

Appendix D. Summary pages of analyses.

This document contains summary pages that provide information about each site monitored in the Moores Run, Baltimore City; Airpark Business Center, Carroll County; and Urbana, Frederick County watersheds. Each summary set begins with two pages of overview material for the instream or outfall site of the given watershed, including pictures taken at the site during July or August of 2019, details about the BMPs in that site’s drainage area, and a series of satellite images showing change over time. Following the two overview pages are nine summary pages for each site, one per parameter, that show plots of data, as well as results of the trend analysis. Please see the next page for a key to the layout of the one-page parameter summaries.

Table 1. The parameters summarized in this document.

Parameters		Units
BOD	Biochemical Oxygen Demand	(mg/L)
TSS	Total Suspended Solids	(mg/L)
<i>E. coli</i>	<i>Escherichia coli</i>	(MPN/100)
NO₂₃	Nitrite plus Nitrate	(mg/L)
TP	Total Phosphorus	(mg/L)
TKN	Total Kjeldahl Nitrogen	(mg/L)
TCU	Total Copper	(µg/L)
TZN	Total Zinc	(µg/L)
TPB	Total Lead	(µg/L)

Key to water quality parameter summary pages.

Watershed name, Jurisdiction - Monitoring location, Parameter

Plot of stormflow and baseflow LOWESS curves of unaltered data.

Summary of trend analysis results.

Two tables displaying the results of several types of analysis, broken down by flow type (i.e., stormflow and baseflow). The content of the tables, going row-by-row, is explained below. If needed, please see the Final Report for more information.

Season: Indicates whether the test was performed on a single season (“Season Name”) or all seasons (“Annual”). Some analyses were only possible for a single season (i.e., spring, summer, autumn, winter) due to a lack of data availability.

Data: Describes the type of data used. Data were culled for some tests to produce an even time series (“Culled”), and some were further median-adjusted (“Median adj.”) using the seasonal median. Unculled, unadjusted data are referred to as “All.”

Method: The statistical test used: permutation, Mann-Kendall, Seasonal Kendall, Modified Flow-Corrected (MFC) Mann-Kendall or Seasonal Kendall, least-squares regression on log-transformed data (LSR), log regression (LOGR), and Kruskal-Wallis for step trends (Mann-Whitney test used to determine which periods are different if the Kruskal-Wallis test is significant). If an analysis method could not be performed due to either issues with data availability or censored values, the cells in the table are left blank.

Direction/Periods: Direction indicates if the trend is increasing (“Pos.”) or decreasing (“Neg.”) over time based on trend analysis. “No direction” is written for slopes with a value of zero. The Periods option is filled in if the Kruskal-Wallis test is significant and lists which Periods were significantly different. Period I: 1999 - 2002; Period II: 2003 - 2009; Period III: 2010 - 2016.

p-value: A trend was considered to be real and significant if the p-value was less than or equal to 0.05. “NS” indicates non-significant results.

Plot showing the parameter against storm intensity (inches/hour), color-coded by season. Lines showing the (untested) relationship between spring/winter and summer/autumn against intensity are plotted, but only if the association appears significant.

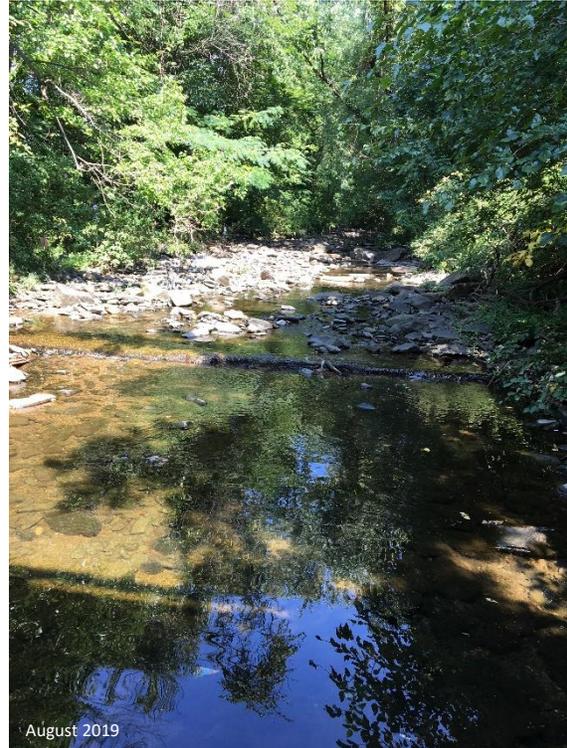
Plot showing the parameter against storm intensity (inches/hour), color-coded by year. The line shows the regression between the parameter and storm intensity for *all* data points and does not take season into consideration. Please note that the shaded grey area describes the 95% confidence interval of where the regression line is drawn.

Summary of the intensity plots.

Moores Run, Baltimore City Instream Site: Radecke Avenue

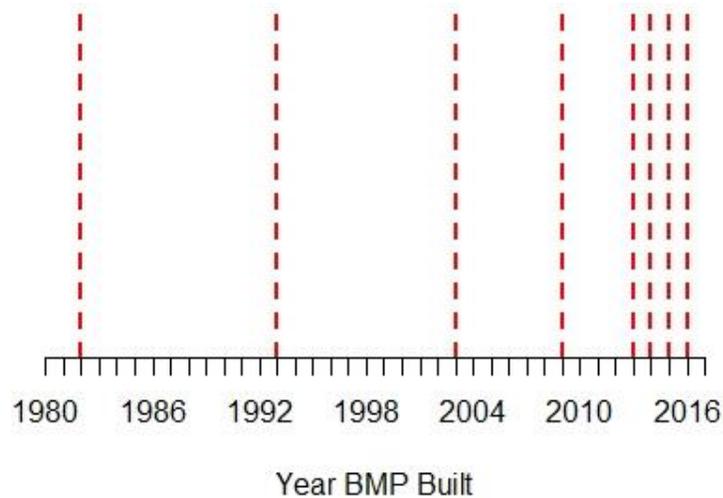


Looking downstream



Looking upstream

Year	Total Imperv. Acres in Monitoring Drainage Area	Imperv. Acres Treated by Ponds	Imperv. Acres Treated by Other BMPs	Imperv. Acres Treated by Dry ED Pond Pos. Sand Filter	% Monitoring Area Imperv. Acres Treated
1982	1020.82	3.05	0.00	0.00	0.30%
1993	1021.89	4.12	0.00	0.00	0.40%
2003	1022.27	4.12	0.37	0.00	0.44%
2009	1023.01	4.12	1.11	0.00	0.51%
2013	1025.78	4.12	3.89	0.00	0.78%
2014	1025.78	4.12	4.06	0.00	0.80%
2015	1025.78	1.07	4.06	3.05	0.80%
2016	1025.78	1.07	5.44	3.05	0.93%



Moore's Run, Baltimore City Instream Site: Radecke Avenue



April 1994

Image: Google, USGS



December 2001

Image: Google, USGS



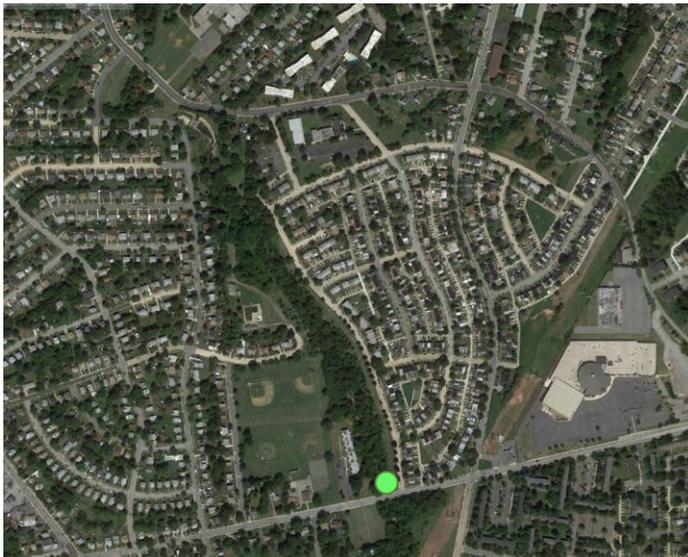
February 2004

Image: Google, USGS



February 2007

Image: Google, USGS



August 2010

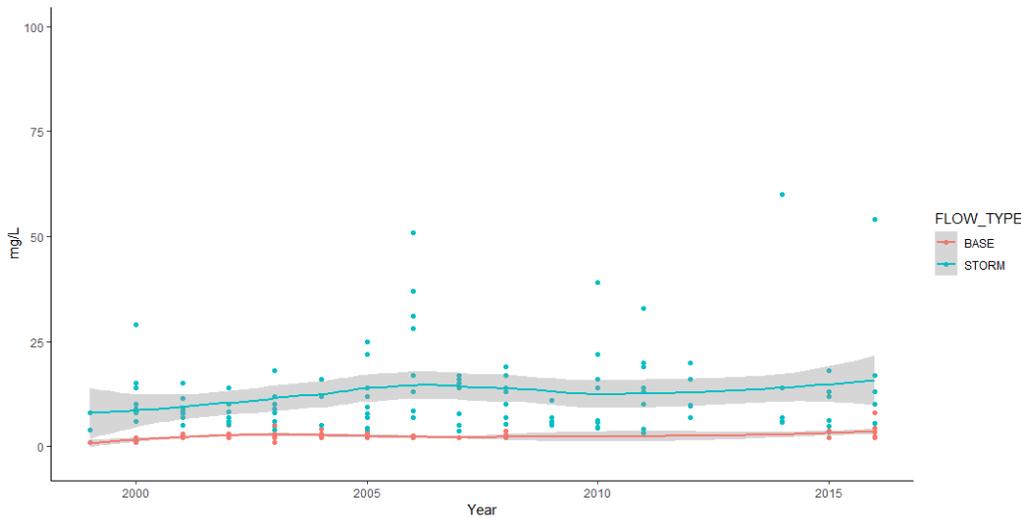
Image: Google, Landsat/Copernicus



June 2017

Image: Google, Landsat/Copernicus

Moores Run, Baltimore City - Instream BOD



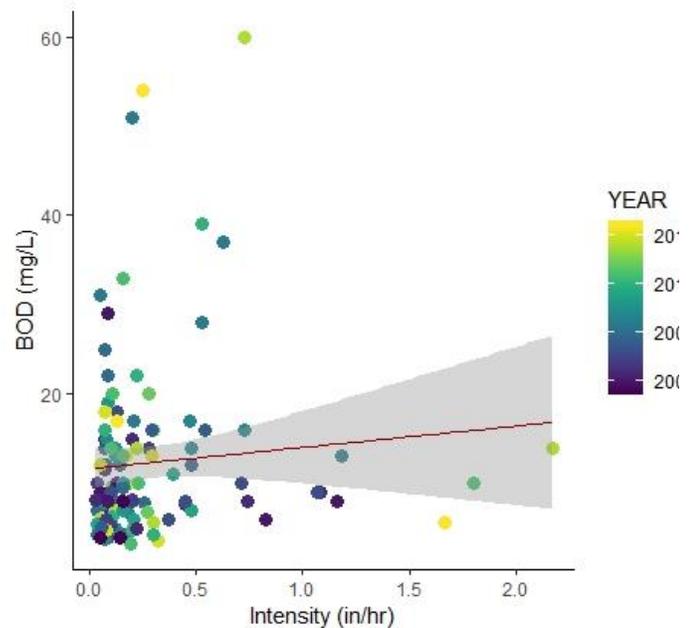
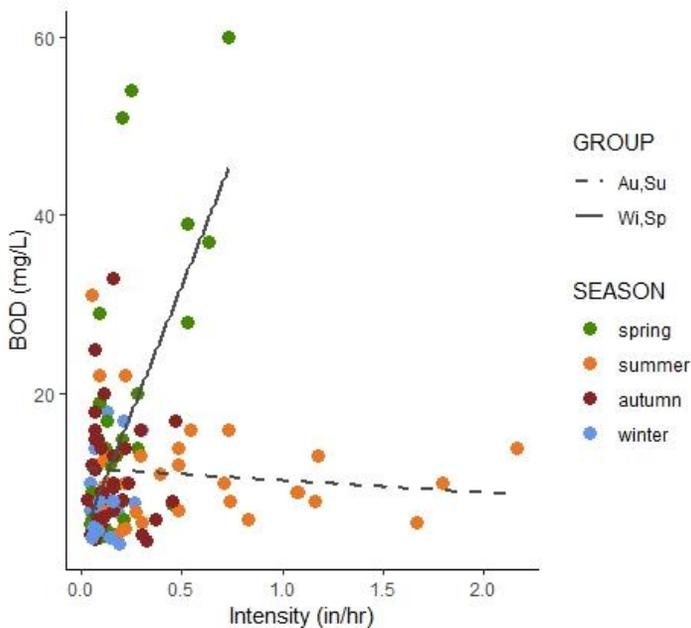
- Summary**
- Baseflow trend analysis could not be completed due to issues with data availability and/or censoring.
 - One method found stormflow values to significantly increase; other trends were positive but not significant.
 - Step trends found no difference between the three time periods.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Pos.	Pos.	Pos.
p-value	NS	NS	NS	NS	0.02

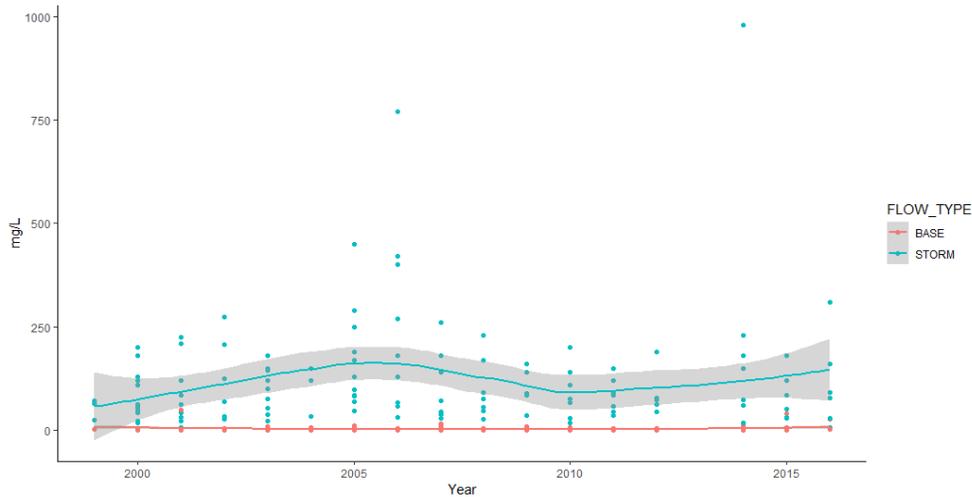
Baseflow

Season
Data
Method
Direction/Periods
p-value



The most intense storms in summer were related to relatively low BOD. BOD measurements taken during spring months have some of the highest values and are mainly associated with medium to low intensity storms. There appears to be a BOD-vs-intensity relationship in winter and spring, with BOD increasing as intensity increases, but the relationship was not tested. The relationship between intensity and BOD does not appear to change over the years.

