCP Paulins EWQ | 6.40 | 7.10 | 7.95 | 8.55 | 11.20 | 1.45 |
| 2070 BCP Paulins Post | 5.53 | 7.20 | 7.94 | 8.93 | 10.76 | 1.73 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 48 | 7.1 | 0.15 |
| 2070 BCP Paulins Post | 14 | 24.4 | 1.75 |

| | |
|---|---|
| H statistic | 0.10 |
| $X^2$ approximation | 0.10 |
| DF | 1 |
| p-value | 0.7554 [1] |

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

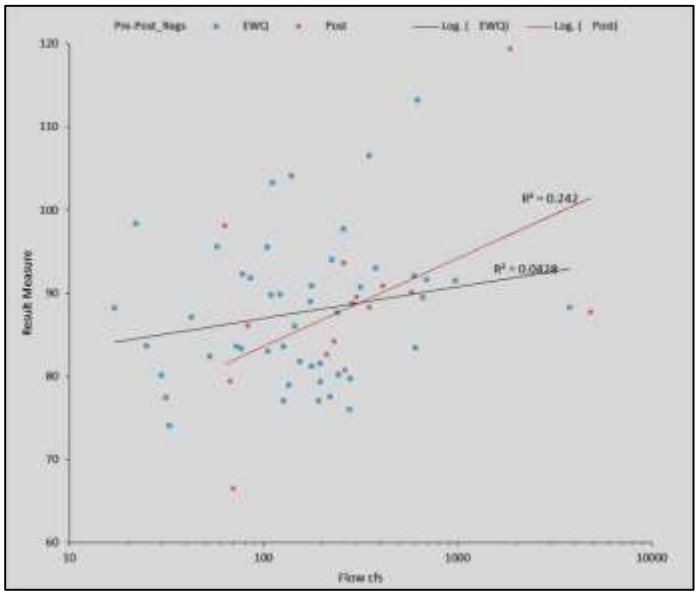
No water quality degradation is evident here. No measurable change took place between the EWQ and Post-EWQ periods. Analytical uncertainty was introduced by insufficient post-EWQ sampling rate. Post-EWQ median DO concentration was within the EWQ 95% confidence intervals. DO concentration is unrelated to flow in both data sets. The low reading of 5.53 mg/l in 2010 was probably a probe malfunction, as low DO was observed at two adjacent sites on the same day. No independent data were available to confirm DRBC results.

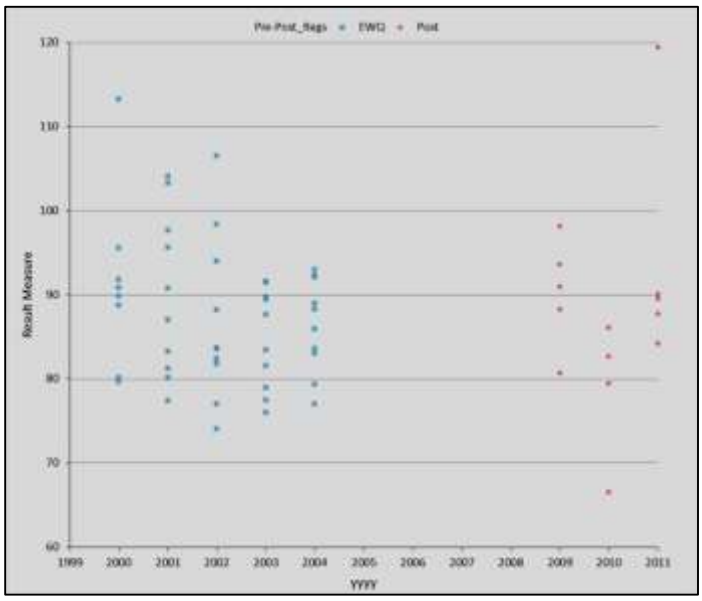
Chapter 22: 1978 ICP Delaware River at Belvidere

Dissolved Oxygen Saturation % (DO%)

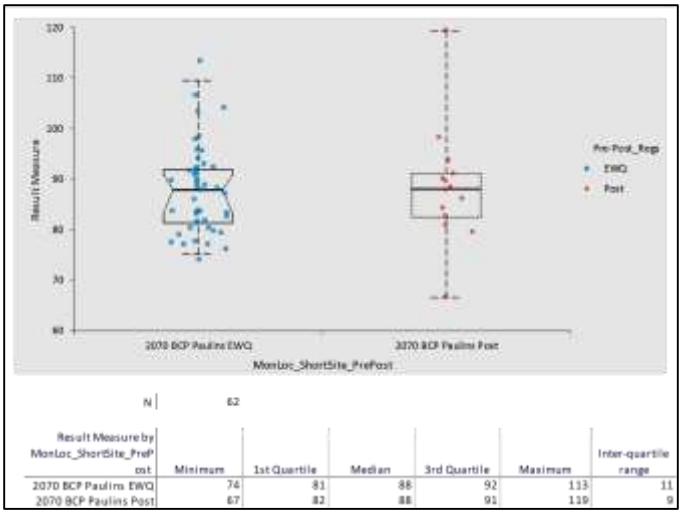
Existing Water Quality (Table 2D):

Median 88%
Lower 95% Confidence Interval 83%
Upper 95% Confidence Interval 91%



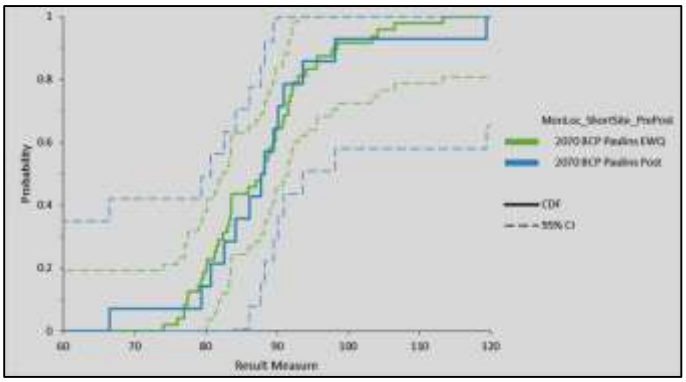




No water quality degradation is evident here. DO% is unrelated to flow, and did not measurably change between the two periods.




| | |
|---|---|
| N | 62 |

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 74 | 81 | 88 | 92 | 113 | 11 |
| 2070 BCP Paulins Post | 67 | 82 | 88 | 91 | 119 | 9 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 48 | 4.1 | 0.09 |
| 2070 BCP Paulins Post | 14 | 14.0 | 1.00 |

| | |
|---|---|
| H statistic | 0.06 |
| $X^2$ approximation | 0.06 |
| DF | 1 |
| p-value | 0.8137[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.

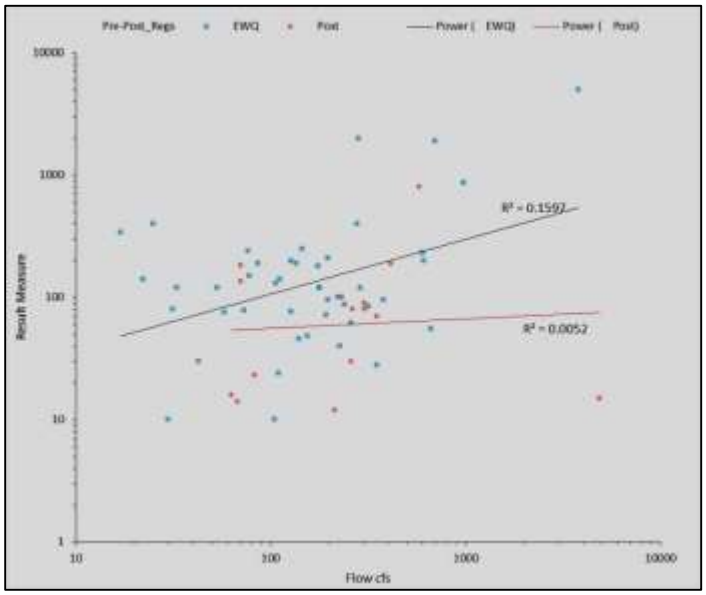
Analytical uncertainty was introduced by insufficient post-EWQ sampling rate. The weakly positive relationship to flow in the post-EWQ data was driven by two outlier values – one high and one low. The low value was probably a probe malfunction, as two adjacent sites showed such low values on the same date. Post-EWQ median DO% fell within EWQ 95% confidence intervals. There are frequent low saturation values (below 80%) at this site, which probably has to do with Columbia Lake's hydropower release structure. Biweekly or continuous sampling is recommended for this location. No independent data were available for comparison with DRBC results.

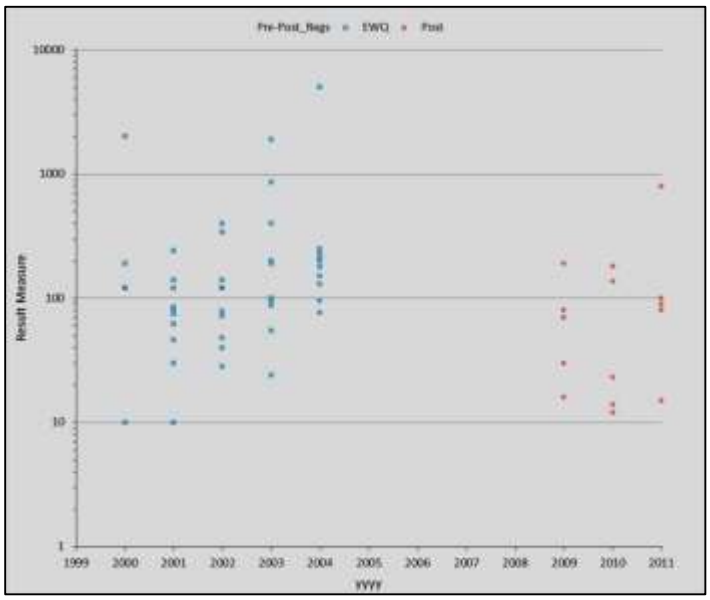
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

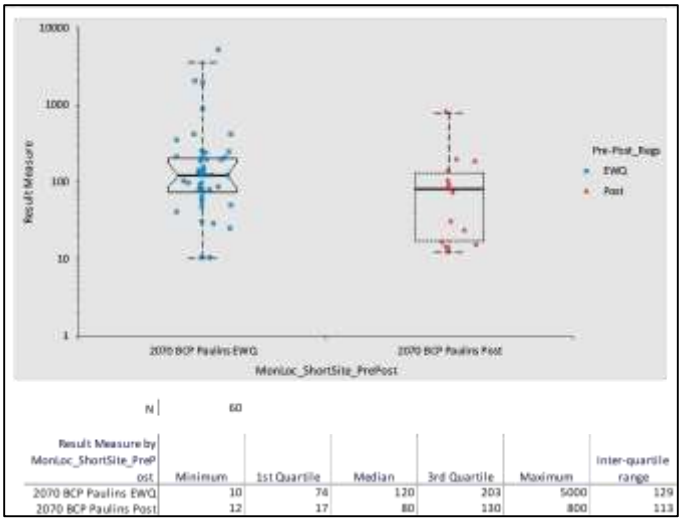
Enterococcus colonies/100 ml

Existing Water Quality (Table 2D):

Median 120/100 ml
Lower 95% Confidence Interval 84/100 ml
Upper 95% Confidence Interval 180/100 ml

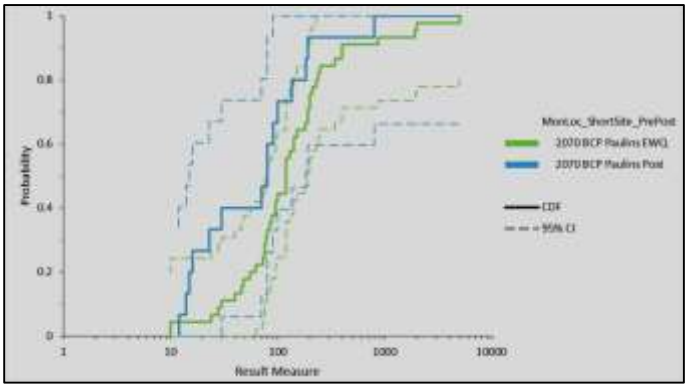



| | |
|---|---|
| N | 60 |

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 10 | 74 | 120 | 203 | 5000 | 129 |
| 2070 BCP Paulins Post | 12 | 17 | 80 | 130 | 800 | 113 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 45 | 317.3 | 7.05 |
| 2070 BCP Paulins Post | 15 | 952.0 | 63.47 |

| | |
|---|---|
| H statistic | 4.17 |
| $X^2$ approximation | 4.17 |
| DF | 1 |
| p-value | 0.0412 [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.

