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

1554 ICP
Delaware River at Bull’s Island Foot Bridge
Analysis of flow differences between the EWQ and post-EWQ monitoring periods:

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

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

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

Tributary BCP Watersheds in Upstream Reach:

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

All other tributaries to the upstream reach are less than 20 square miles drainage area, are not expected to have significant influence upon Delaware River water quality, and possess no wastewater discharges.
Alkalinity as CaCO₃, Total mg/l

Existing Water Quality (Table 2T):

Median 45 mg/l
Lower 95% Confidence Interval 38 mg/l
Upper 95% Confidence Interval 51 mg/l

Defined in regulations as a flow-related parameter

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

Existing Water Quality (Table 2T):

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

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

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

Existing Water Quality (Table 2T):
Median 17 mg/l
Lower 95% Confidence Interval 15 mg/l
Upper 95% Confidence Interval 20 mg/l
Defined in regulations as a flow-related parameter

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

Existing Water Quality (Table 2T):
Median 8.80 mg/l
Lower 95% Confidence Interval 8.40 mg/l
Upper 95% Confidence Interval 9.30 mg/l

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

Existing Water Quality (Table 2T):

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

No water quality degradation is evident. Dissolved Oxygen Saturation did not measurably change between the EWQ and post-EWQ periods. Post-EWQ median DO saturation was within the EWQ 95% confidence intervals. Dissolved Oxygen Saturation is unrelated to flow.
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Enterococcus colonies/100 ml

Existing Water Quality (Table 2T):

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

No water quality degradation is evident. Enterococci did not measurably change between the EWQ and Post-EWQ periods, though the median for the post-EWQ period was higher than the upper 95% confidence interval established in the rules. There were too few measurements taken in the post-EWQ period. Bi-weekly instead of monthly sampling is recommended to improve statistical comparisons. Enterococcus concentrations are unrelated to flow in both data sets. Note that concentrations and flows are plotted on a logarithmic scale.
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Escherichia coli colonies/100 ml

Existing Water Quality (Table 2T):

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

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

E. coli results are extremely variable, as are the other bacteria parameters, especially since too few samples were taken in the post-EWQ period (n=16). E. coli concentrations are weakly related to flow in both data sets. Note that concentrations and flow are plotted on a logarithmic scale. No independent data from other agencies were available at this site to validate DRBC’s conclusion.
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Fecal coliform colonies/100 ml

Existing Water Quality (Table 2T):

Median 71/100 ml
Lower 95% Confidence Interval 36/100 ml
Upper 95% Confidence Interval 90/100 ml

Defined in regulations as a flow-related parameter

No water quality degradation is evident. Fecal coliform concentrations did not measurably change between the EWQ and post-EWQ periods. EWQ fecal coliform concentrations are positively but weakly related to flow, but post-EWQ data are unrelated to flow, probably because of too few post-EWQ samples (n=16). Post-EWQ median concentrations fell within the EWQ 95% confidence intervals. Note that both concentrations and flows are presented on a logarithmic scale.
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Hardness as CaCO3, Total mg/l

Existing Water Quality (Table 2T):
Median 68 mg/l
Lower 95% Confidence Interval 60 mg/l
Upper 95% Confidence Interval 72 mg/l
Defined in regulations as a flow-related parameter

No water quality degradation is indicated. Hardness did not measurably change between the EWQ and post-EWQ periods. Hardness is inversely related to flow. Post-EWQ median hardness fell within the EWQ 95% confidence intervals.
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Nitrate + Nitrite as N, Total mg/l

Existing Water Quality (Table 2T as Nitrate):

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

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

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

Existing Water Quality (Table 2T):
Median 1.48 mg/l
Lower 95% Confidence Interval 1.26 mg/l
Upper 95% Confidence Interval 1.59 mg/l

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

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

Existing Water Quality (Table 2T):
Median 0.32 mg/l
Lower 95% Confidence Interval 0.27 mg/l
Upper 95% Confidence Interval 0.55 mg/l

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

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

Existing Water Quality (Table 2T):

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

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

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

Existing Water Quality (Table 2T):

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

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

Existing Water Quality (Table 2T):

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

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

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

Existing Water Quality (Table 2T):

- Median 186 µmho/cm
- Lower 95% Confidence Interval 170 µmho/cm
- Upper 95% Confidence Interval 202 µmho/cm

Defined in regulations as a flow-related parameter

Slight evidence indicates water quality degradation. Specific conductance did not measurably change between the EWQ and post-EWQ periods. However, there were too few post-EWQ data (n=15) for reliable statistical comparison. In both data sets, specific conductance is strongly and inversely related to flow. Post-EWQ median specific conductance rose above the EWQ upper 95% confidence interval, but the overall distribution was not significantly different. Flow is plotted on a logarithmic scale.
No water quality degradation is evident. TDS measurably declined between the EWQ and post-EWQ periods. However, potential laboratory artifacts and insufficient post-EWQ data produced uncertainty in conclusions. TDS is inversely related to flow in the EWQ data set, but unrelated to flow in the post-EWQ data set – probably due to insufficient sampling not fully representative of flow conditions. Post-EWQ median TDS was well below the EWQ 95% lower confidence interval. Post-EWQ detection limits were lower than EWQ detection limits, though there were no non-detect results in either data set. Flow is plotted on a logarithmic scale.
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Total Suspended Solids (TSS) mg/l

Existing Water Quality (Table 2T):

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

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

Existing Water Quality (Table 2T):

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

No water quality degradation is evident. Turbidity did not measurably change between the EWQ and post-EWQ periods. All post-EWQ turbidity results were below 9 NTU. The post-EWQ median turbidity was within the EWQ 95% confidence intervals. In the EWQ data set, the turbidity vs. flow relationship is weakly positive, and strongly positive in the post-EWQ data set. Both concentration and flow are represented on a logarithmic scale.
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Water Temperature, degrees C

Not included in DRBC Existing Water Quality rules

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