Moores Run, Baltimore City - Instream TSS



Summary

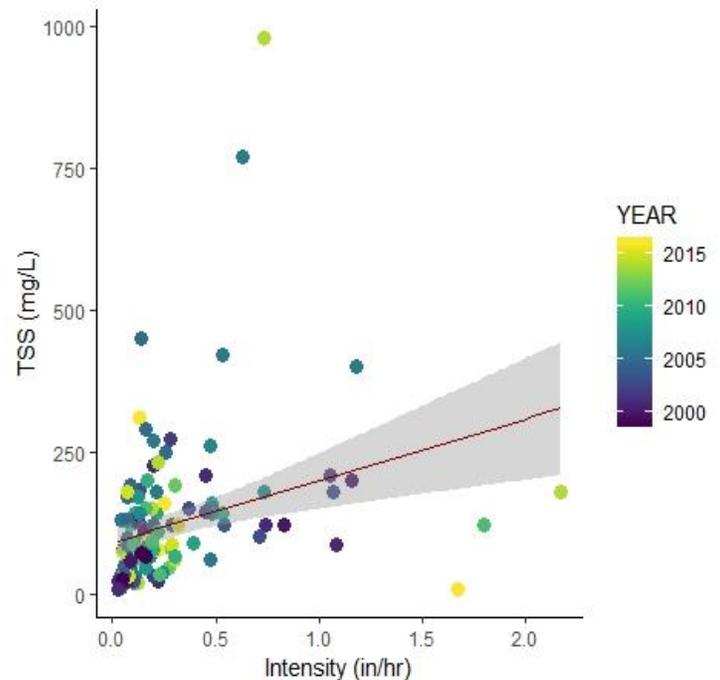
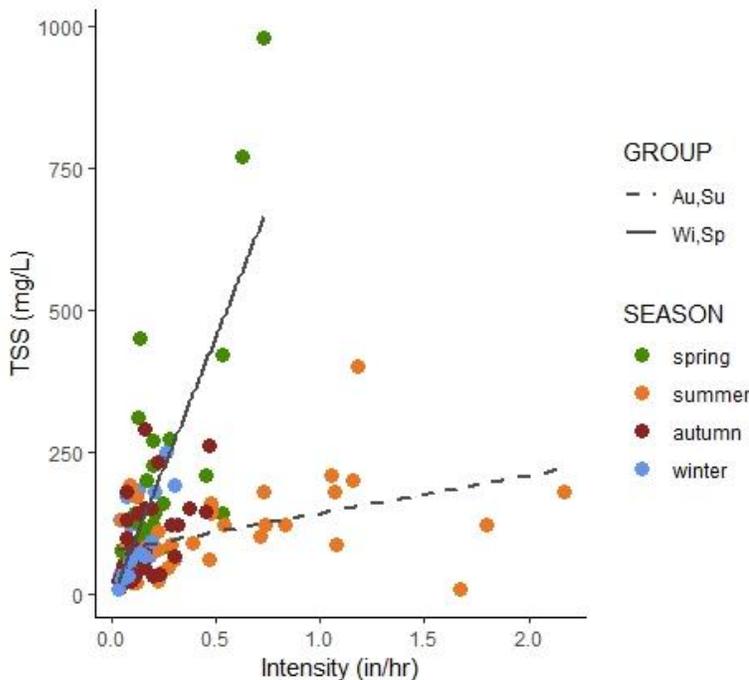
- Stormflow values did not significantly change; trends found were a mix of positive and negative.
- Baseflow values are generally lower than stormflow values and had a slight, non-significant negative trend.
- Step trends found no difference between the three time periods in either stormflow or baseflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Pos.	Pos.	Pos.
p-value	NS	NS	NS	NS	NS

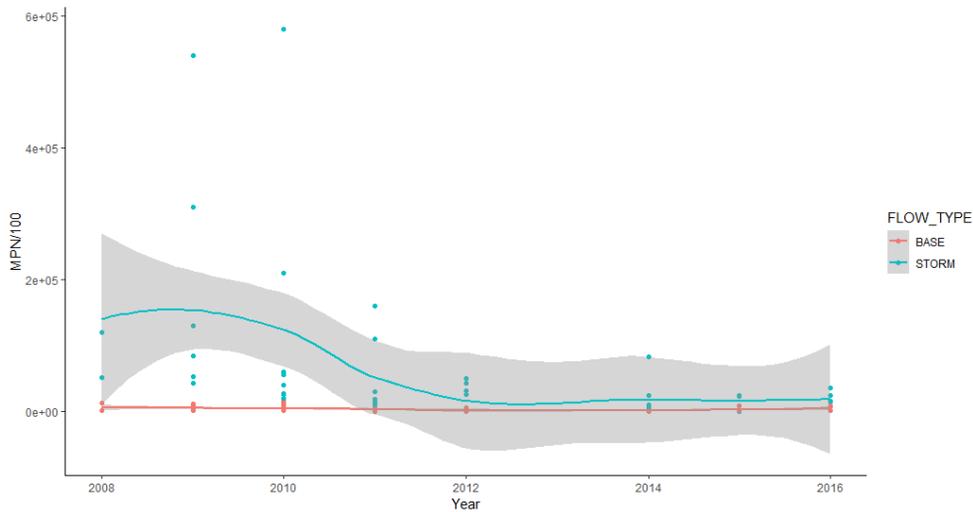
Baseflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS	NS	NS



The most intense storms in summer were related to a range of summertime TSS values. TSS measurements taken during winter and spring months are mainly associated with medium to low intensity storms. There appears to be a TSS-vs-intensity relationship in winter and spring, with TSS increasing as intensity increases, but the relationship was not tested. The overall relationship between intensity and TSS does not appear to change over the years.

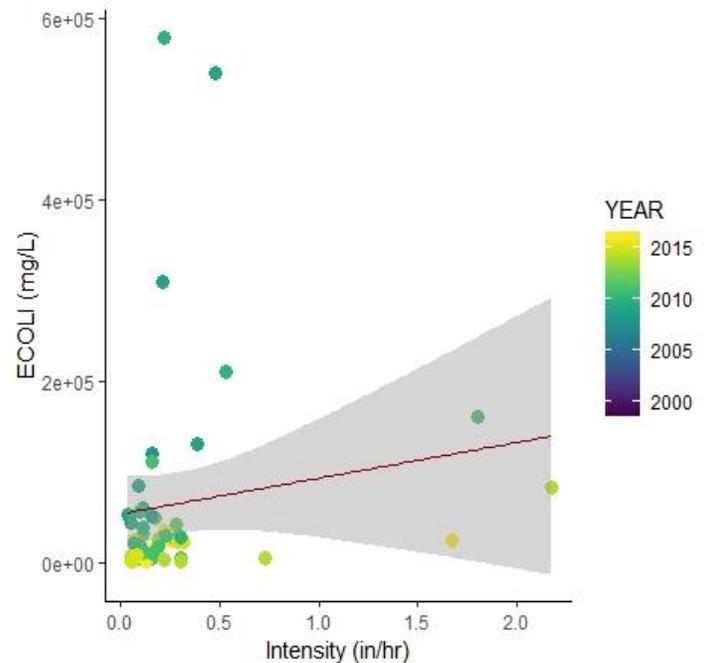
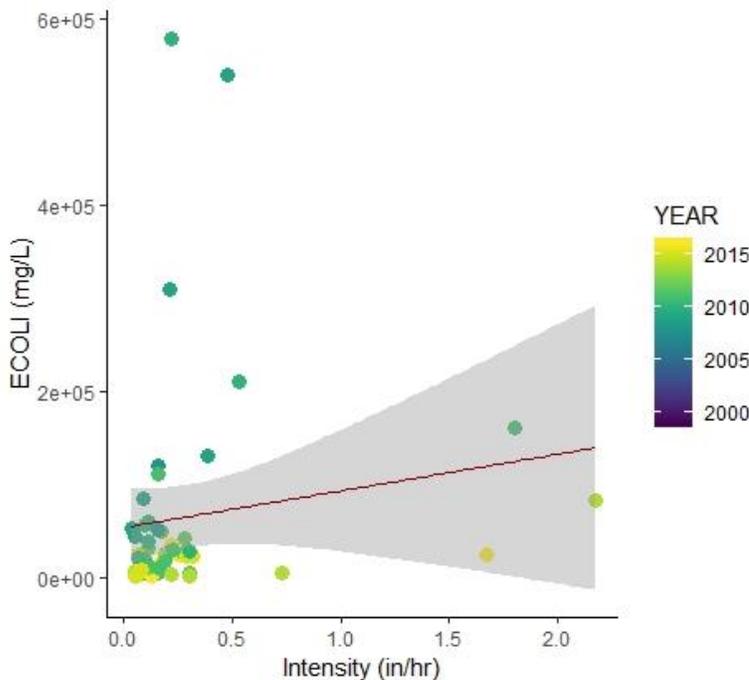
Moore's Run, Baltimore City - Instream *E. coli*



- Summary**
- Stormflow values decreased significantly.
 - Baseflow values had a non-significant negative trend.
 - Storm- and baseflow values are about the same after 2012

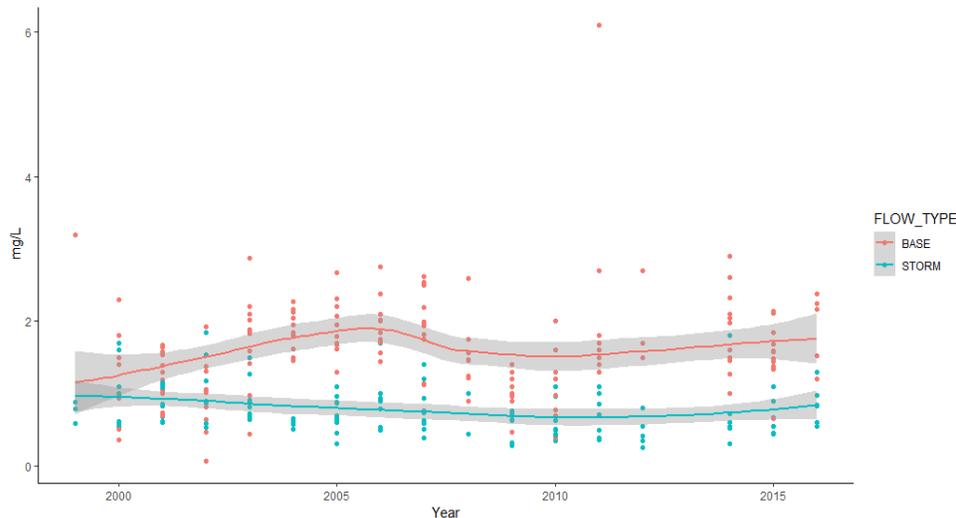
Stormflow			
Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	Neg.
p-value	< 0.01	0.01	< 0.01

Baseflow			
Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	Neg.
p-value	NS	NS	NS



The highest *E. coli* measurements occurred in two moderately intense spring storms. Based on the year color-coded plot, *E. coli* appears to be lower in more recent years, compared to earlier in the monitoring time period. This agrees with the trend results (above).

Moore's Run, Baltimore City - Instream NO₂₃



Summary

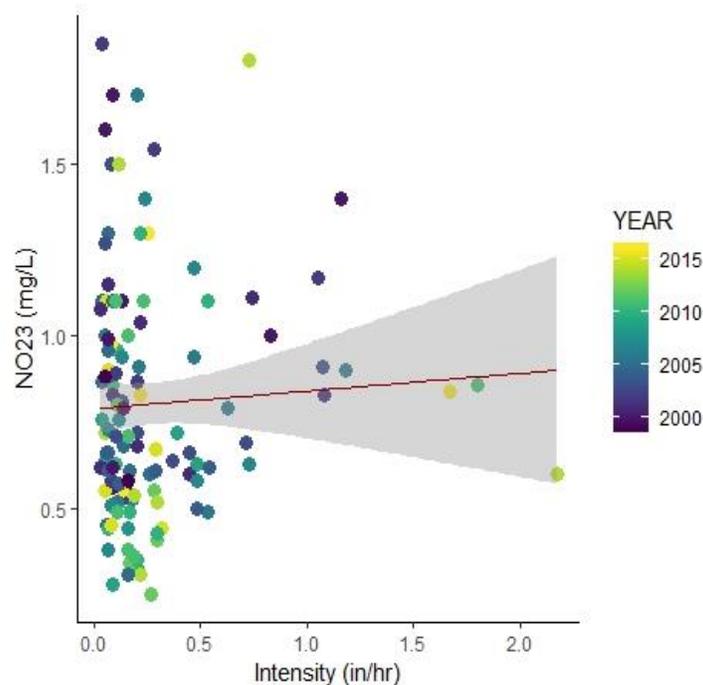
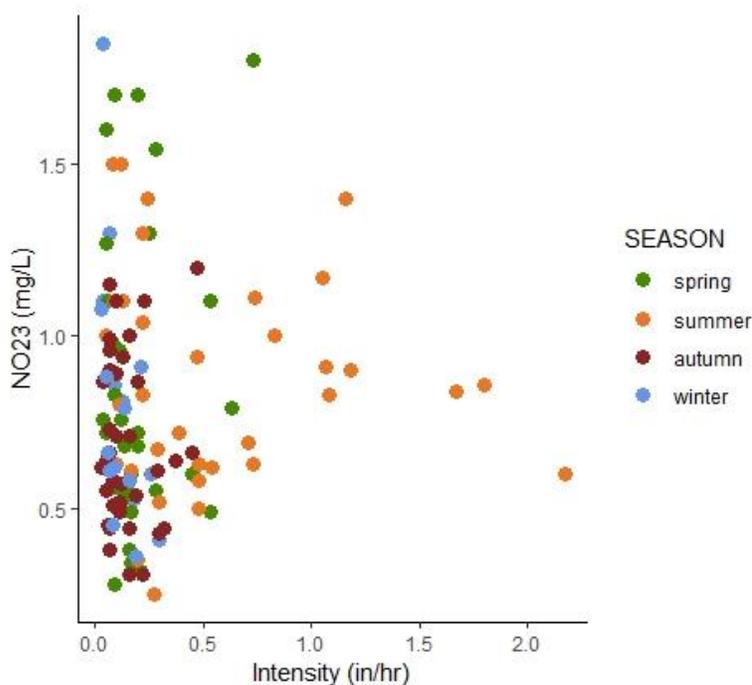
- Stormflow values significantly decreased.
- Baseflow values are generally higher than stormflow values had non-significant increasing trends.
- Step trends found differences in stormflow values only; Periods I and II, I and III differed significantly.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled, MFC	Culled	Culled	All	All	All
Method	Seasonal Kendall	Seasonal Kendall	Kruskal-Wallis	Mann-Whitney	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	I~II, I~III	Neg.	Neg.	Neg.
p-value	0.045	0.03	0.01	0.02, 0.007	< 0.01	< 0.01	0.02