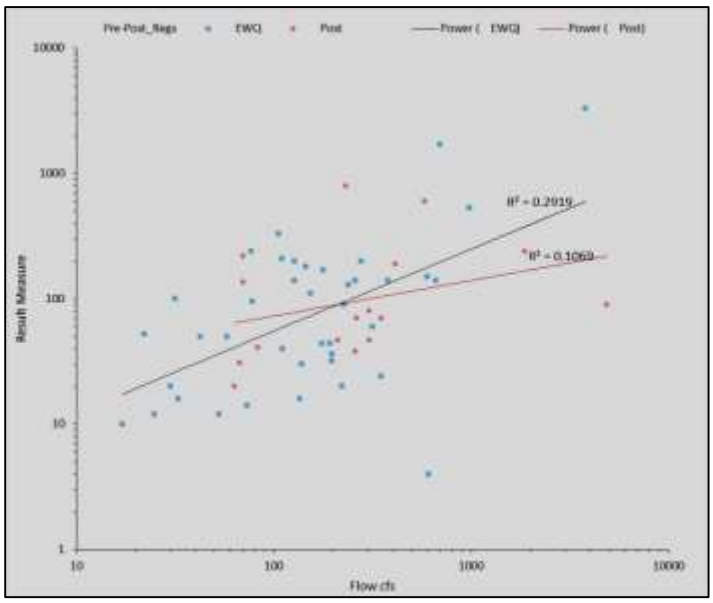
No water quality degradation is evident here. Enterococci apparently declined between the two periods. Analytical uncertainty was introduced by potential laboratory artifacts and insufficient post-EWQ sampling rate. Biweekly sampling is recommended to improve the strength of statistical comparisons. 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. No independent data were available for comparison with DRBC results.

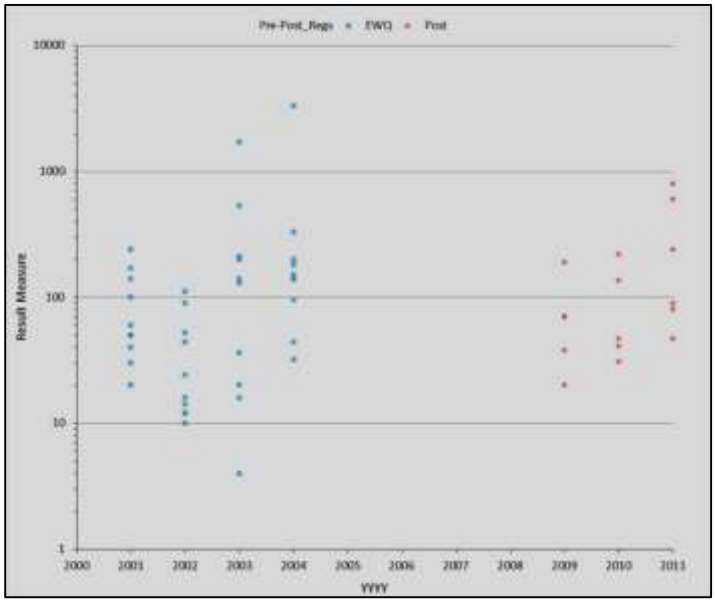
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

Escherichia coli colonies/100 ml

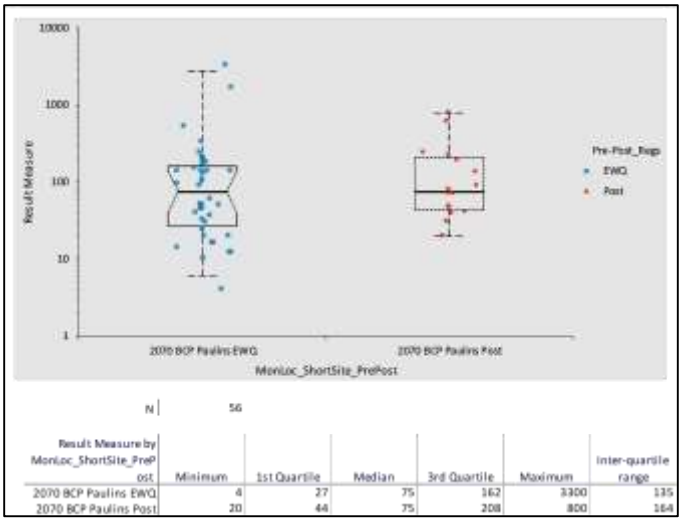
Existing Water Quality (Table 2D):

Median 75/100 ml
Lower 95% Confidence Interval 40/100 ml
Upper 95% Confidence Interval 140/100 ml
Defined in regulations as a flow-related parameter



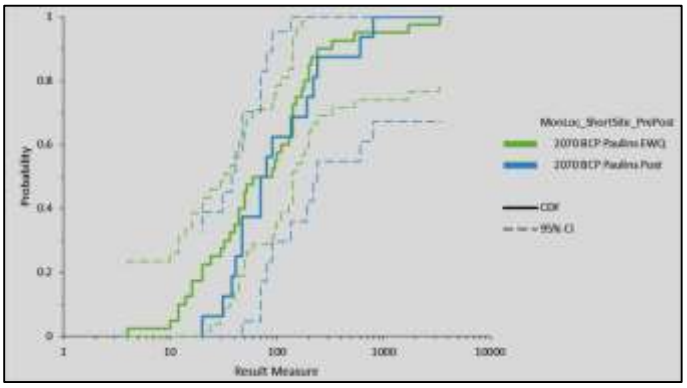




No water quality degradation is evident here. E. coli apparently did not measurably change between the two periods.




| | |
|---|---|
| N | 56 |

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 4 | 27 | 75 | 162 | 3300 | 135 |
| 2070 BCP Paulins Post | 20 | 44 | 75 | 208 | 800 | 164 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 40 | 44.1 | 1.10 |
| 2070 BCP Paulins Post | 16 | 110.3 | 6.89 |

| | |
|---|---|
| H statistic | 0.58 |
| $X^2$ approximation | 0.58 |
| DF | 1 |
| p-value | 0.4460[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.

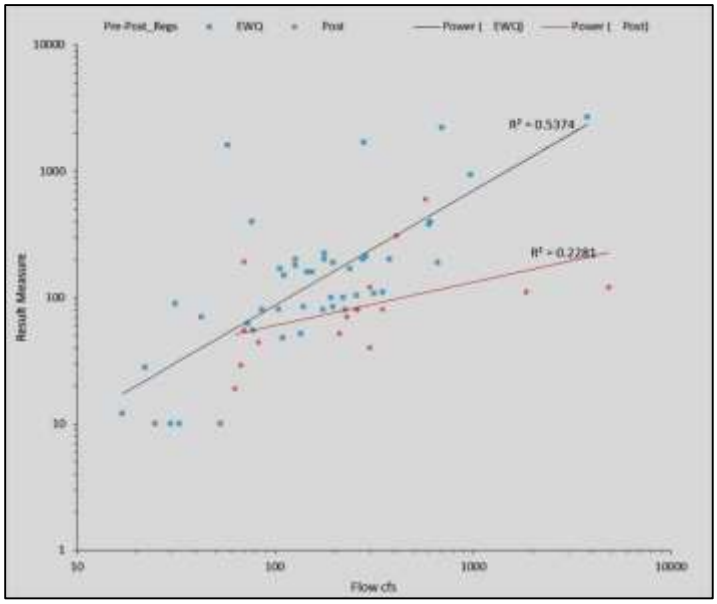
Analytical uncertainty was introduced by potential laboratory artifacts and insufficient post-EWQ sampling rate. Post-EWQ median E. coli fell within the EWQ 95% confidence intervals. Concentrations and flows are plotted on logarithmic scale, and regressions are power relationships. An insufficient number of samples were taken in the post-EWQ period (n=16). Biweekly instead of monthly sampling is recommended. E. coli concentrations are weakly related to flow in EWQ data, but unrelated in post-EWQ data. No independent data were available to validate DRBC results at this location.

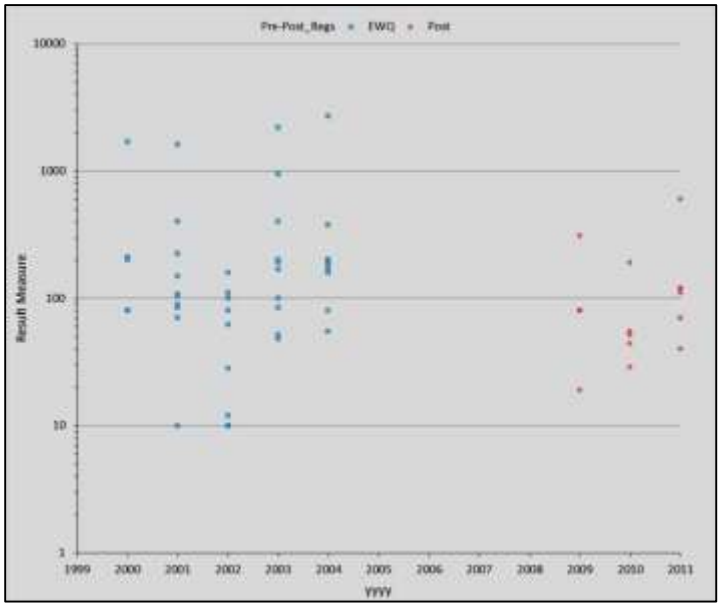
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

Fecal coliform colonies/100 ml

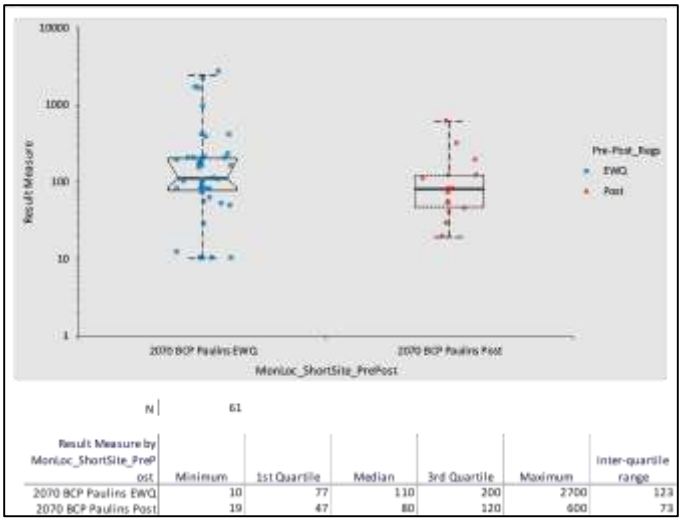
Existing Water Quality (Table 2D):

Median 110/100 ml
Lower 95% Confidence Interval 84/100 ml
Upper 95% Confidence Interval 190/100 ml
Defined in regulations as a flow-related parameter



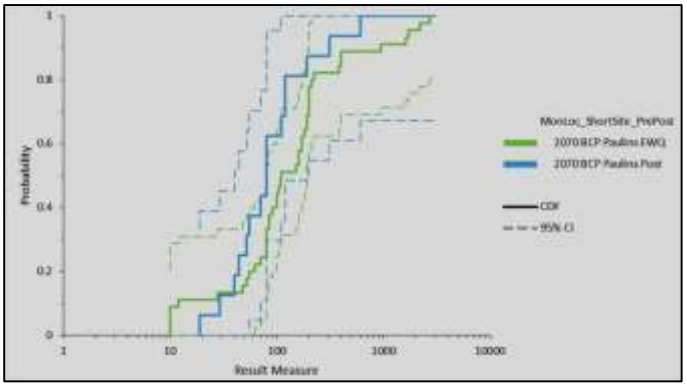




No water quality degradation is evident here. Fecal coliform concentrations apparently fell below the lower EWQ 95% confidence interval, but did not measurably change between the two periods.




N 61

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 10 | 77 | 110 | 200 | 2700 | 123 |
| 2070 BCP Paulins Post | 19 | 47 | 80 | 120 | 600 | 73 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 45 | 200.6 | 4.46 |
| 2070 BCP Paulins Post | 16 | 564.1 | 35.25 |

| | |
|---|---|
| H statistic | 2.43 |
| $X^2$ approximation | 2.43 |
| DF | 1 |
| p-value | 0.1189 [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.