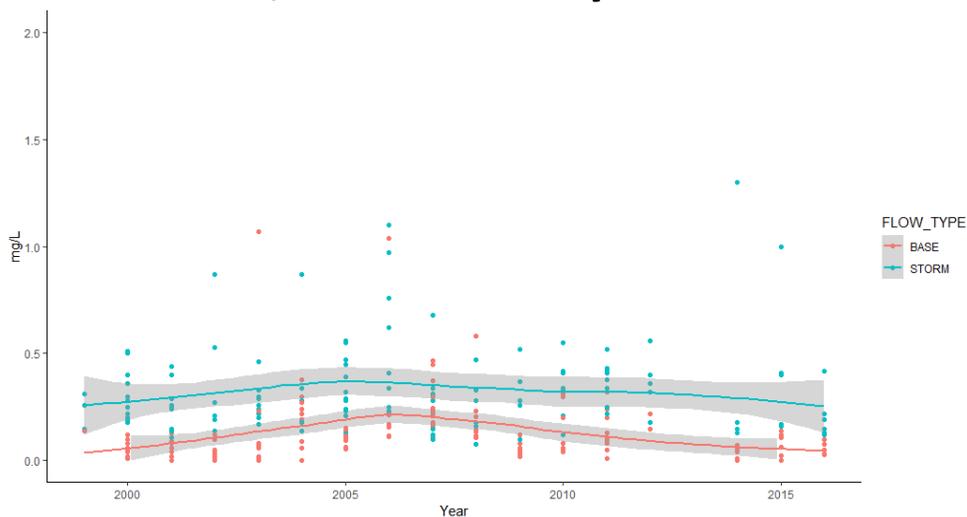
Baseflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Pos.	Pos.	Pos.
p-value	NS	NS	NS	NS	NS



The highest intensity storms in summer -are associated with moderate NO₂₃ levels. Low to moderate intensity storms are associated with a broad range of NO₂₃ values, some of which are very high. There is no clear pattern regarding when the highest values of NO₂₃ occur. For low and moderate intensity storms, NO₂₃ values were slightly higher during Period I. There does not appear to be an NO₂₃ -vs-intensity relationship in the seasons.

Moores Run, Baltimore City - Instream TP



Summary

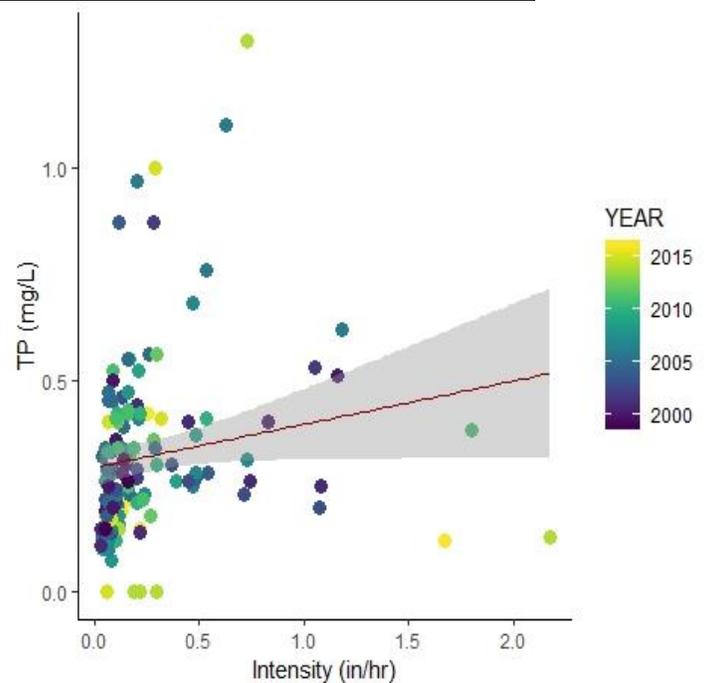
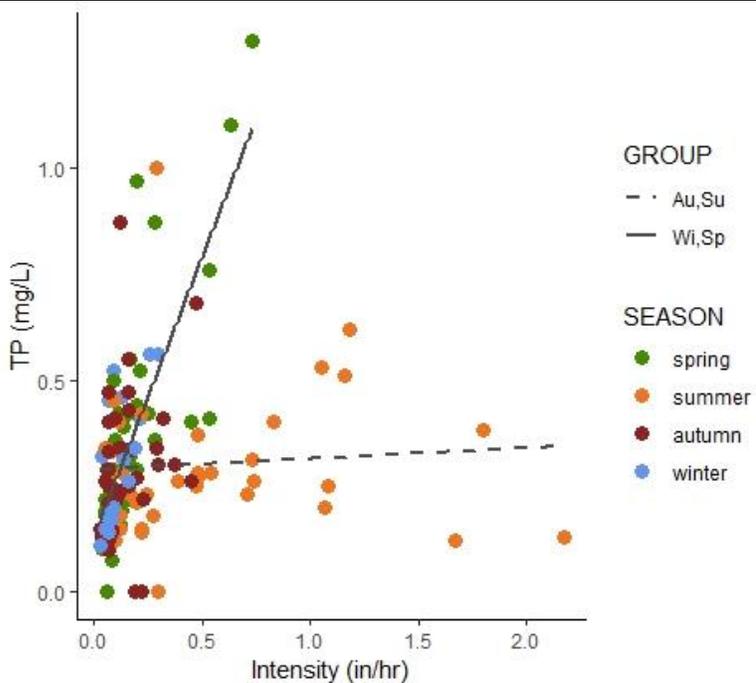
- Stormflow and baseflow values were described as both increasing and decreasing by the analysis methods, but none were significant.
- Step trends found no difference between the three time periods in either stormflow or baseflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled, MFC	Culled	All	All	All
Method	Seasonal Kendall	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	Pos.	Pos.	Pos.
p-value	NS	NS	NS	NS	NS.	NS

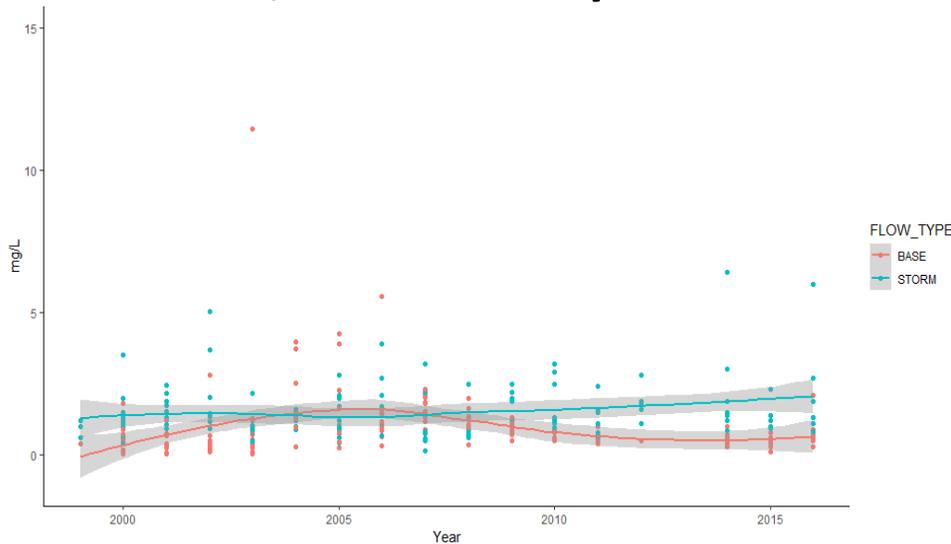
Baseflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Pos.	Pos.
p-value	NS	NS	NS	NS	NS



The most intense storms are associated with moderate summertime TP. Overall, spring TP measurements are the highest, with some additional high values associated with autumn and summer storms. There appears to be a TP-vs-intensity relationship in winter and spring, with TP increasing as intensity increases, but the relationship was not tested. The relationship between intensity and TP does not appear to change over the years.

Moore's Run, Baltimore City - Instream TKN



Summary

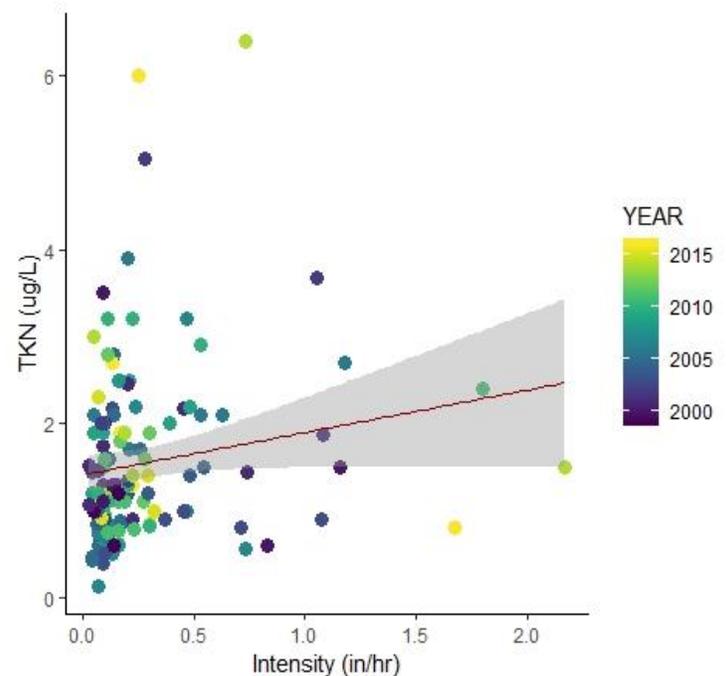
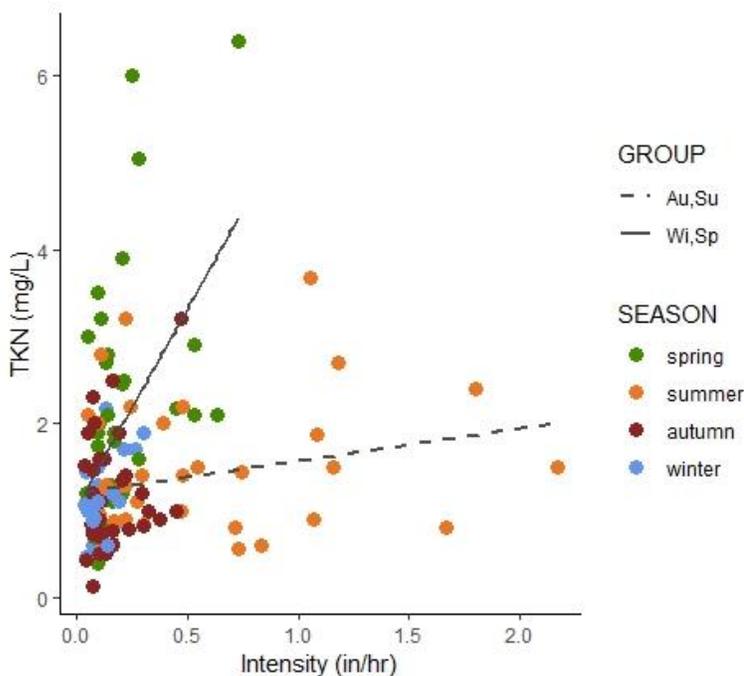
- Stormflow values had non-significant increasing trends.
- Baseflow values had non-significant decreasing trends.
- Unlike NO₂₃, baseflow values of TKN are slightly *lower* than stormflow values.
- Step trends found differences in baseflow values only; all periods differed significantly.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled, MFC	Culled	All	All	All
Method	Seasonal Kendall	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	NA	Pos.	Pos.	Pos.
p-value	NS	NS	NS	NS	NS	NS

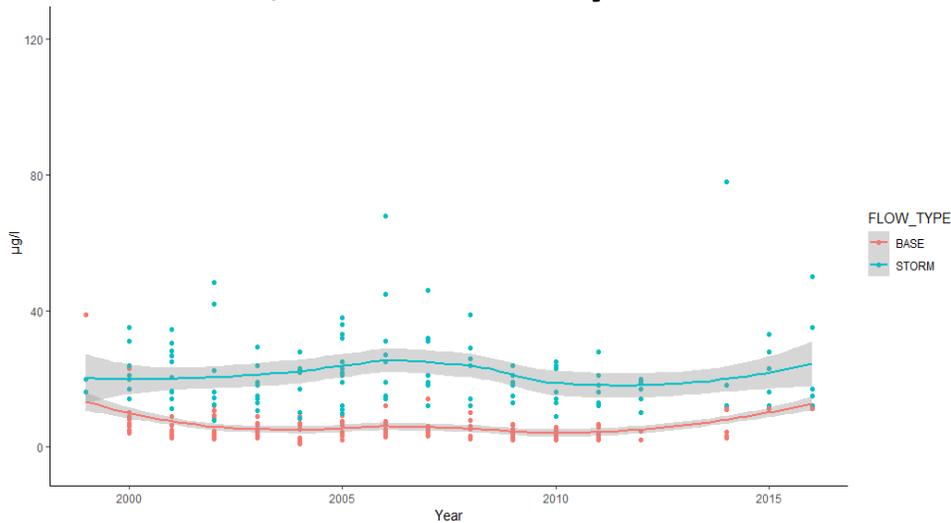
Baseflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Mann-Whitney	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	I~II, I~III, II~III	Neg.	Neg.	Neg.
p-value	NS	< 0.001	< 0.01, 0.049, < 0.01	NS	NS	NS



Moderate TKN levels are associated with the most intense storms which occur in summer. Spring TKN measurements range widely and are mainly associated with medium to low intensity storms. There appears to be a TKN-vs-intensity relationship in winter and spring, with TKN increasing as intensity increases, but the relationship was not tested. The relationship between intensity and TKN does not appear to change over the years.