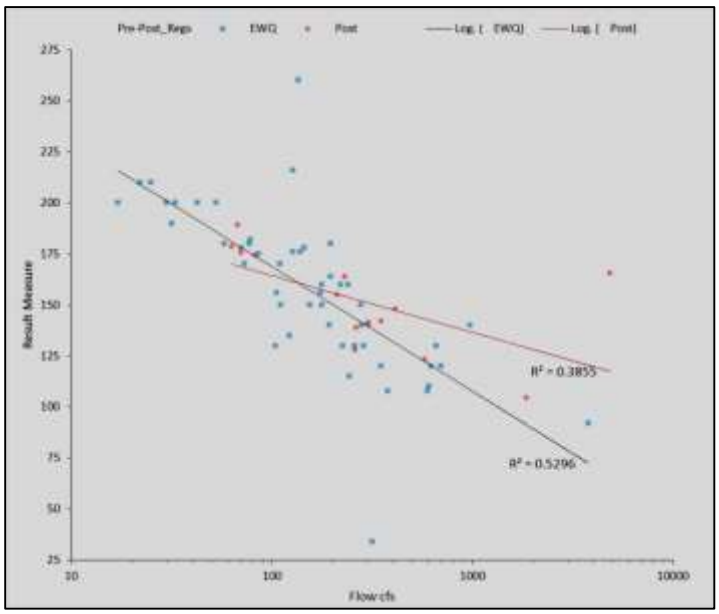
Analytical uncertainty was introduced by potential laboratory artifacts and insufficient post-EWQ sampling rate. There were fewer high results in the post-EWQ data set, but insufficient data to indicate significant change. Fecal coliform concentrations are related to flow in both data sets, though weakly so in post-EWQ data. Biweekly instead of monthly sampling is recommended. Concentrations and flows are plotted on logarithmic scale, and regressions are power relationships. No independent data were available for comparison with DRBC data.

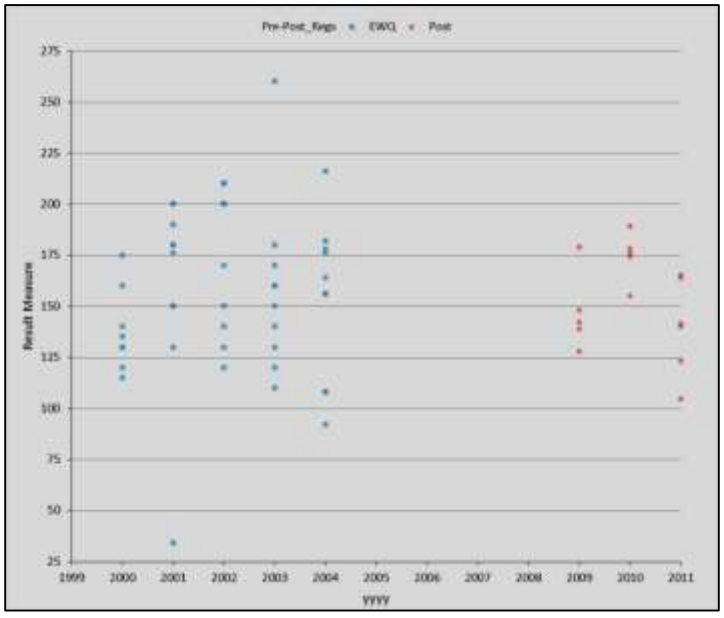
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

Hardness as CaCO3, Total mg/l

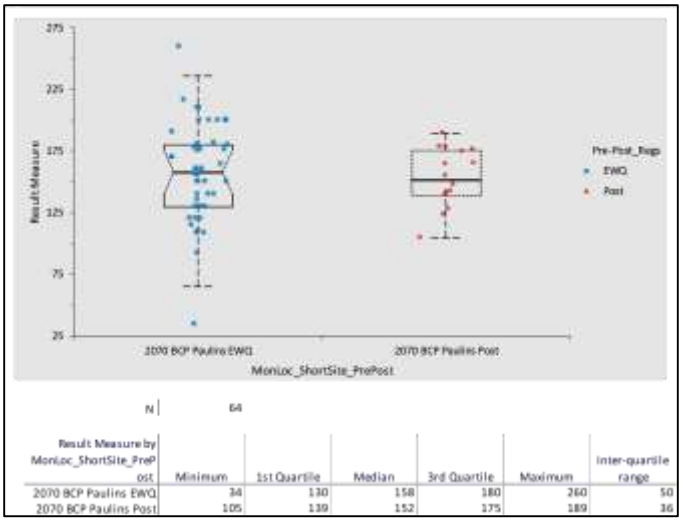
Existing Water Quality (Table 2D):

Median 158 mg/l
Lower 95% Confidence Interval 140 mg/l
Upper 95% Confidence Interval 176 mg/l
Defined in regulations as a flow-related parameter



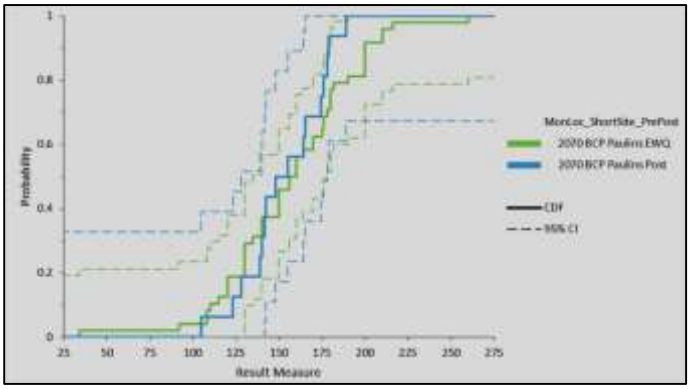




No water quality degradation is evident here. Hardness apparently did not measurably change between the EWQ and post-EWQ periods.




N 64

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 34 | 130 | 158 | 180 | 260 | 50 |
| 2070 BCP Paulins Post | 105 | 139 | 152 | 175 | 189 | 36 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 48 | 24.1 | 0.50 |
| 2070 BCP Paulins Post | 16 | 72.3 | 4.52 |

| | |
|---|---|
| H statistic | 0.28 |
| $X^2$ approximation | 0.28 |
| DF | 1 |
| p-value | 0.5978 [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.

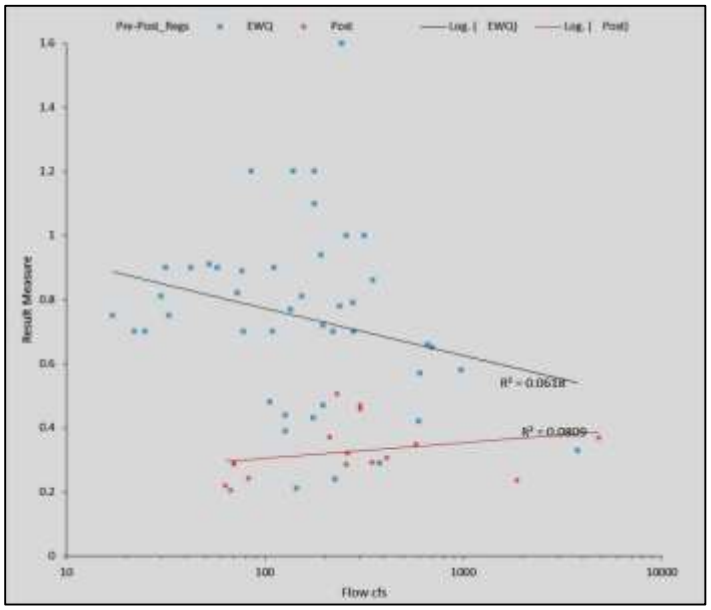
Analytical uncertainty was introduced by potential laboratory artifacts and insufficient post-EWQ sampling rate. Hardness is inversely related to flow in both data sets. The strength of the relationship in the post-EWQ data is weakened by too few data across the full range of flow, so the relationship is not certain. Post-EWQ median hardness fell within the EWQ 95% confidence intervals, and the cumulative distributions were nearly identical. Flow is plotted on logarithmic scale. No independent data were available for comparison with DRBC results. The high concentrations observed are typical of limestone-influenced streams.

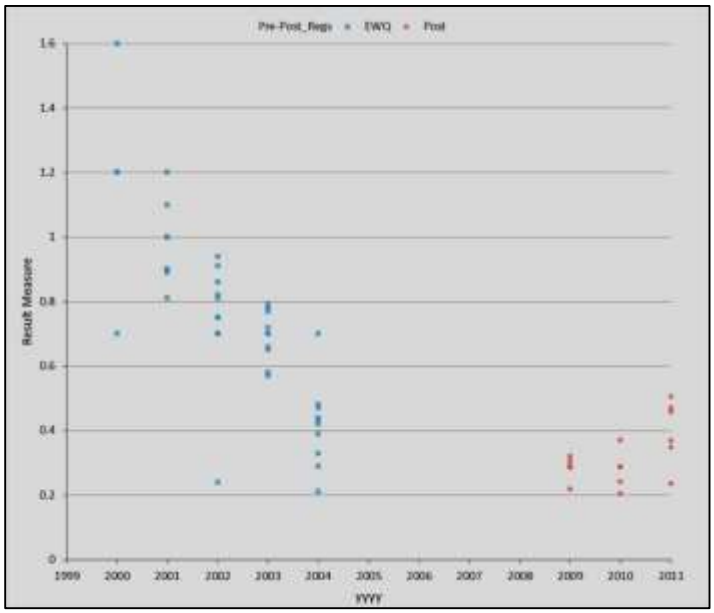
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

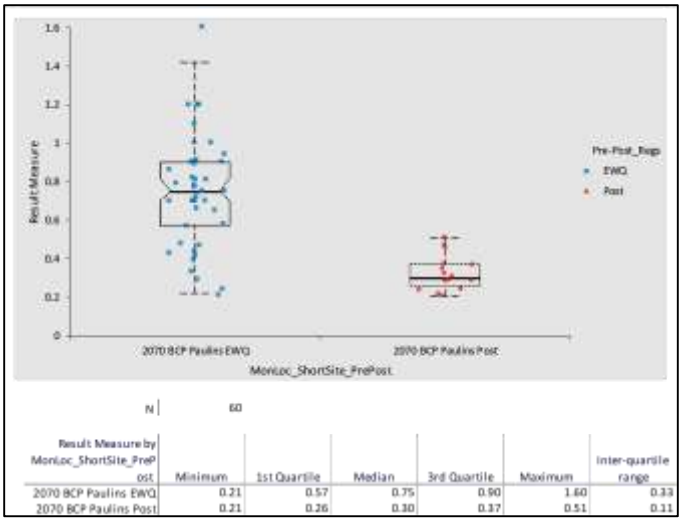
Nitrate + Nitrite as N, Total mg/l

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

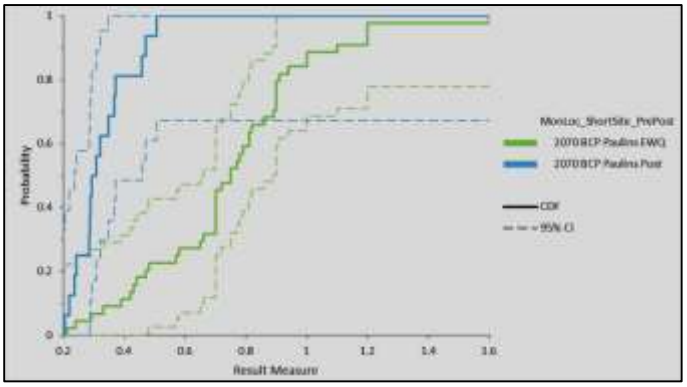
Median 0.75 mg/l
Lower 95% Confidence Interval 0.70 mg/l
Upper 95% Confidence Interval 0.86 mg/l




| N | 60 | | | | | |
|---|---|---|---|---|---|---|
| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
| 2070 BCP Paulins EWQ | 0.21 | 0.57 | 0.75 | 0.90 | 1.60 | 0.33 |
| 2070 BCP Paulins Post | 0.21 | 0.26 | 0.30 | 0.37 | 0.51 | 0.11 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 44 | 1977.8 | 44.95 |
| 2070 BCP Paulins Post | 16 | 5439.1 | 339.94 |

| | |
|---|---|
| H statistic | 24.35 |
| $X^2$ approximation | 24.35 |
| 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.

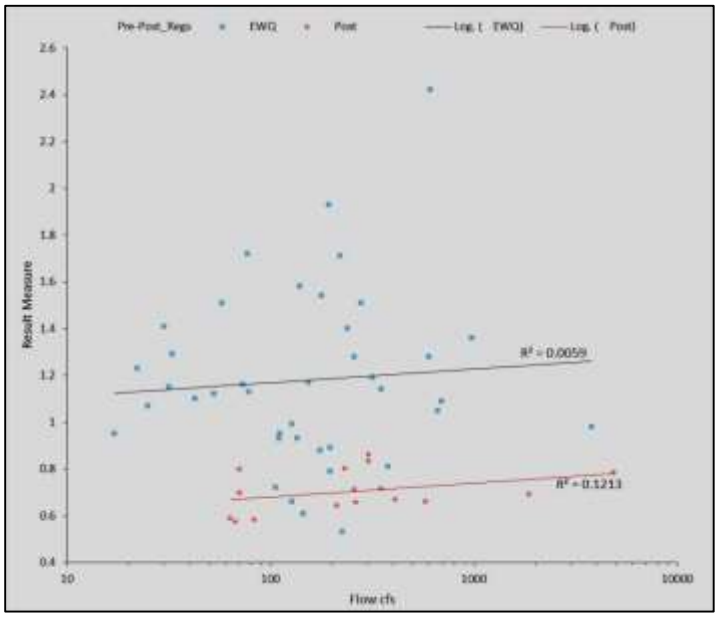
No water quality degradation is evident here. Nitrate concentrations apparently declined between the EWQ and post-EWQ periods. Analytical uncertainty was introduced by potential laboratory artifacts and insufficient post-EWQ sampling rate. Nitrate is unrelated to flow in both data sets. Post-EWQ nitrate concentrations fell below the lower EWQ 95% confidence interval, and were less variable than EWQ nitrate. Post-EWQ nitrate + nitrite concentrations were assumed equivalent with EWQ nitrate concentrations since EWQ nitrite concentrations were never detected. No independent data were available for comparison with DRBC results.

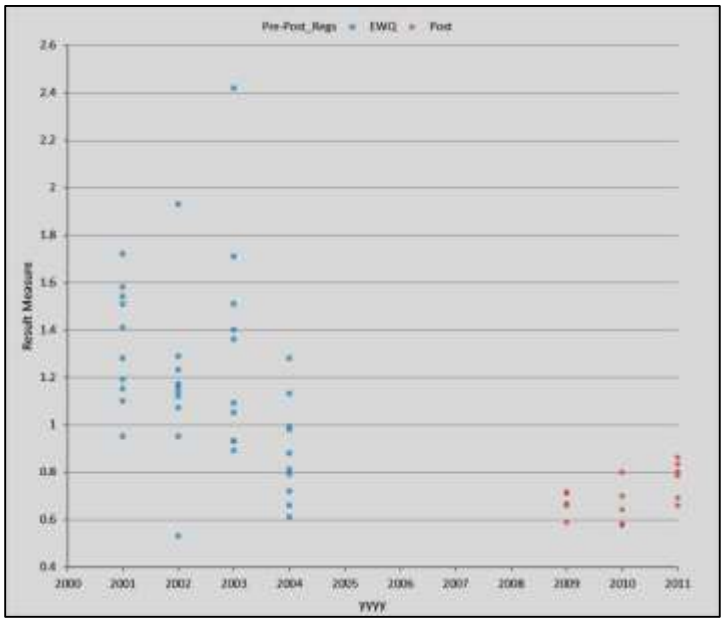
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

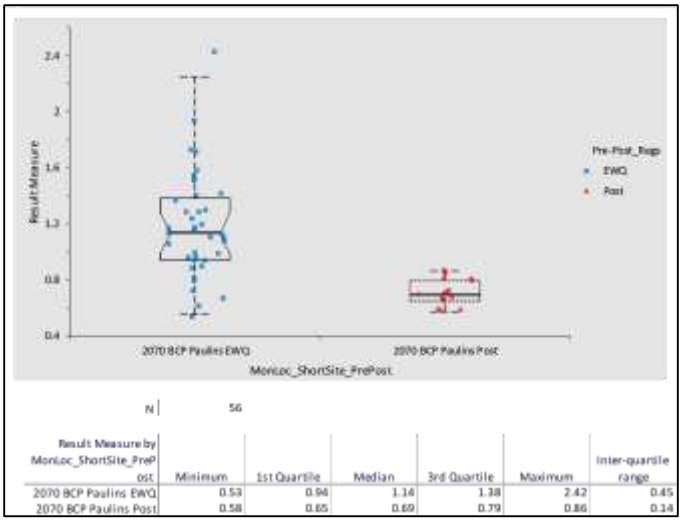
Nitrogen as N, Total (TN) mg/l

Existing Water Quality (Table 2D):

Median 1.13 mg/l
Lower 95% Confidence Interval 0.99 mg/l
Upper 95% Confidence Interval 1.28 mg/l

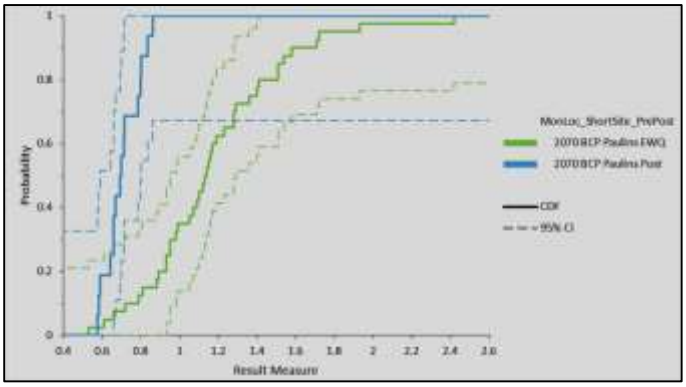



| | |
|---|---|
| N | 56 |

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 0.53 | 0.94 | 1.14 | 1.38 | 2.42 | 0.45 |
| 2070 BCP Paulins Post | 0.58 | 0.65 | 0.69 | 0.79 | 0.86 | 0.14 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 40 | 1809.0 | 45.23 |
| 2070 BCP Paulins Post | 16 | 4522.6 | 282.66 |

| | |
|---|---|
| H statistic | 23.80 |
| $X^2$ approximation | 23.80 |
| 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.

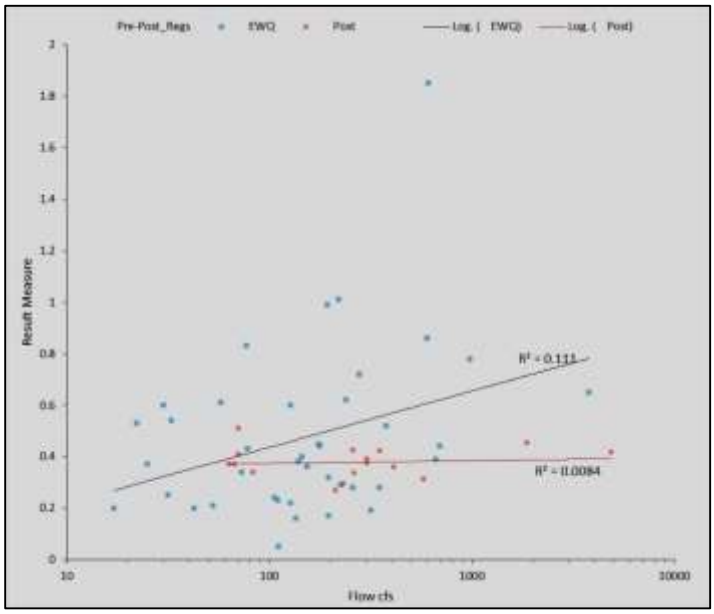
No water quality degradation is evident here. Total Nitrogen concentrations apparently declined between the two periods. Analytical uncertainty was introduced by potential laboratory artifacts and insufficient post-EWQ sampling rate. TN is unrelated to flow in both data sets. Post-EWQ median TN concentrations fell below the EWQ lower 95% confidence intervals. There were no independent data available to confirm DRBC results.

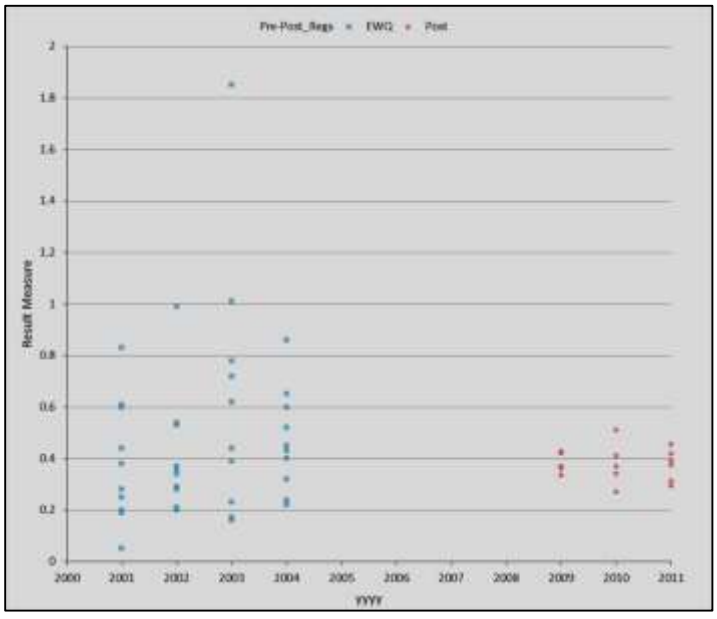
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

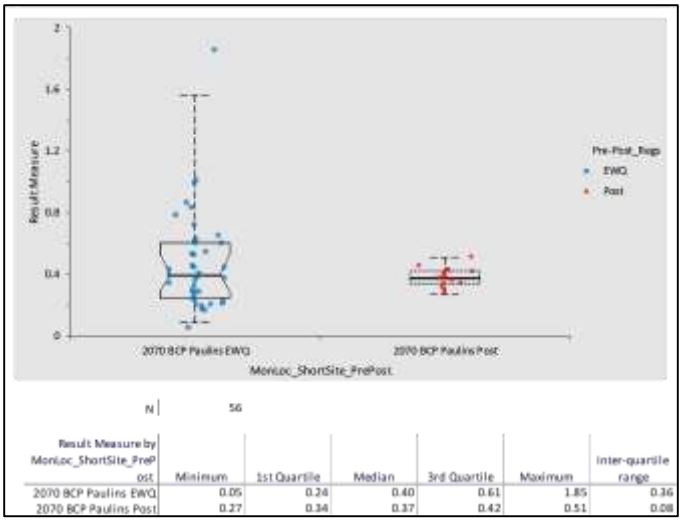
Nitrogen, Kjeldahl as N, Total (TKN) mg/l

Existing Water Quality (Table 2D):

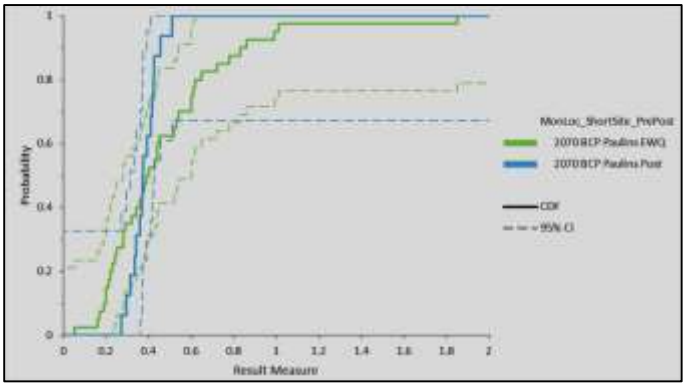
Median 0.39 mg/l
Lower 95% Confidence Interval 0.29 mg/l
Upper 95% Confidence Interval 0.53 mg/l




| N | 56 | | | | | |
|---|---|---|---|---|---|---|
| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
| 2070 BCP Paulins EWQ | 0.05 | 0.24 | 0.40 | 0.61 | 1.85 | 0.36 |
| 2070 BCP Paulins Post | 0.27 | 0.34 | 0.37 | 0.42 | 0.51 | 0.08 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 40 | 19.6 | 0.49 |
| 2070 BCP Paulins Post | 16 | 49.0 | 3.06 |

| | |
|---|---|
| H statistic | 0.26 |
| $X^2$ approximation | 0.26 |
| DF | 1 |
| p-value | 0.6115 [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.