Moore's Run, Baltimore City - Instream TCU



Summary

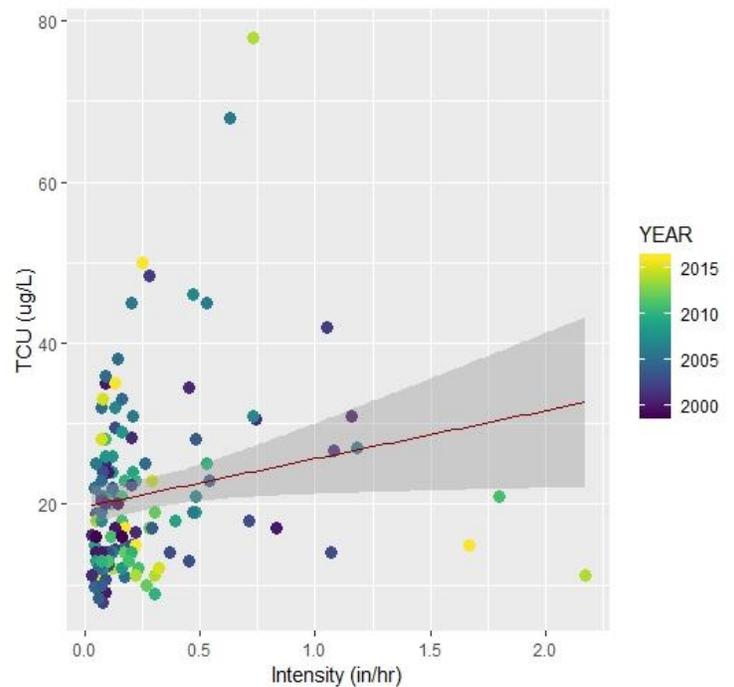
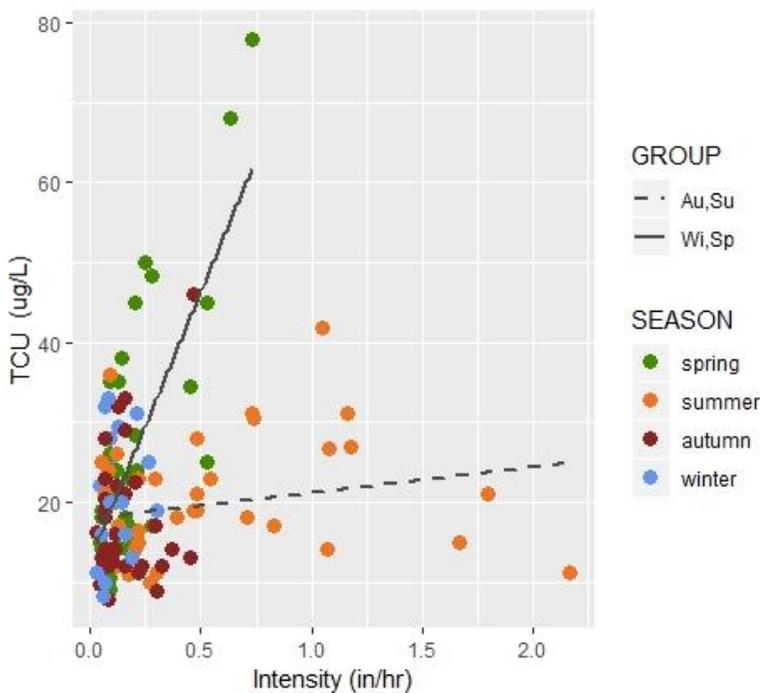
- Stormflow values had non-significant decreasing trends.
- Baseflow values decreased significantly.
- Step trends found differences in baseflow values only; Periods I and III, II and III differed significantly.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS	NS	NS

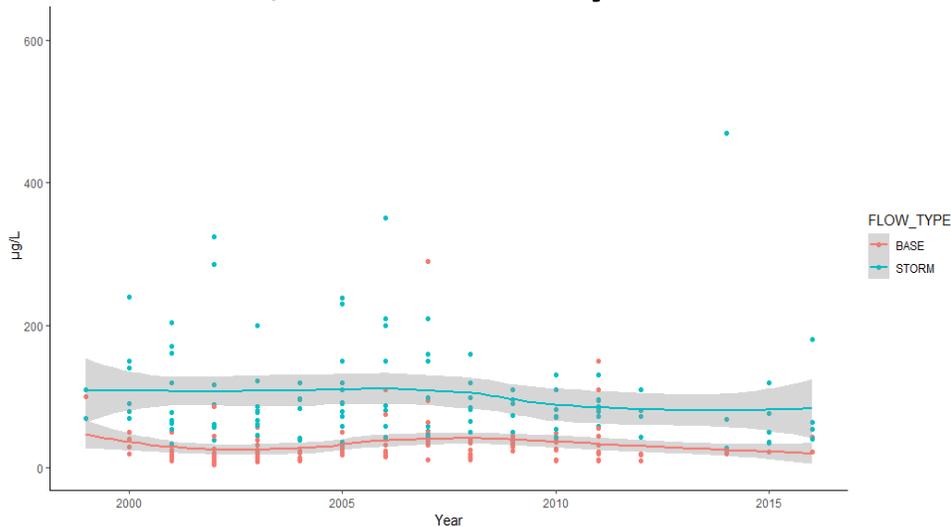
Baseflow

Season	Annual	Annual	Annual
Data	Culled, median adj.	Culled	Culled
Method	Mann-Kendall	Kruskal-Wallis	Mann-Whitney
Direction/Periods	Neg.	NA	I~III, II~III
p-value	< 0.001	< 0.001	< 0.001, < 0.001



The most intense storms are associated with summertime TCU. Spring TCU measurements are the highest and are mainly associated with medium to low intensity storms. There appears to be a TCU-vs-intensity relationship in winter and spring, with TCU increasing as intensity increases, but the relationship was not tested. The relationship between intensity and TCU does not appear to change over the years.

Moores Run, Baltimore City - Instream TZN



Summary

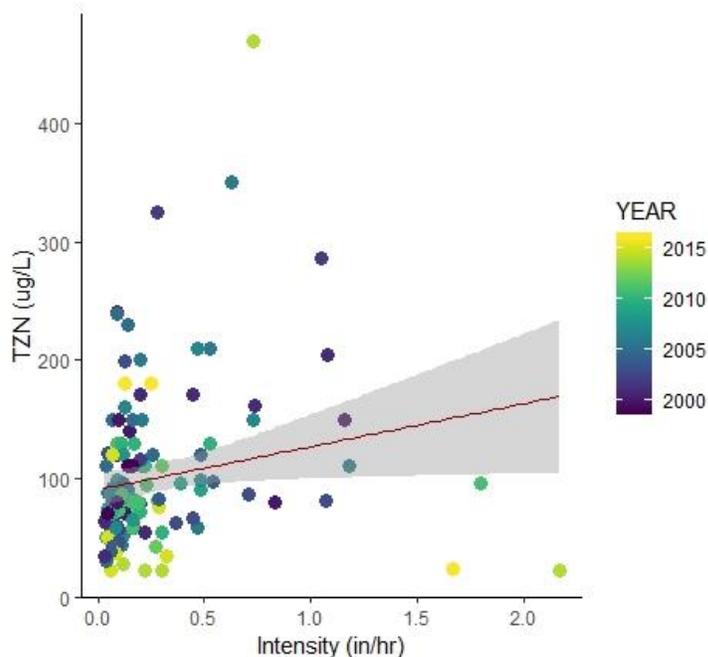
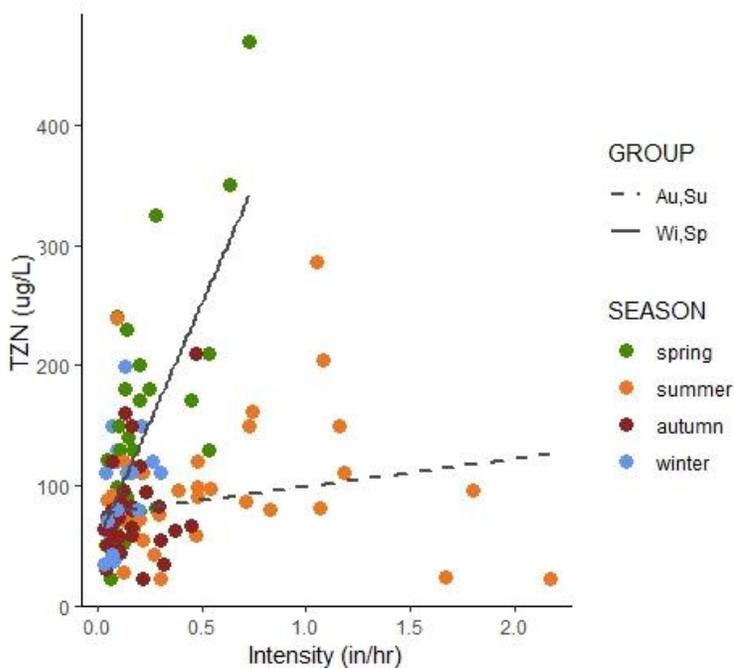
- Stormflow values significantly decreased by using most methods.
- Baseflow values significantly decreased.
- Step trends found no difference between the three time periods in either stormflow or baseflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	0.01	NS	0.03	0.05	NS

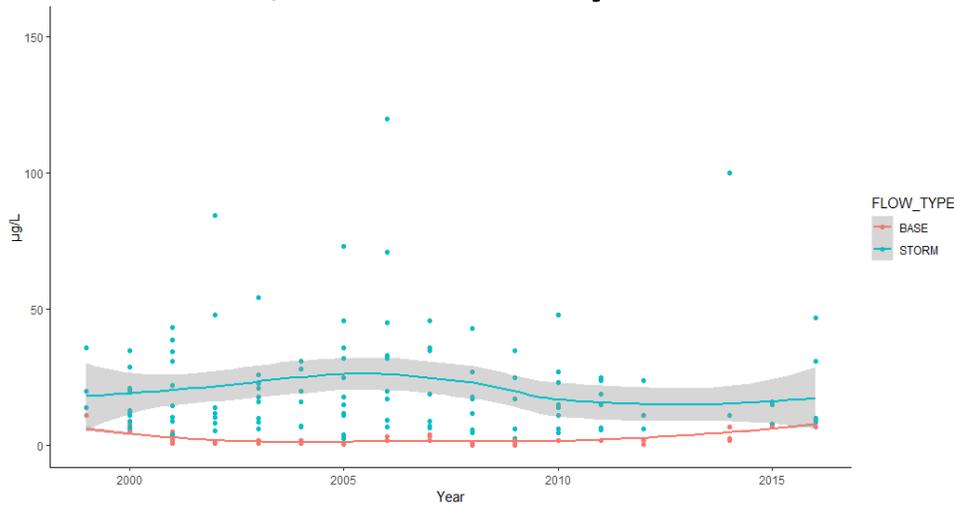
Baseflow

Season	Annual	Annual
Data	Median adj.	Culled
Method	Mann-Kendall	Kruskal-Wallis
Direction/Periods	Neg.	NA
p-value	0.01	NS



The most intense storms are associated with summertime TZN. Spring TZN measurements are the highest and are mainly associated with medium to low intensity storms. There appears to be a TZN-vs-intensity relationship in winter and spring, with TZN increasing as intensity increases, but the relationship was not tested. The relationship between intensity and TZN does not appear to change over the years.

Moore's Run, Baltimore City - Instream TPB



Summary

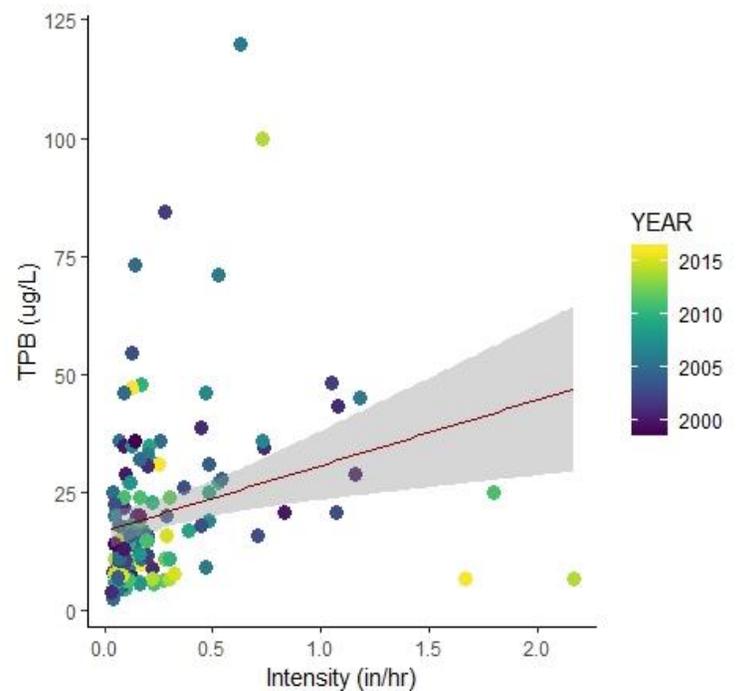
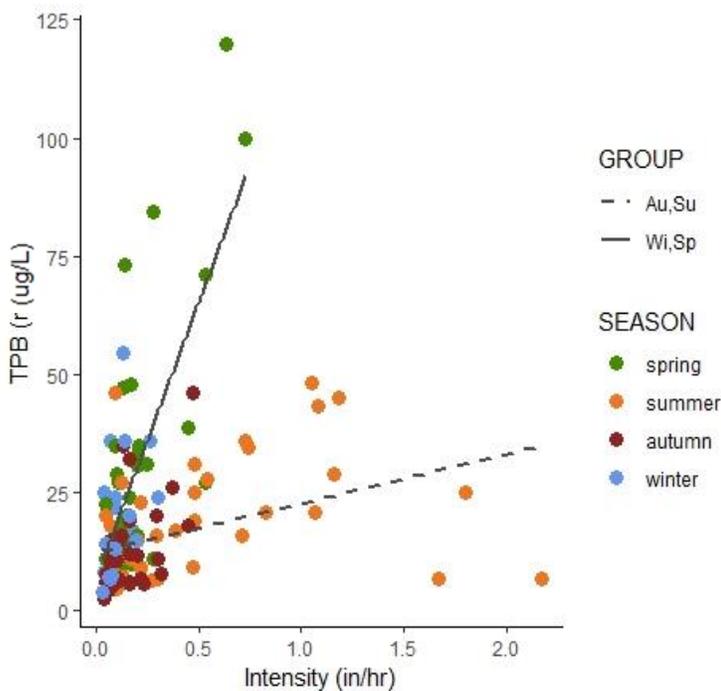
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values decreased significantly with half of the analysis methods.
- Step trends found no difference between the three time periods in stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	0.04	NS	NS	NS	0.02