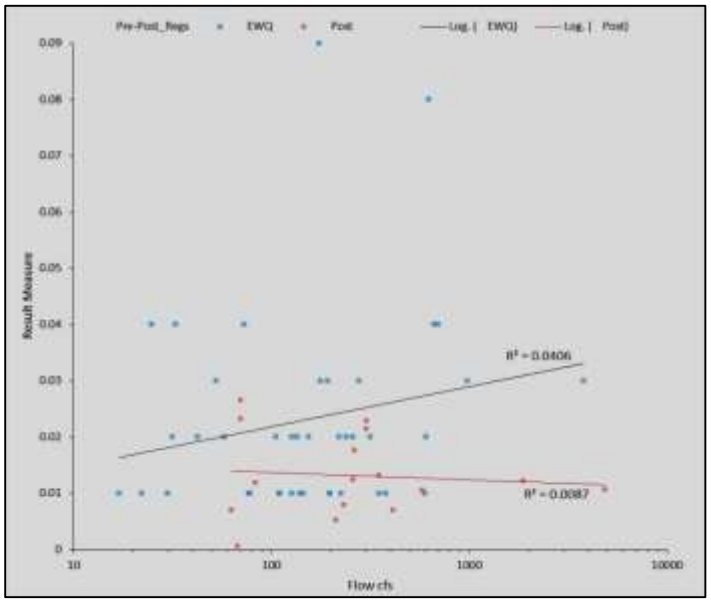
No water quality degradation is evident here. TKN median concentrations apparently did not measurably change between the EWQ and post-EWQ periods. Analytical uncertainty was introduced by potential laboratory artifacts and insufficient post-EWQ sampling rate. The post-EWQ range was far narrower and all concentrations were less than 0.51 mg/l, but post-EWQ median TKN concentration fell within EWQ 95% confidence intervals. TKN concentration is unrelated to flow in both data sets. There were no independent data to confirm DRBC results.

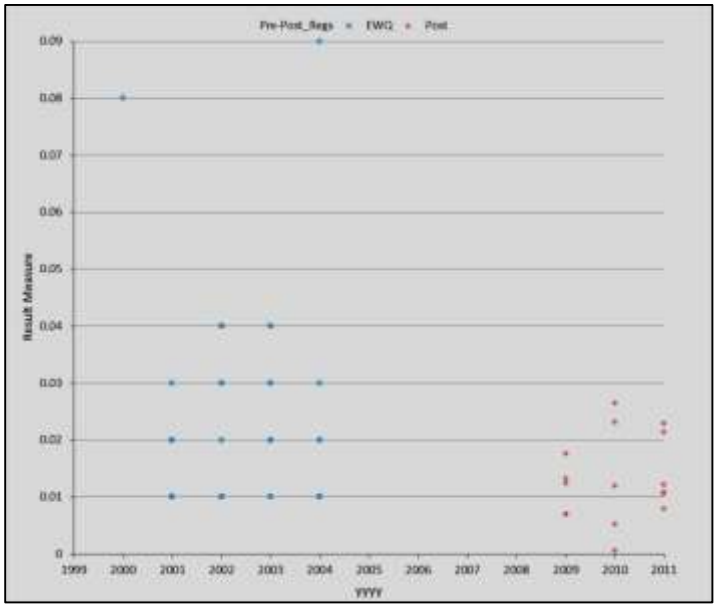
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

Orthophosphate as P, Total mg/l (OP)

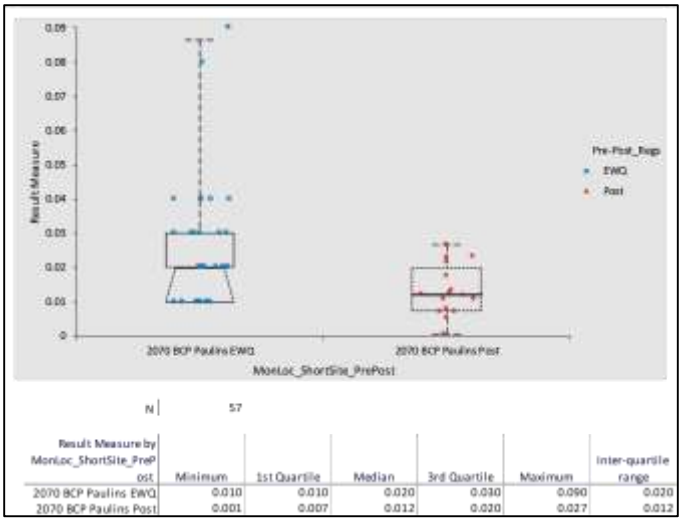
Existing Water Quality (Table 2D):

Median 0.02 mg/l
Lower 95% Confidence Interval 0.01 mg/l
Upper 95% Confidence Interval 0.02 mg/l



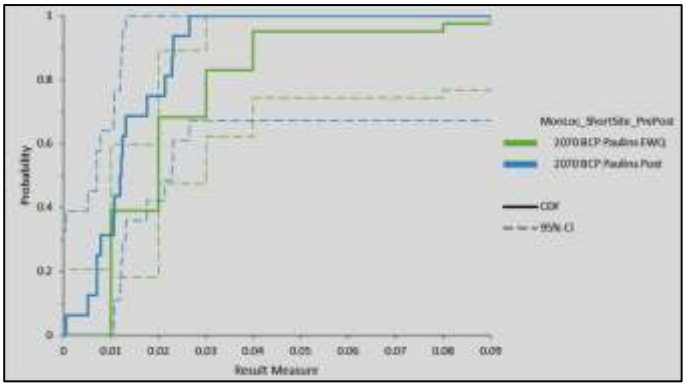




No water quality degradation is evident here. Orthophosphate concentrations apparently declined between the EWQ and post-EWQ periods.




| | |
|---|---|
| N | 57 |

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 0.010 | 0.010 | 0.020 | 0.030 | 0.090 | 0.020 |
| 2070 BCP Paulins Post | 0.001 | 0.007 | 0.012 | 0.020 | 0.027 | 0.012 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 41 | 263.8 | 6.43 |
| 2070 BCP Paulins Post | 16 | 676.0 | 42.25 |

| | |
|---|---|
| H statistic | 3.53 |
| $X^2$ approximation | 3.53 |
| DF | 1 |
| p-value | 0.0603 [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.

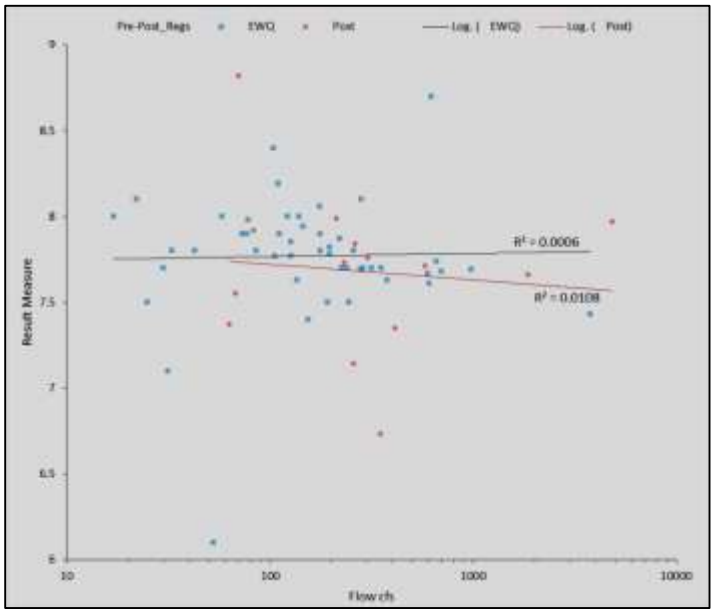
Analytical uncertainty was introduced by potential laboratory artifacts, detection limit differences, and insufficient post-EWQ sampling rate (n=16). OP is unrelated to flow in both data sets. Post-EWQ median OP fell near the EWQ lower 95% confidence interval. Detection limits improved between the two periods. There were no post-EWQ undetected concentrations, and no results higher than 0.027 mg/l. The EWQ non-detection rate was 16 out of 41 samples, so the undetected results did not interfere with estimation of the median. Post-EWQ orthophosphate ranged less widely than EWQ data. There were no independent data available to confirm DRBC results.

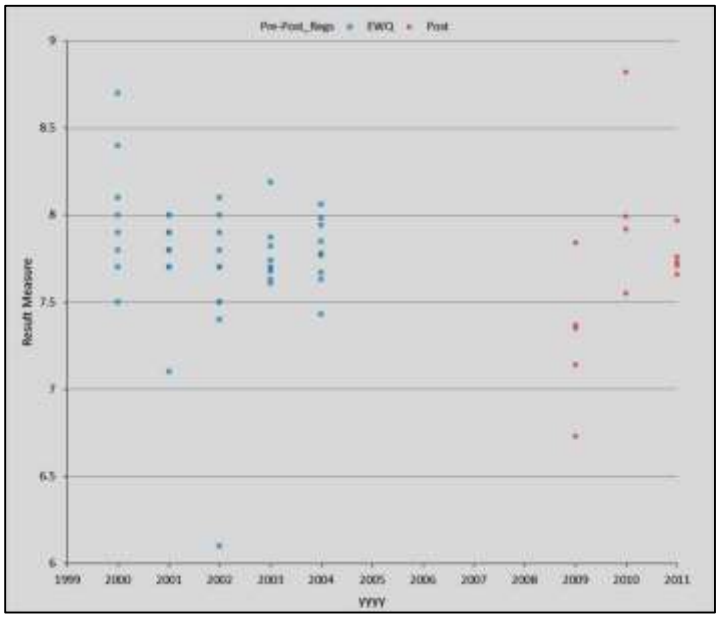
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

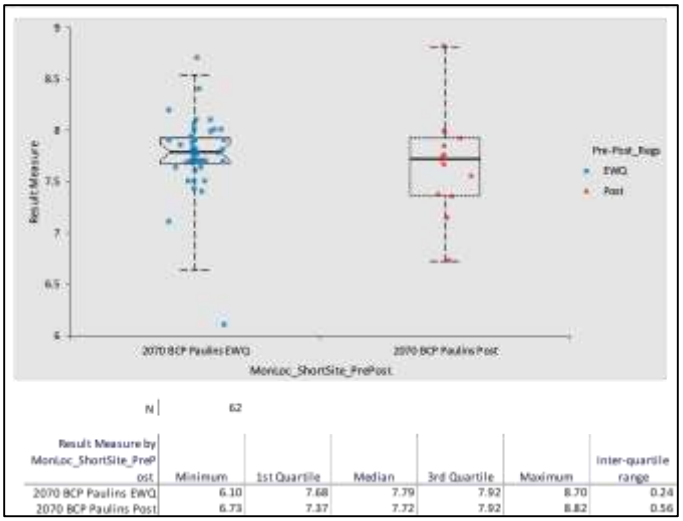
pH

Existing Water Quality (Table 2D):

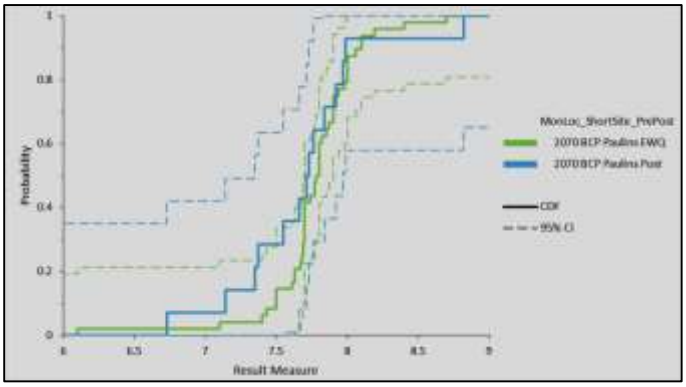
Median 7.79 standard units
Lower 95% Confidence Interval 7.70 standard units
Upper 95% Confidence Interval 7.87 standard units




| N | 62 | | | | | |
|---|---|---|---|---|---|---|
| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
| 2070 BCP Paulins EWQ | 6.10 | 7.68 | 7.79 | 7.92 | 8.70 | 0.24 |
| 2070 BCP Paulins Post | 6.73 | 7.37 | 7.72 | 7.92 | 8.82 | 0.56 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 48 | 80.1 | 1.67 |
| 2070 BCP Paulins Post | 14 | 274.6 | 19.61 |

| | |
|---|---|
| H statistic | 1.09 |
| $X^2$ approximation | 1.09 |
| DF | 1 |
| p-value | 0.2961 [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.

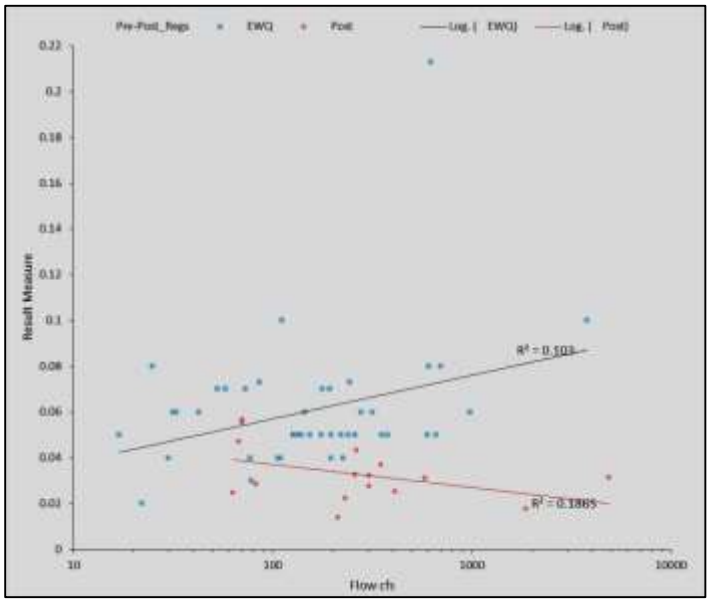
No water quality degradation is evident here. pH apparently did not measurably change between the EWQ and post-EWQ periods. Analytical uncertainty was introduced by insufficient post-EWQ sampling rate (n=14). pH is unrelated to flow in both data sets. Post-EWQ median pH was within the EWQ 95% confidence intervals. No independent data were available to confirm DRBC results.

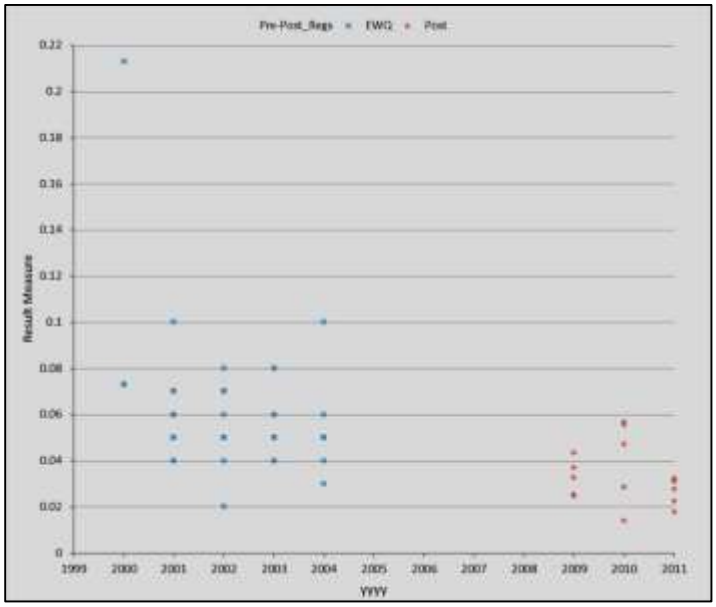
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

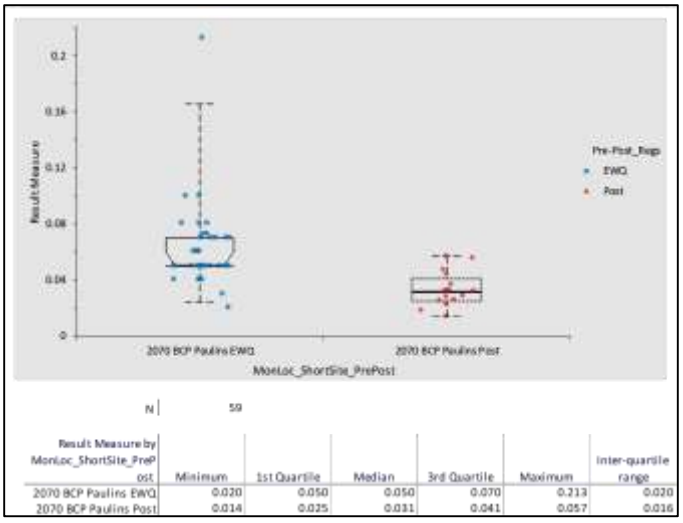
Phosphorus as P, Total (TP) mg/l

Existing Water Quality (Table 2D):

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

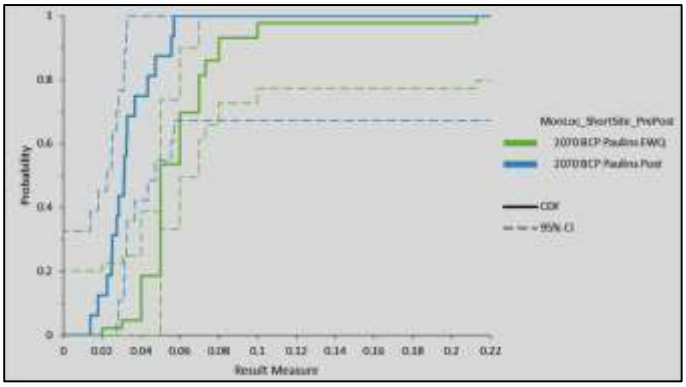



| | |
|---|---|
| N | 59 |

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 0.020 | 0.050 | 0.050 | 0.070 | 0.213 | 0.020 |
| 2070 BCP Paulins Post | 0.014 | 0.025 | 0.031 | 0.041 | 0.057 | 0.016 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 43 | 1657.9 | 38.56 |
| 2070 BCP Paulins Post | 16 | 4455.6 | 278.47 |

| | |
|---|---|
| H statistic | 21.14 |
| $X^2$ approximation | 21.14 |
| 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.

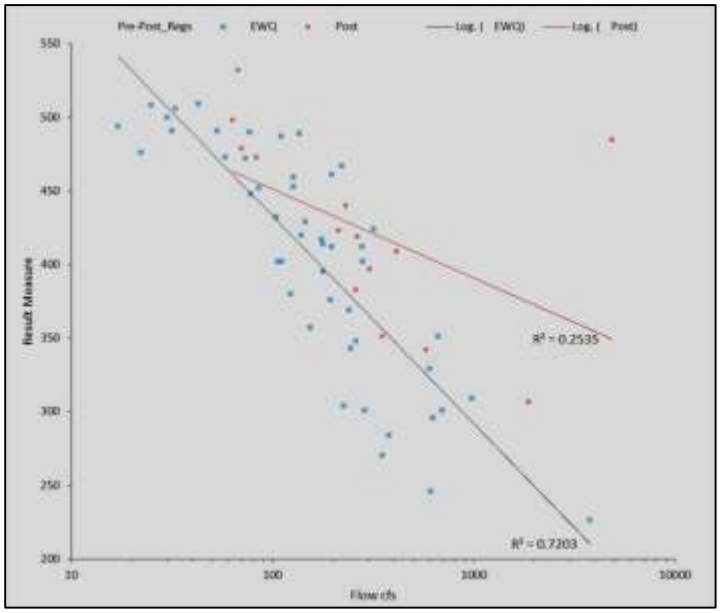
No water quality degradation is evident here. Total Phosphorus (TP) concentrations apparently declined between the EWQ and post-EWQ periods. Analytical uncertainty was introduced by potential laboratory artifacts and insufficient post-EWQ sampling rate (n=16). Post-EWQ median total phosphorus fell below the EWQ lower 95% confidence interval. TP is unrelated to flow in both data sets. There were no undetected results in either data set. No independent data were available to confirm DRBC results.

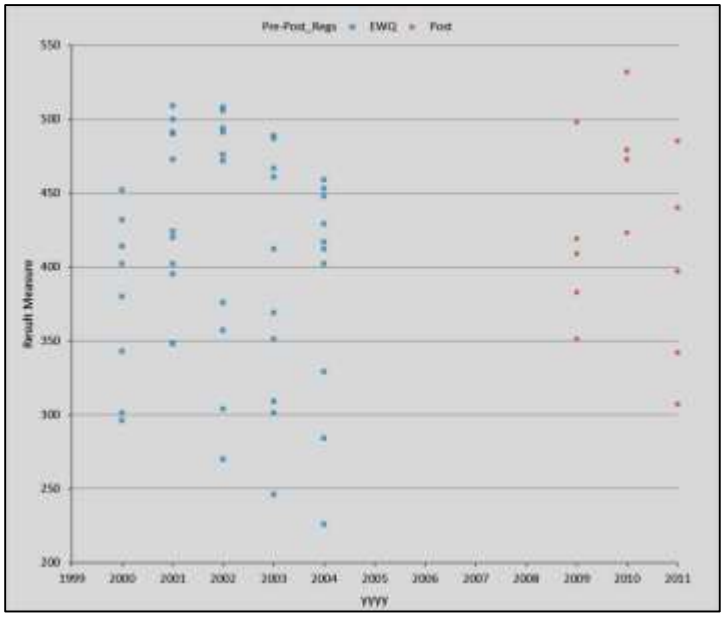
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

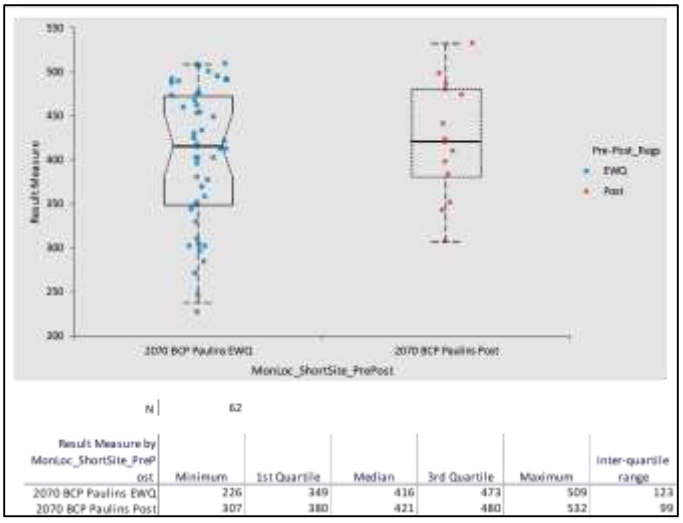
Specific Conductance µmho/cm

Existing Water Quality (Table 2D):

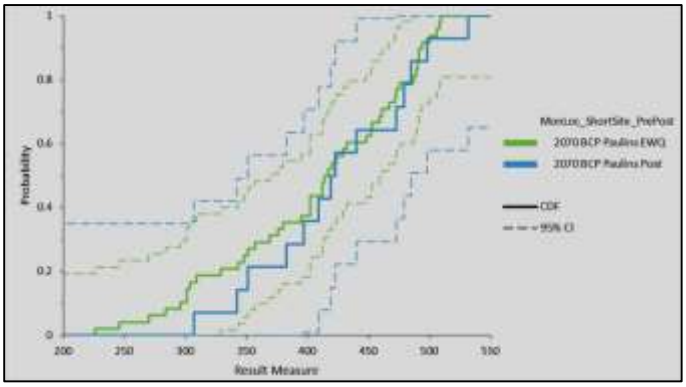
Median 416 µmho/cm
Lower 95% Confidence Interval 380 µmho/cm
Upper 95% Confidence Interval 453 µmho/cm
Defined in regulations as a flow-related parameter




| Result Measure by MonLoc_ShortSite_PrePost | N | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|---|
| | 62 | | | | | | |
| 2070 BCP Paulins EWQ | | 226 | 349 | 416 | 473 | 509 | 123 |
| 2070 BCP Paulins Post | | 307 | 380 | 421 | 480 | 532 | 99 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 48 | 25.5 | 0.53 |
| 2070 BCP Paulins Post | 14 | 87.5 | 6.25 |

| | |
|---|---|
| H statistic | 0.35 |
| $X^2$ approximation | 0.35 |
| DF | 1 |
| p-value | 0.5556[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.

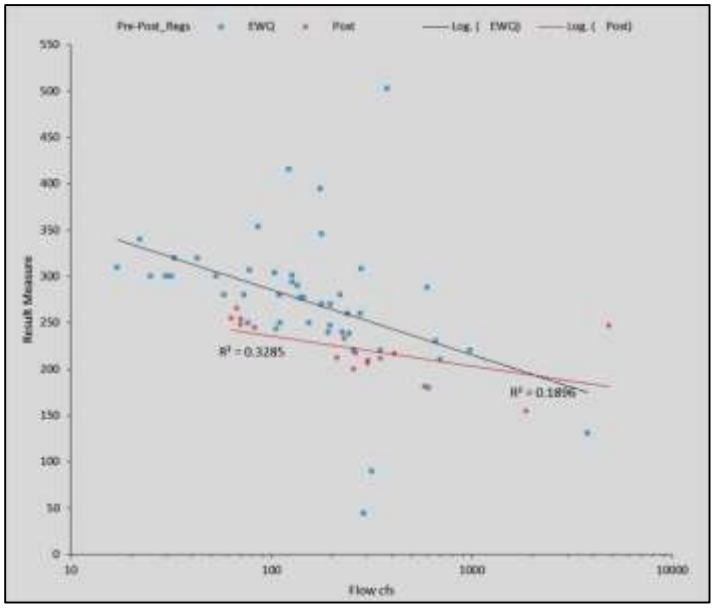
No water quality degradation is evident here. Specific conductance increased by only 5 µmho/cm between the EWQ and post-EWQ periods which was well within the EWQ 95% confidence intervals. There were an insufficient number of samples taken in the post-EWQ time frame (n=14). Biweekly instead of monthly sampling is recommended at this site. Specific conductance is inversely related to flow in both data sets, but due to too few samples the post-EWQ relationship is disrupted by a single unusual and unexplained value. The rise in specific conductance seen elsewhere is not apparent here. There were no available independent data to confirm results.