Baseflow

Season
Data
Method
Direction/Periods
p-value

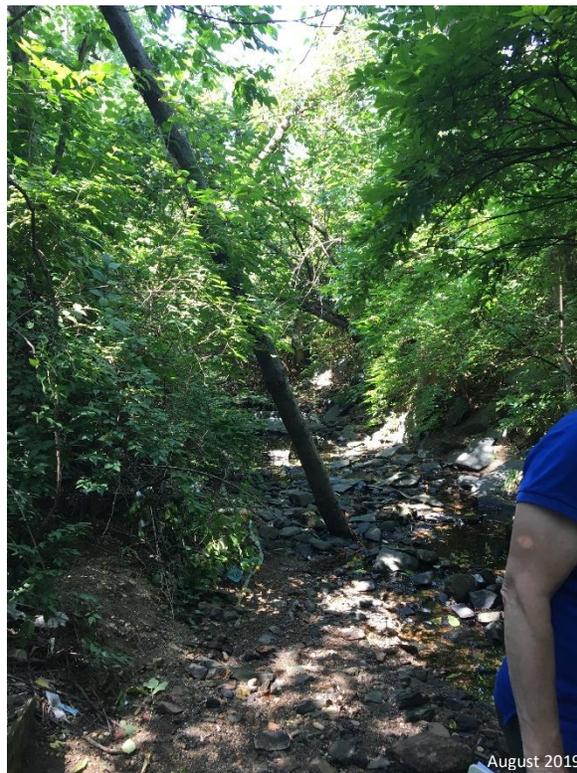


The most intense storms are associated with summertime TPB. Spring TPB measurements are the highest and are mainly associated with medium to low intensity storms. There appears to be a TPB-vs-intensity relationship in winter and spring, with TPB increasing as intensity increases, but the relationship was not tested. The relationship between intensity and TPB does not appear to change over the years.

Moore's Run, Baltimore City Outfall Site: Hamilton Avenue



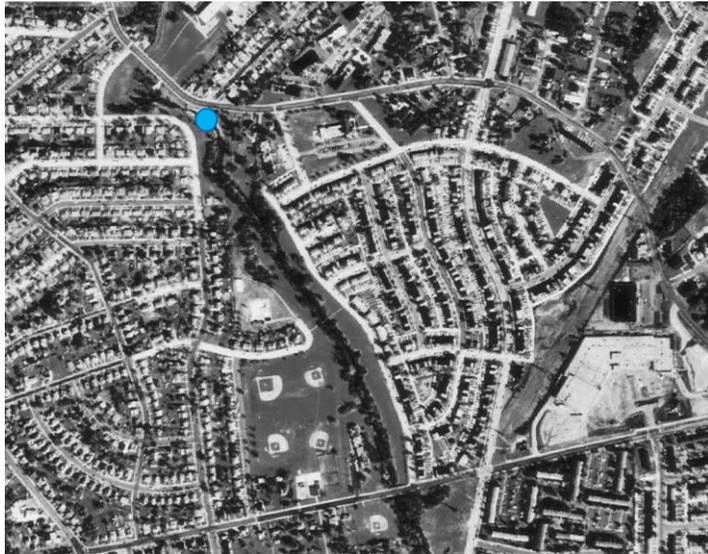
Looking downstream



Looking upstream

No BMPs were implemented in the outfall drainage area.

Moore's Run, Baltimore City Outfall Site: Hamilton Avenue



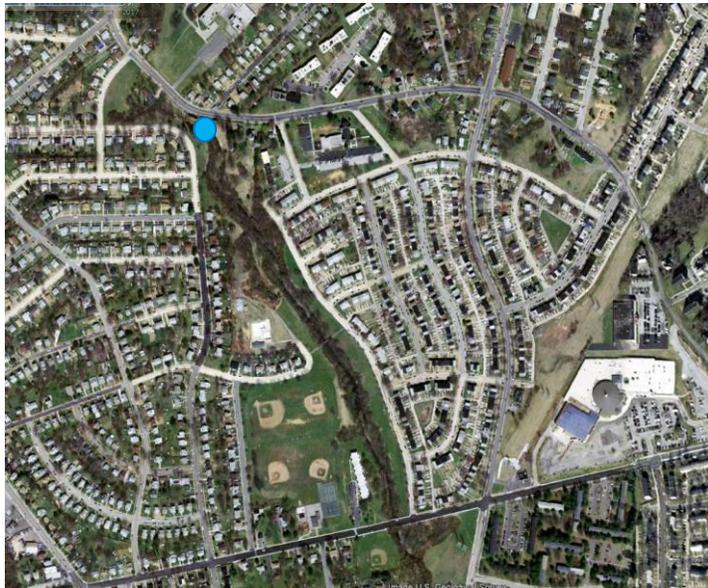
April 1994

Image: Google, USGS



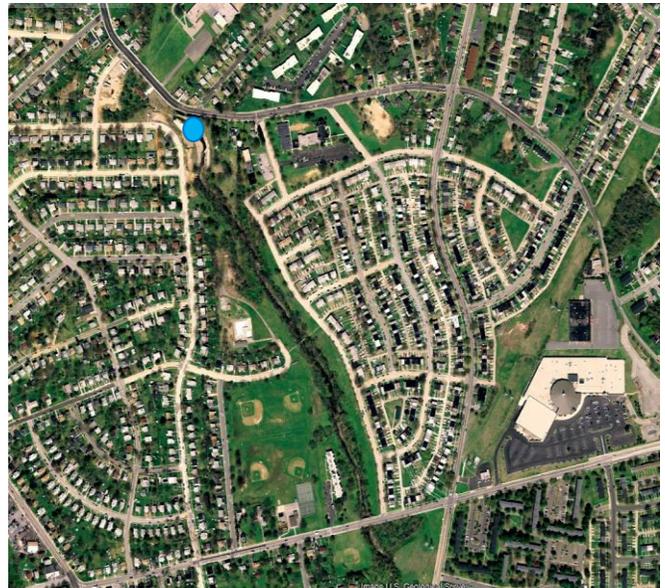
December 2001

Image: Google, USGS



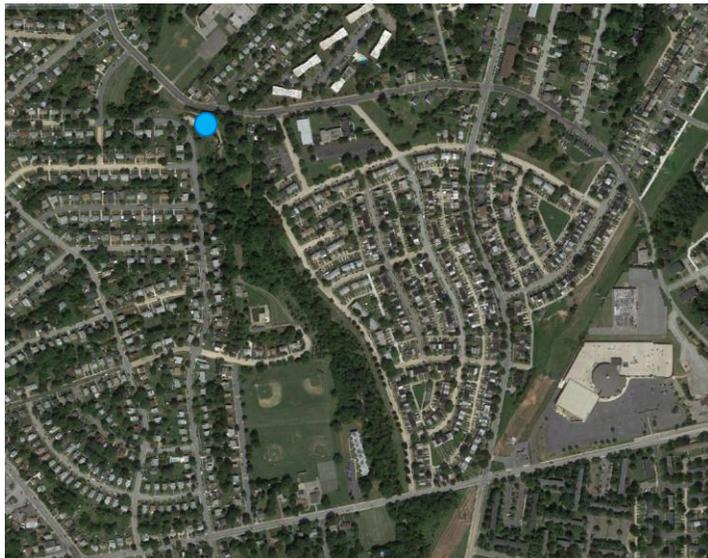
February 2004

Image: Google, USGS



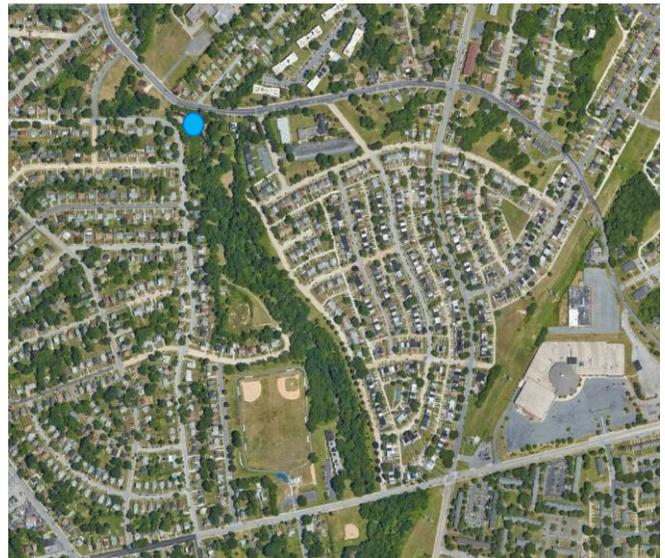
February 2007

Image: Google, USGS



August 2010

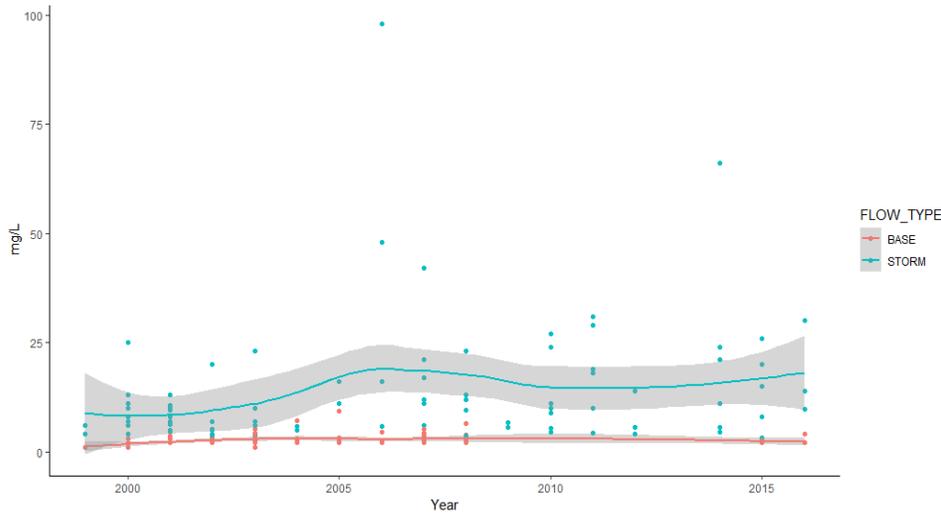
Image: Google,
Landsat/Copernicus



June 2017

Image: Google,
Landsat/Copernicus

Moore's Run, Baltimore City - Outfall BOD



Summary

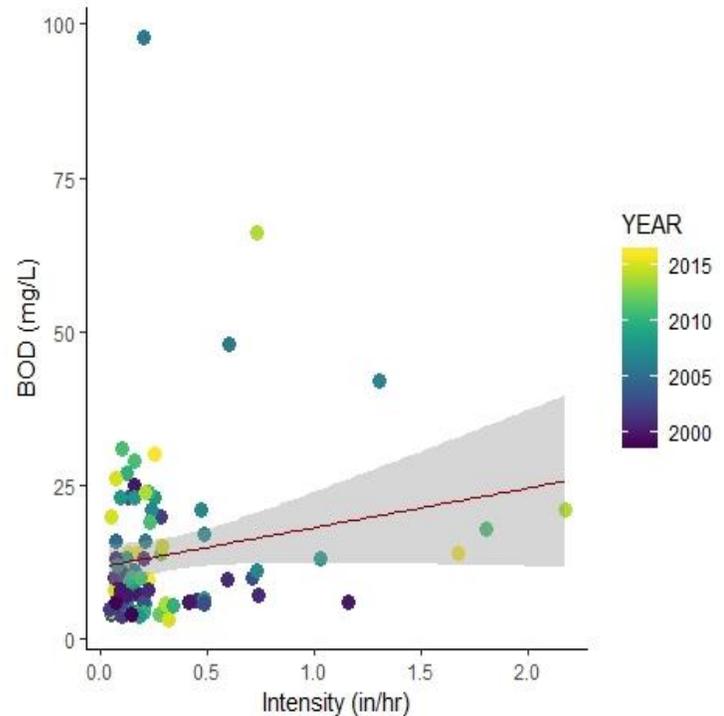
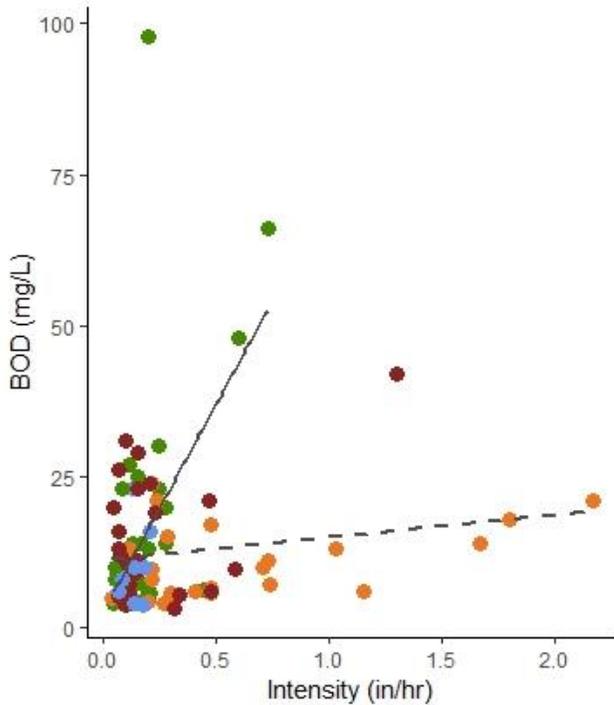
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Spring and summer stormflow values had non-significant increasing trends.
- Annual stormflow values significantly increased in two-thirds of the methods used.
- Step trends found no difference between the three time periods in spring and summer stormflow.

Stormflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled, median adj.	Culled, median adj.	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	NA	NA	Pos.	Pos.	Pos.
p-value	NS	NS	NS	NS	0.03	NS	< 0.01

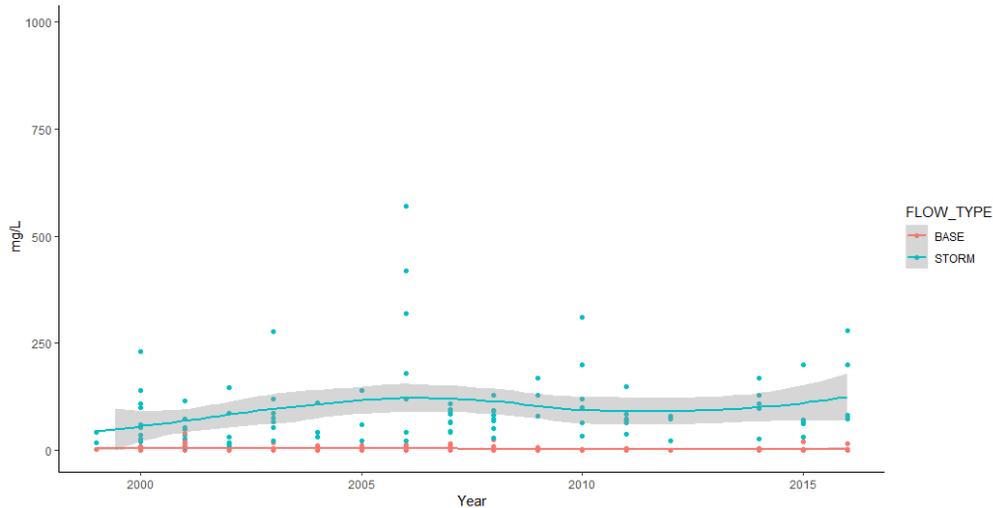
Baseflow

Season
Data
Method
Direction/Periods
p-value



The most intense storms are associated with summertime BOD, as well as with one autumn storm. Spring BOD measurements are the highest and are mainly associated with medium to low intensity storms. There appears to be a BOD-vs-intensity relationship in winter and spring, with BOD increasing as intensity increases, but the relationship was not tested. The relationship between intensity and BOD does not appear to change over the years.

Moore's Run, Baltimore City - Outfall TSS

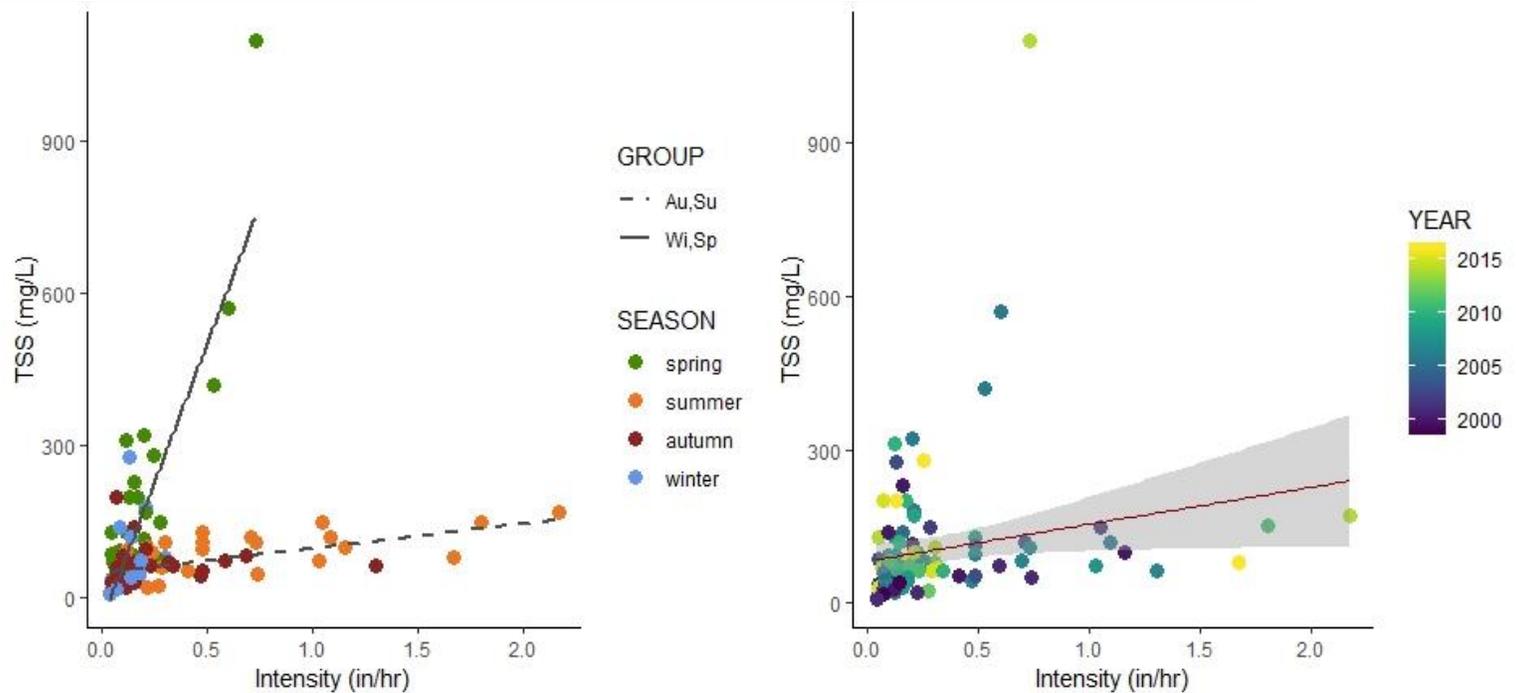


Summary

- Spring and annual stormflow values significantly increased; summer stormflow values had non-significant decreasing trends.
- Baseflow values decreased, but only significantly for one method.
- Step trends found no difference between the three time periods in stormflow or baseflow.

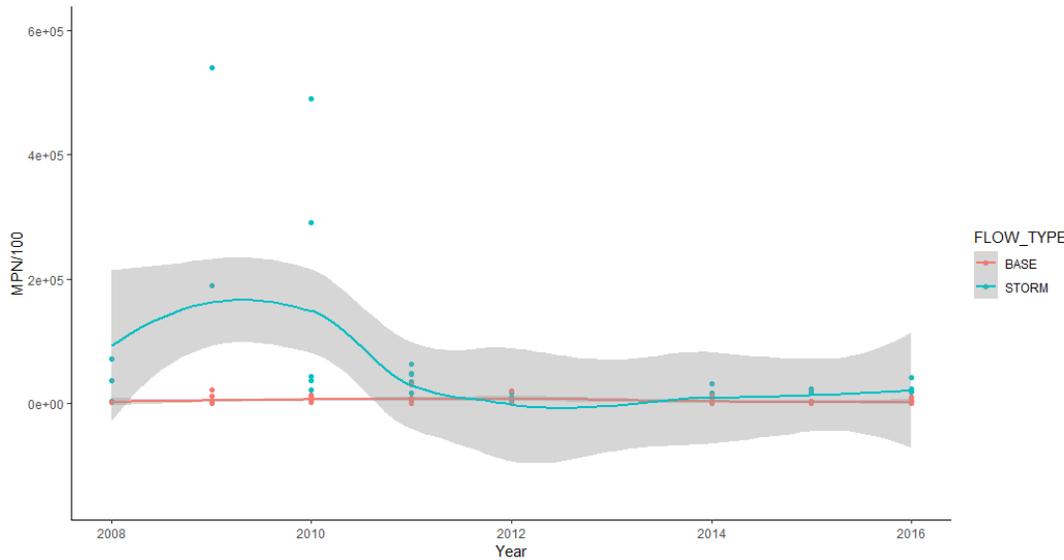
Stormflow							
Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled	Culled	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	Neg.	NA	NA	Pos.	Pos.	Pos.
p-value	< 0.001	NS	NS	NS	0.05	0.05	0.02

Baseflow					
Season	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS	NS	0.02



The most intense storms are associated with summertime TSS, as well as with one autumn storm. Spring TSS measurements are the highest and are mainly associated with medium to low intensity storms. There appears to be a TSS-vs-intensity relationship in winter and spring, with TSS increasing as intensity increases, but the relationship was not tested. The relationship between intensity and TSS does not appear to change over the years.

Moore's Run, Baltimore City - Outfall *E. coli*



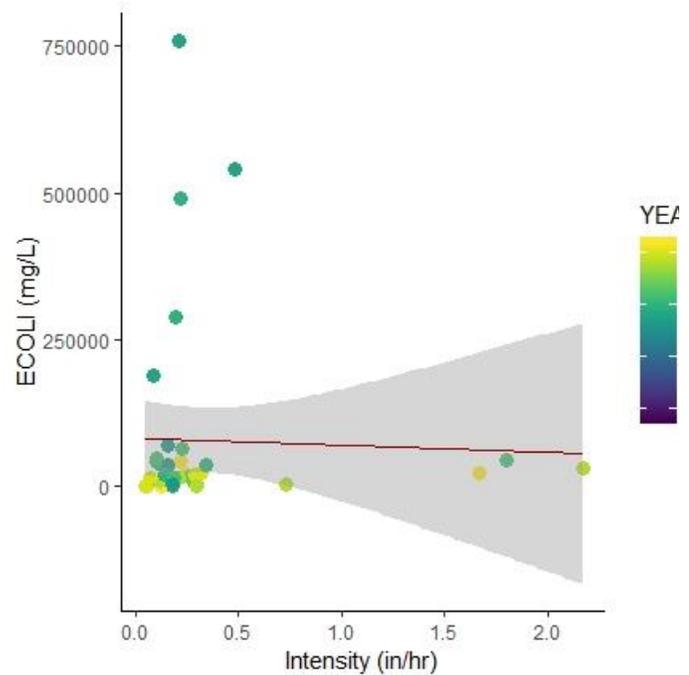
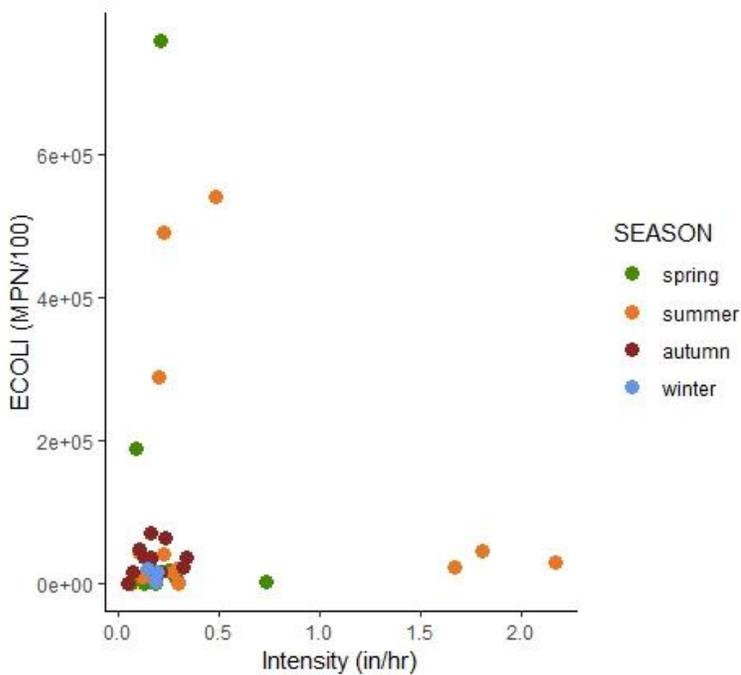
- Summary**
- Stormflow values significantly decreased.
 - Baseflow values had non-significantly decreasing trends.

Stormflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction	Neg.	Neg.	Neg.
p-value	0.01	0.04	0.02

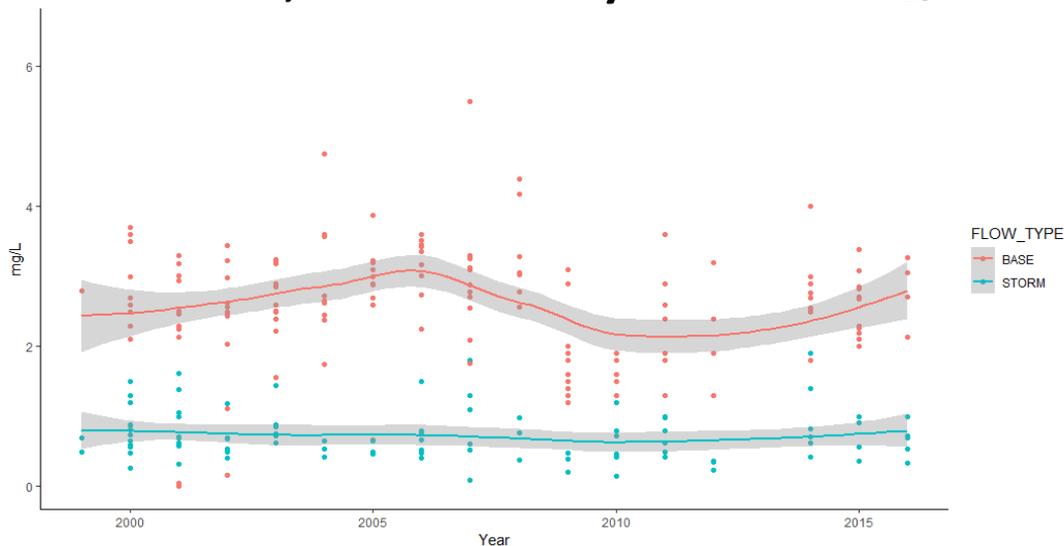
Baseflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction	Neg.	Neg.	Neg.
p-value	NS	NS	NS



The most intense storms are associated with summertime *E. coli*. Spring and summer values are the highest and are mainly associated with medium to low intensity storms. There does not appear to be an *E. coli*-vs-intensity relationship in the seasons. More recent *E. coli* values seem to be lower in intensity than ones taken earlier in the monitoring time period.