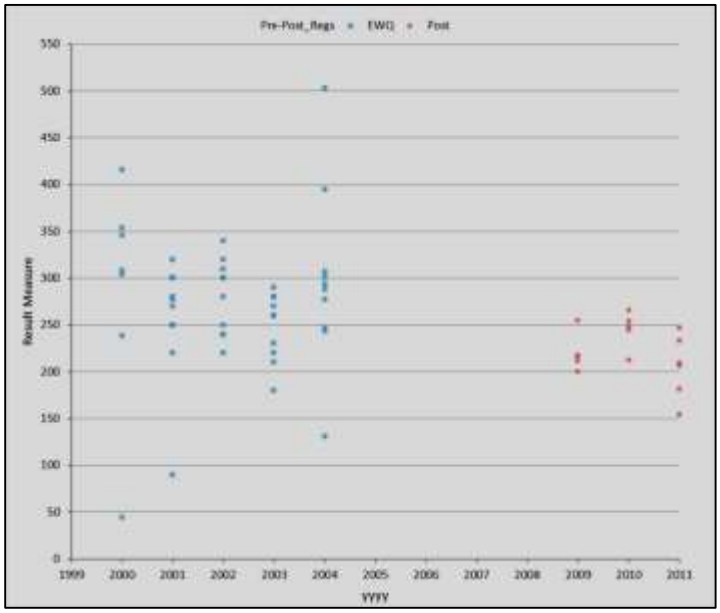
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

Total Dissolved Solids (TDS) mg/l

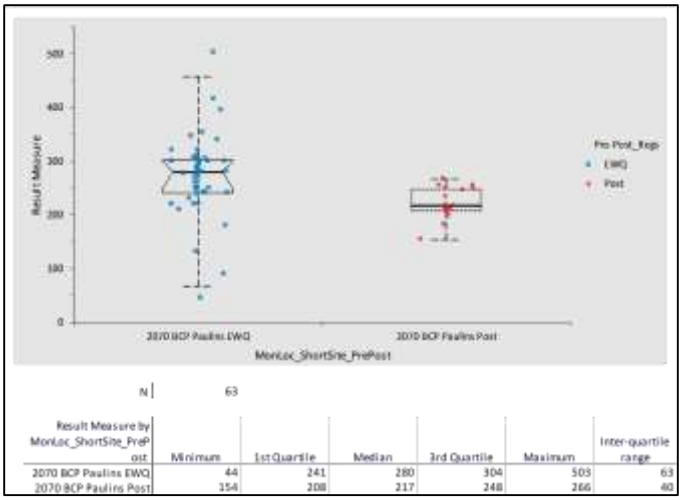
Existing Water Quality (Table 2D):

Median 280 mg/l
Lower 95% Confidence Interval 250 mg/l
Upper 95% Confidence Interval 300 mg/l
Defined in regulations as a flow-related parameter



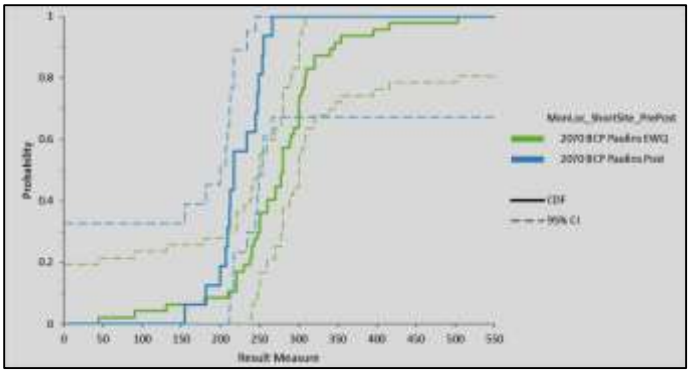




No water quality degradation is evident here. TDS apparently declined between the two periods.




| | |
|---|---|
| N | 63 |

| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|
| 2070 BCP Paulins EWQ | 44 | 241 | 280 | 304 | 503 | 63 |
| 2070 BCP Paulins Post | 154 | 208 | 217 | 248 | 266 | 40 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 47 | 1175.0 | 25.00 |
| 2070 BCP Paulins Post | 16 | 3451.6 | 215.72 |

| | |
|---|---|
| H statistic | 13.78 |
| $X^2$ approximation | 13.78 |
| DF | 1 |
| p-value | 0.0002[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.

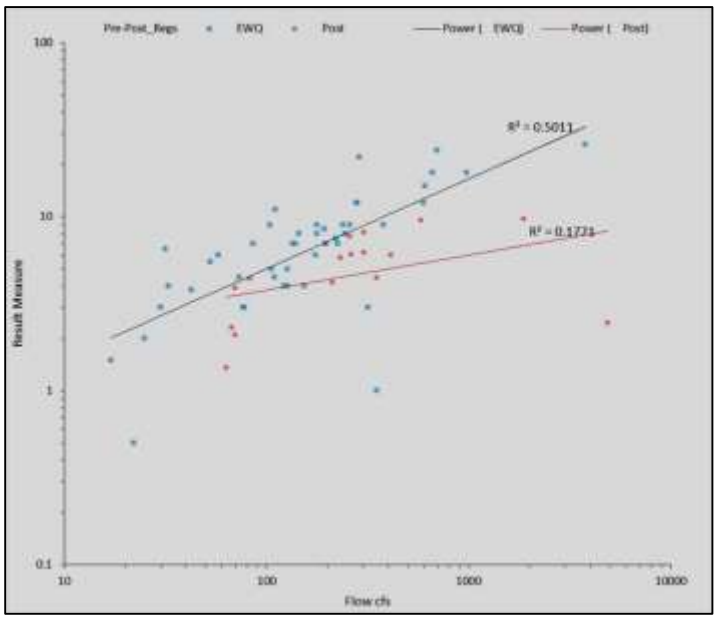
Analytical uncertainty was introduced by potential laboratory artifacts, insufficient post-EWQ sampling rate (n=16), and low-flow differences. TDS is weakly related to flow in both data sets. Post-EWQ median TDS fell below the EWQ lower 95% lower confidence interval, and was less variable than the baseline samples as well. Post-EWQ detection limits were lower than EWQ detection limits, though there were no undetected results at any time. Perhaps this decline is not real but an artifact of different laboratories. It should be noted that the 2003 data are comparable to 2009-2011 data, so some reduction shown here may be real. There were no independent data available for comparison with DRBC results.

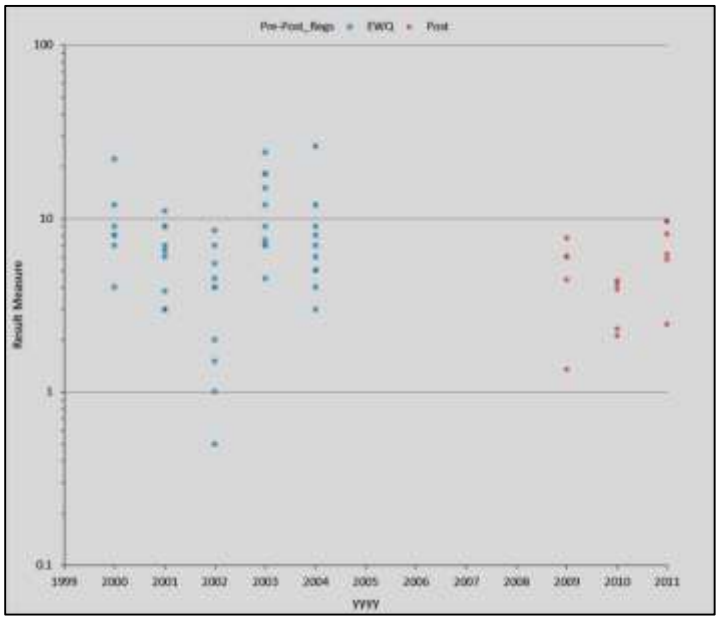
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

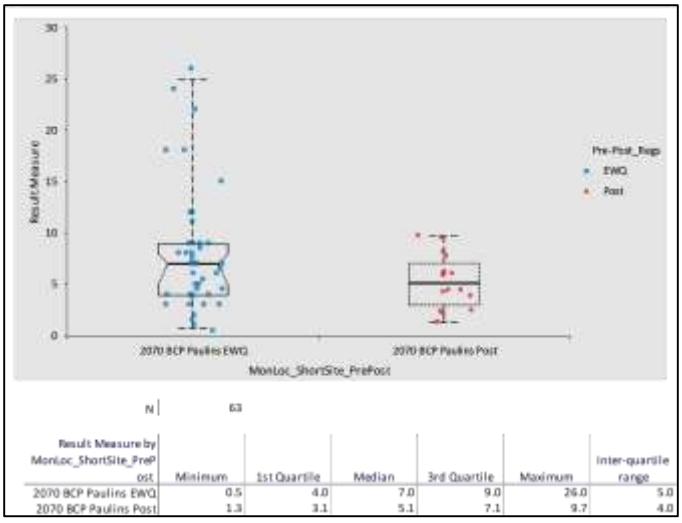
Total Suspended Solids (TSS) mg/l

Existing Water Quality (Table 2D):

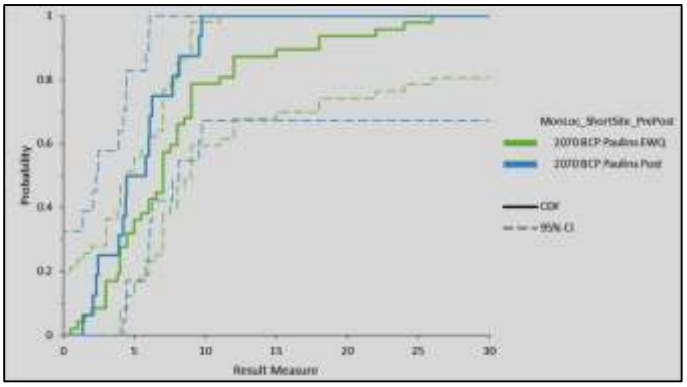
Median 7.0 mg/l
Lower 95% Confidence Interval 5.0 mg/l
Upper 95% Confidence Interval 8.0 mg/l
*Should have been designated as flow-related in rules




| N | 63 | | | | | |
|---|---|---|---|---|---|---|
| Result Measure by MonLoc_ShortSite_PrePost | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
| 2070 BCP Paulins EWQ | 0.5 | 4.0 | 7.0 | 9.0 | 26.0 | 5.0 |
| 2070 BCP Paulins Post | 1.3 | 3.1 | 5.1 | 7.1 | 9.7 | 4.0 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 47 | 225.7 | 4.80 |
| 2070 BCP Paulins Post | 16 | 663.1 | 41.44 |

| | |
|---|---|
| H statistic | 2.65 |
| $X^2$ approximation | 2.65 |
| DF | 1 |
| p-value | 0.1035 [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.

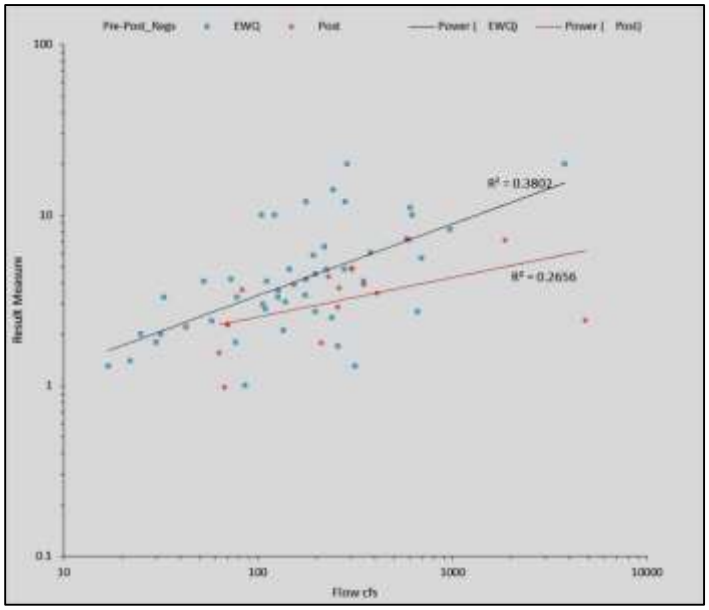
No water quality degradation is evident here. TSS apparently did not measurably change between the EWQ and post-EWQ periods. Analytical uncertainty was introduced by potential laboratory artifacts, insufficient post-EWQ sampling rate (n=16), and low-flow differences. TSS is positively related to flow in both data sets, though the post-EWQ relationship is very weak because of insufficient sampling (n=16). Post-EWQ median TSS fell near the lower EWQ 95% confidence interval. Flows and concentrations are plotted on logarithmic scale, and regressions are power relationships. There were no independent data available for comparison with DRBC results.

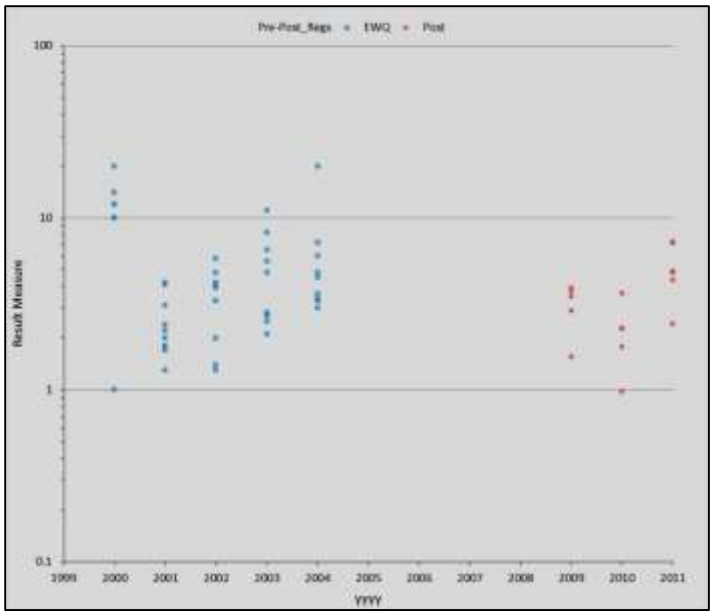
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

Turbidity NTU

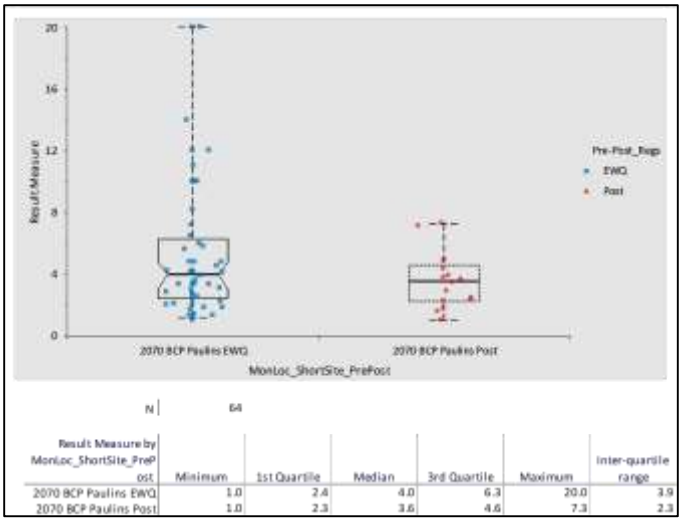
Existing Water Quality (Table 2D):

Median 4.0 NTU
Lower 95% Confidence Interval 3.0 NTU
Upper 95% Confidence Interval 4.8 NTU
Defined in regulations as a flow-related parameter

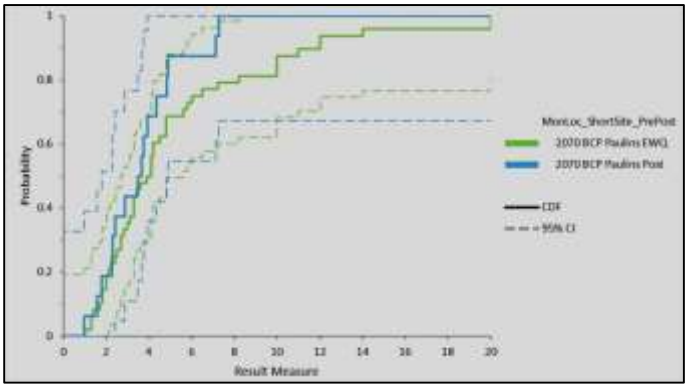



No water quality degradation is evident here. Turbidity apparently did not measurably change between the EWQ and post-EWQ periods.




| Result Measure by MonLoc_ShortSite_PrePost | N | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|---|
| | 64 | | | | | | |
| 2070 BCP Paulins EWQ | | 1.0 | 2.4 | 4.0 | 6.3 | 20.0 | 3.9 |
| 2070 BCP Paulins Post | | 1.0 | 2.3 | 3.6 | 4.6 | 7.3 | 2.3 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 48 | 82.7 | 1.72 |
| 2070 BCP Paulins Post | 16 | 248.1 | 15.50 |

| | |
|---|---|
| H statistic | 0.95 |
| $X^2$ approximation | 0.95 |
| DF | 1 |
| p-value | 0.3286 [1] |

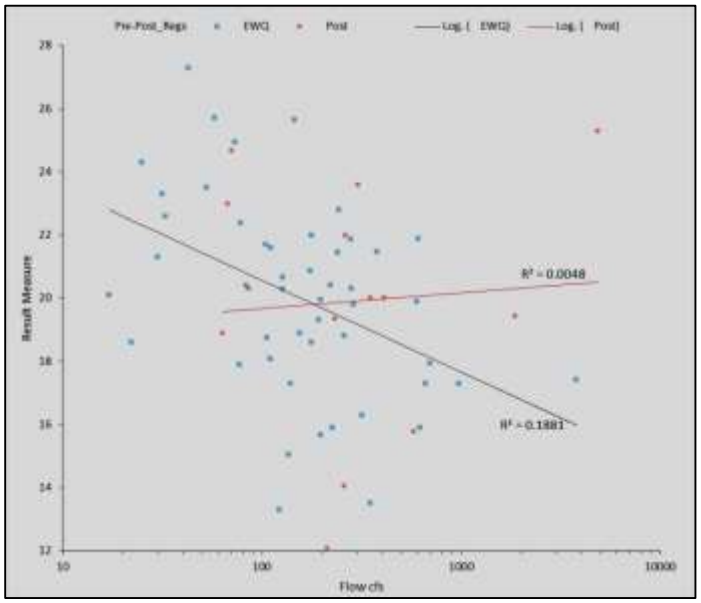
H0: $\theta_1 = \theta_2 = \theta...$
The median of the populations are all equal.
H1: $\theta_i \neq \theta_j$ for at least one i,j
The median of the populations are not all equal.
[1] Do not reject the null hypothesis at the 5% significance level.

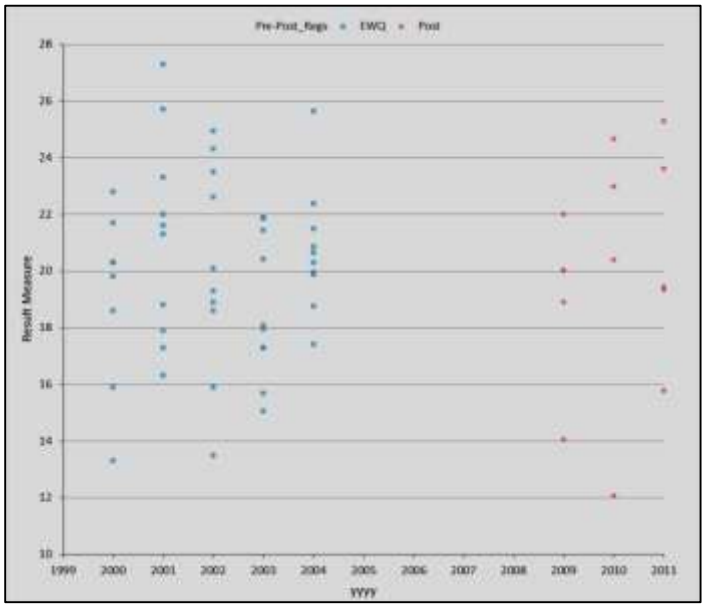
There were an insufficient number of post-EWQ samples (n=16), and too few samples taken under low-flow conditions. Post-EWQ median turbidity fell within the EWQ 95% confidence intervals of the median. Turbidity is positively related to flow in both data sets. The post-EWQ regression is weak because of the low sample number and insufficient range of flow conditions sampled. Concentrations and flows are represented on logarithmic scale, and regressions are power relationships. There were no independent data available for comparison with DRBC results. Biweekly instead of monthly sampling is recommended at this location.

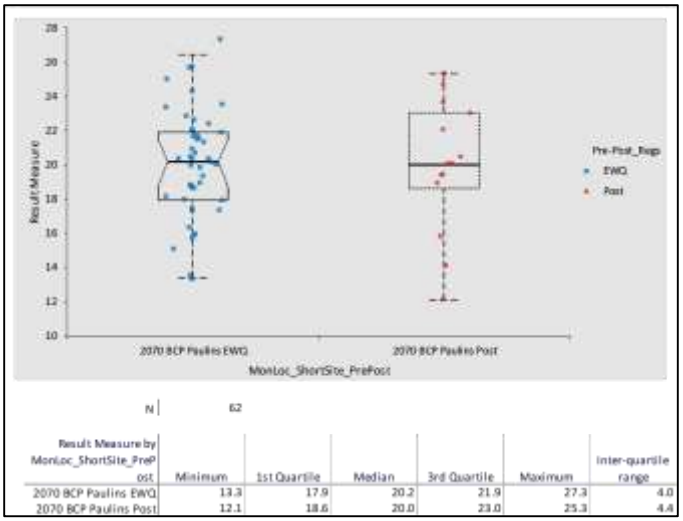
Chapter 23: 2070 BCP Paulins Kill at Rt. 46, NJ

Water Temperature, degrees C

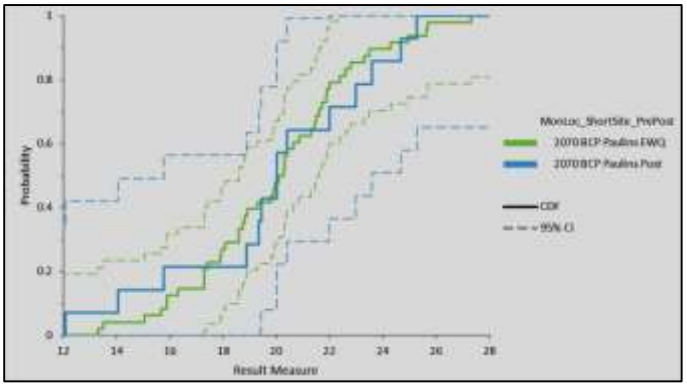
Not included in DRBC Existing Water Quality rules




| Result Measure by MonLoc_ShortSite_PrePost | N | Minimum | 1st Quartile | Median | 3rd Quartile | Maximum | Inter-quartile range |
|---|---|---|---|---|---|---|---|
| | 62 | | | | | | |
| 2070 BCP Paulins EWQ | | 13.3 | 17.9 | 20.2 | 21.9 | 27.3 | 4.0 |
| 2070 BCP Paulins Post | | 12.1 | 18.6 | 20.0 | 23.0 | 25.3 | 4.4 |




Kruskal-Wallis test

| Result Measure by MonLoc_ShortSite_PrePost | n | Rank sum | Mean rank |
|---|---|---|---|
| 2070 BCP Paulins EWQ | 48 | 2.8 | 0.06 |
| 2070 BCP Paulins Post | 14 | 9.4 | 0.67 |

| | |
|---|---|
| H statistic | 0.04 |
| $X^2$ approximation | 0.04 |
| DF | 1 |
| p-value | 0.8465 [1] |

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

No water quality degradation is evident here. Water temperature did not measurably change between the EWQ and post-EWQ periods. There were an insufficient number of post-EWQ samples (n=14), and too few samples taken under low-flow conditions. Water temperature is unrelated to flow in either data set. Note that flows are plotted on logarithmic scale. No independent data were available for comparison with DRBC results.