Moore's Run, Baltimore City - Outfall NO₂₃



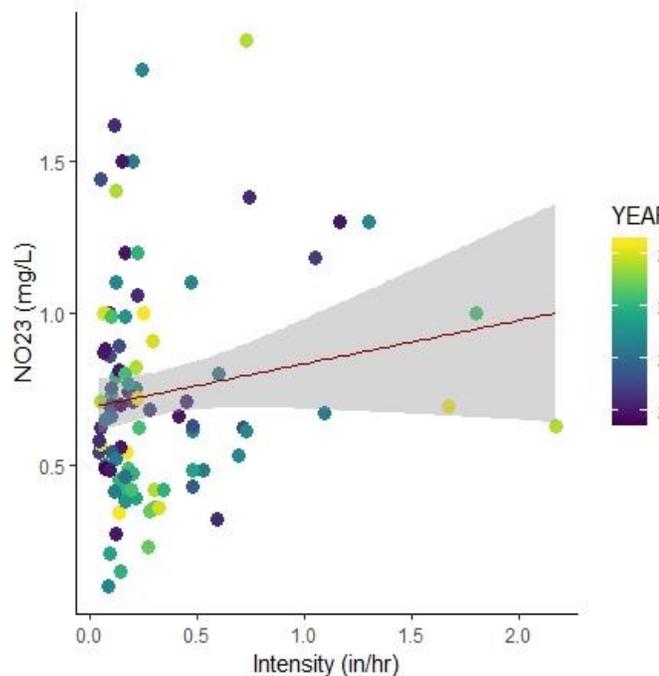
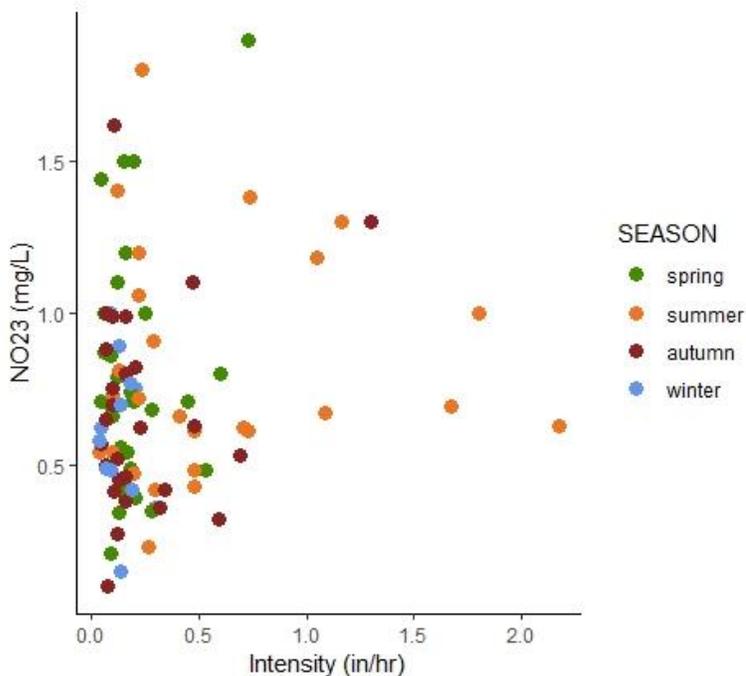
- Summary**
- Stormflow values had non-significant negative trends.
 - Baseflow values had non-significant negative trends.
 - Step trends found no difference between the three time periods in stormflow or baseflow.

Stormflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled	Culled	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS	NS	NS	NS	NS

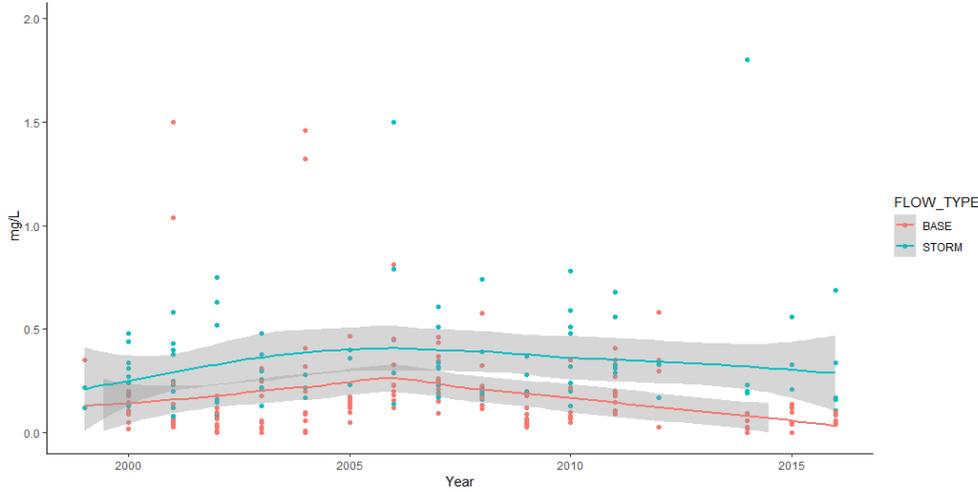
Baseflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Pos.	Neg.
p-value	NS	NS	NS	NS	NS



The most intense storms primarily occur during the summer, with the exception of an intense autumn storm. There does not appear to be an NO₂₃-vs-intensity relationship in the seasons. The relationship between intensity and NO₂₃ does not appear to change over the years.

Moore's Run, Baltimore City - Outfall TP



Summary

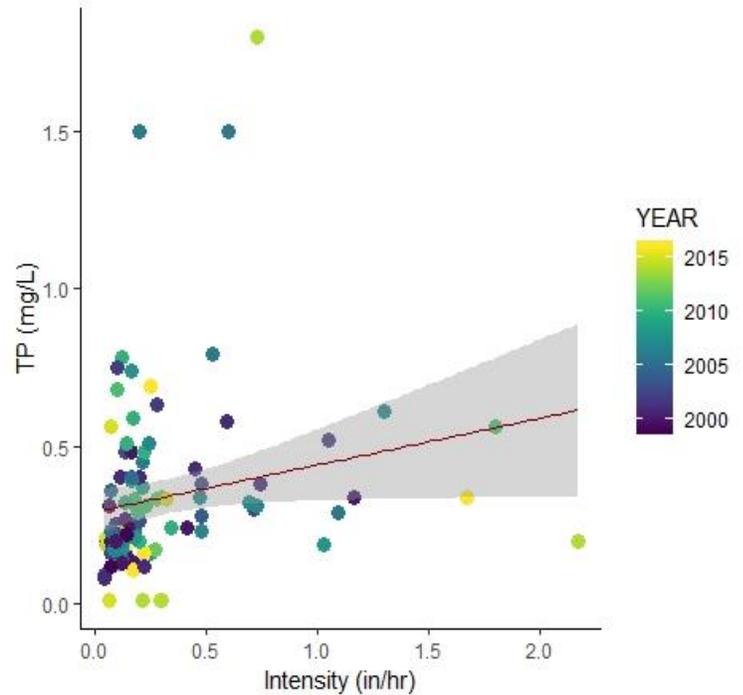
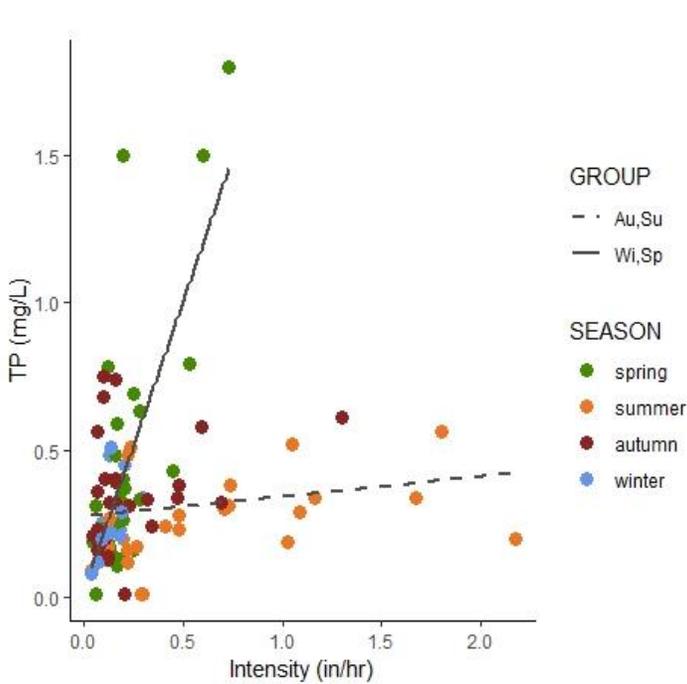
- Spring and annual stormflow values had non-significant increasing trends; summer values decreased significantly.
- Baseflow values had a mix of non-significant positive and negative trends.
- Step trends found no difference between the three time periods in stormflow or baseflow.

Stormflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled	Culled	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	Neg.	NA	NA	Pos.	Pos.	Pos.
p-value	NS	0.02	NS	NS	NS	NS	NS

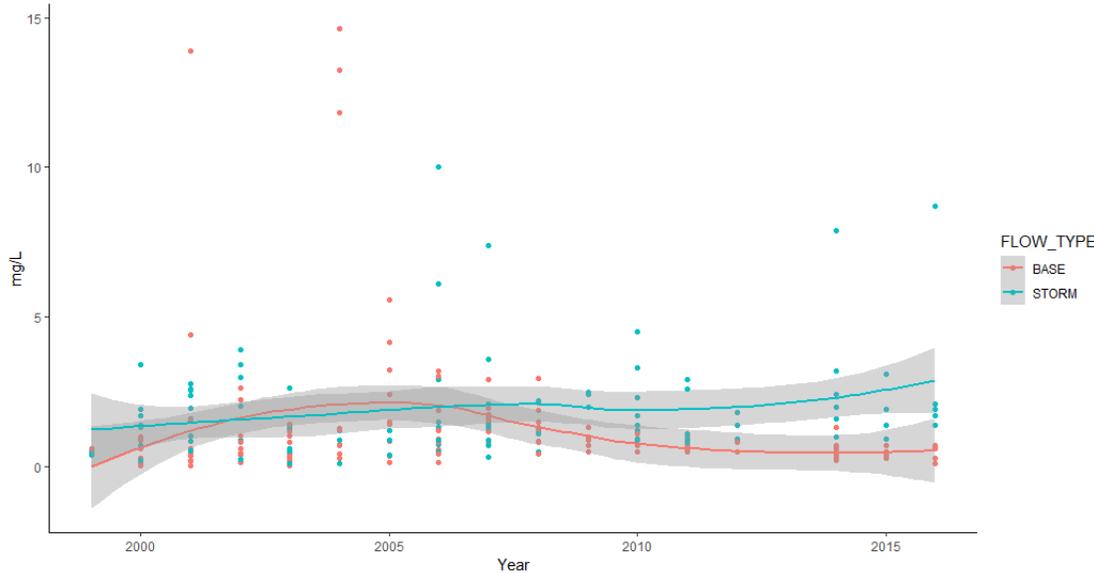
Baseflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS	NS	NS



The most intense storms are associated with summertime TP, as well as with one autumn storm. Spring TP measurements are the highest and are mainly associated with medium to low intensity storms. There appears to be a TP-vs-intensity relationship in winter and spring, with TP increasing as intensity increases, but the relationship was not tested. The relationship between intensity and TP does not appear to change over the years.

Moore's Run, Baltimore City - Outfall TKN



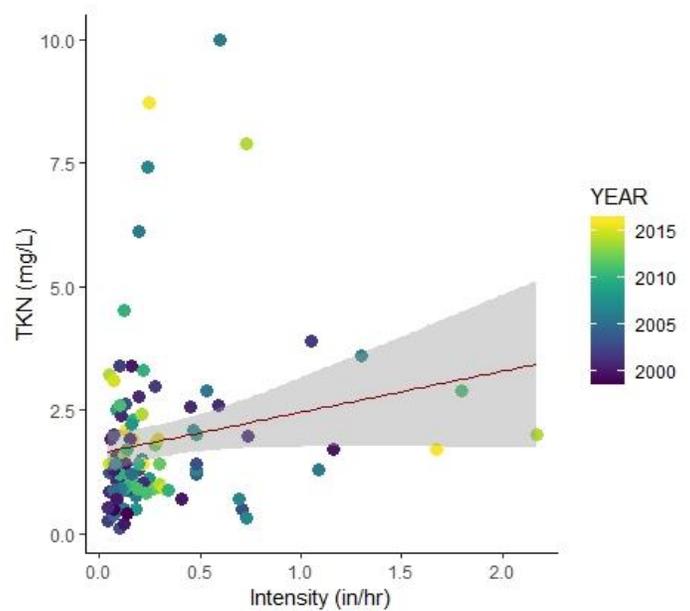
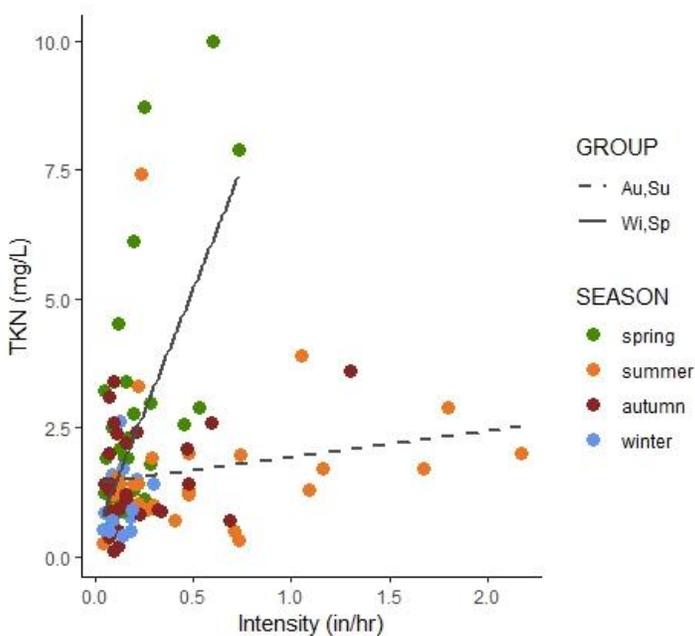
- Summary**
- One method found a significantly increasing trend in stormflow values; others were not significant.
 - Baseflow values had non-significant decreasing trends, as well as a barely-significant negative trend.
 - Step trends found differences in baseflow values only; Periods I and II, II and III differed significantly.

Stormflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled	Culled	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	NA	NA	Pos.	Pos.	Pos.
p-value	NS	NS	NS	NS	NS	0.04	NS

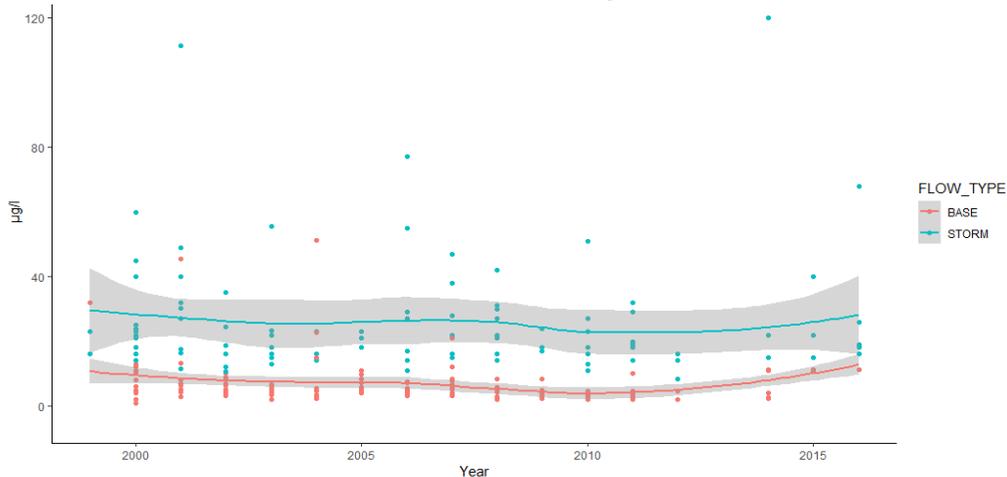
Baseflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Mann-Whitney	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	I~II, II~III	Neg.	Neg.	Neg.
p-value	NS	< 0.001	0.008, < 0.001	0.04	NS	NS



The most intense storms are associated with summertime TKN, as well as with one autumn storm. Spring and one summer TKN measurements are the highest and are mainly associated with medium to low intensity storms. There appears to be a TKN-vs-intensity relationship in winter and spring, with TKN increasing as intensity increases, but the relationship was not tested. The relationship between intensity and TKN does not appear to change over the years.

Moore's Run, Baltimore City - Outfall TCU



Summary

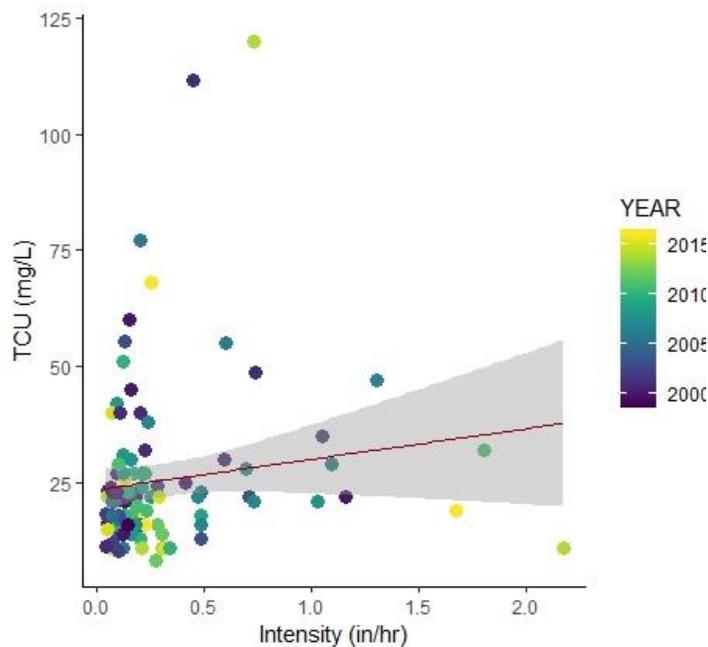
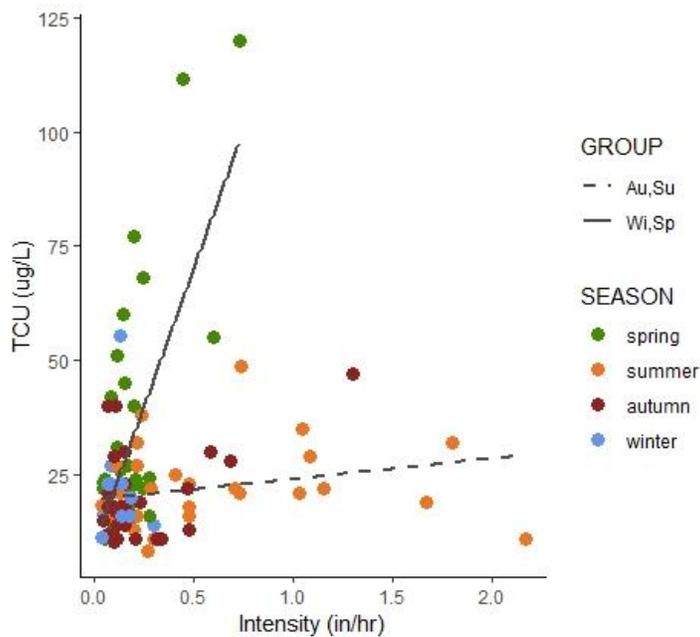
- Stormflow values decreased, but only summer values significantly so.
- Baseflow values significantly decreased.
- Step trends found differences in baseflow values only; Periods I and III, II and III differed significantly.

Stormflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled, median adj.	Culled, median adj.	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	NA	Neg.	Neg.	Neg.
p-value	NS	0.019	NS	NS	NS	NS	NS

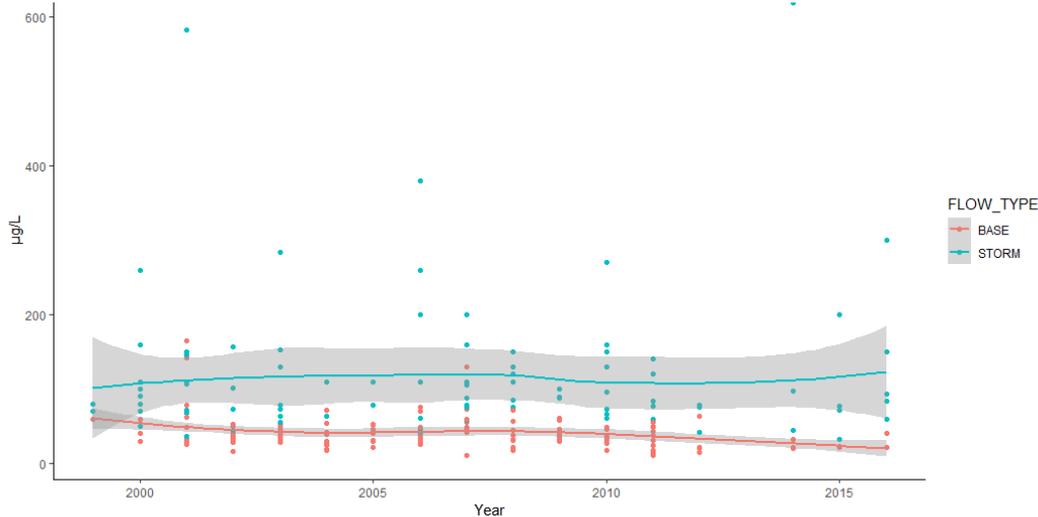
Baseflow

Season	Annual	Annual	Annual
Data	Culled, median adj.	Culled	Culled
Method	Mann-Kendall	Kruskal-Wallis	Mann-Whitney
Direction/Periods	Neg.	NA	I~III, II~III
p-value	< 0.001	< 0.001	< 0.001, < 0.001



The most intense storms are associated with summertime TCU, as well as with one autumn storm. Spring measurements are the highest and are mainly associated with medium to low intensity storms. There appears to be a TCU-vs-intensity relationship in winter and spring, with TCU increasing as intensity increases, but the relationship was not tested. The relationship between intensity and TCU does not appear to change over the years.

Moores Run, Baltimore City - Outfall TZN



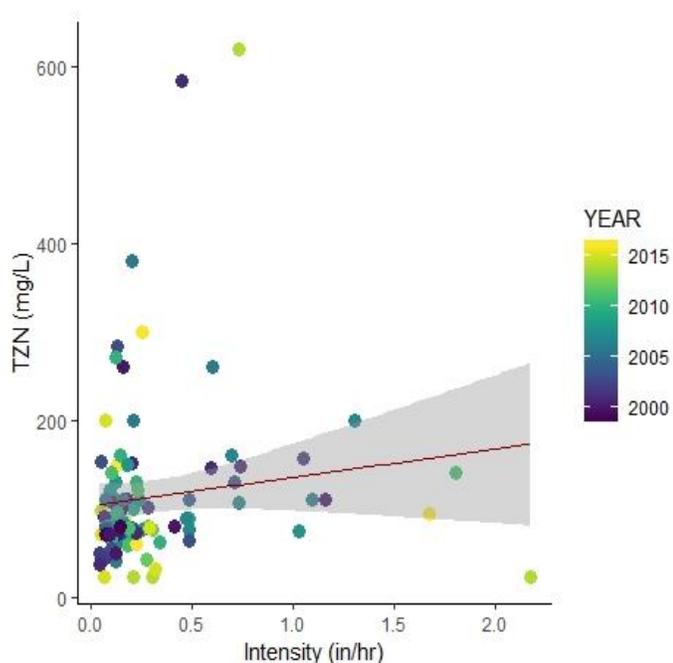
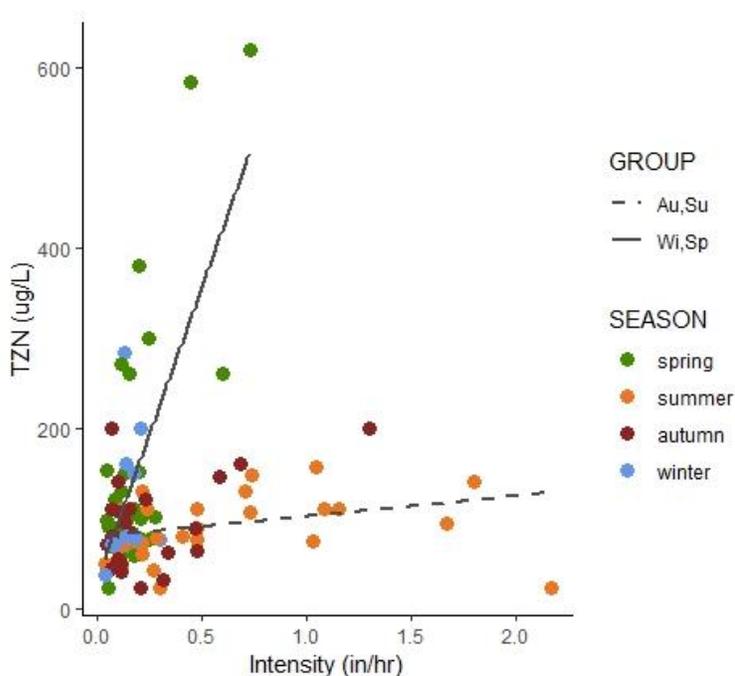
- Summary**
- Spring and annual stormflow values had significantly increasing and decreasing trends; summer values decreased significantly.
 - Stormflow values significantly decreased.
 - Step trends found differences in baseflow values only; Periods I and III, II and III differed significantly.

Stormflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled, median adj.	Culled, median adj.	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	Neg.	NA	NA	Neg.	No direction	Neg.
p-value	NS	< 0.001	NS	NS	NS	NS	NS

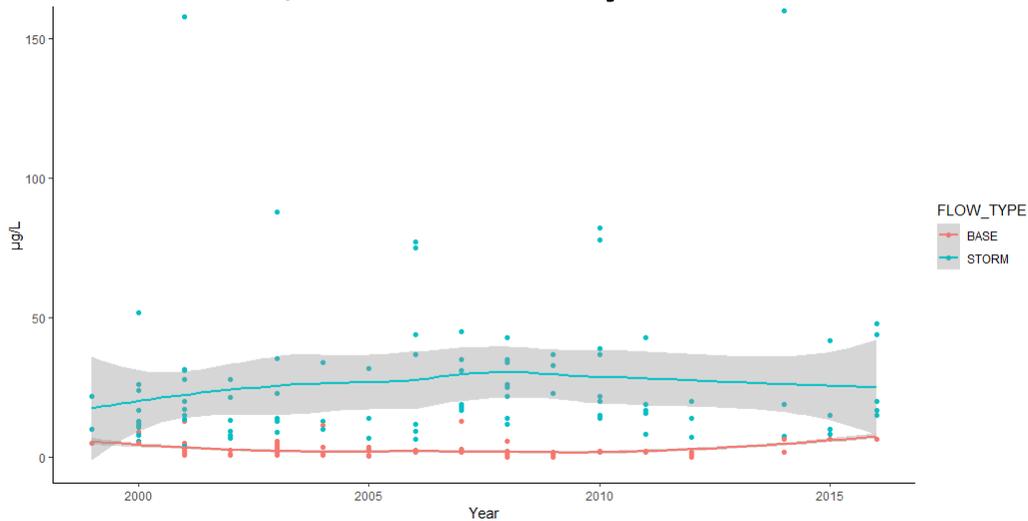
Baseflow

Season	Annual	Annual	Annual
Data	Culled, median adj.	Culled	Culled
Method	Mann-Kendall	Kruskal-Wallis	Mann-Whitney
Direction/Periods	Neg.	NA	I~III, II~III
p-value	< 0.001	< 0.001	< 0.001, < 0.001



The most intense storms are associated with summer TZN values, except for an intense autumn storm. The highest TZN measurements occur during spring. There appears to be a TZN-vs-intensity relationship in winter and spring, with TZN increasing as intensity increases, but the relationship was not tested. The relationship between intensity and TZN does not appear to change over the years.

Moores Run, Baltimore City - Outfall TPB



Summary

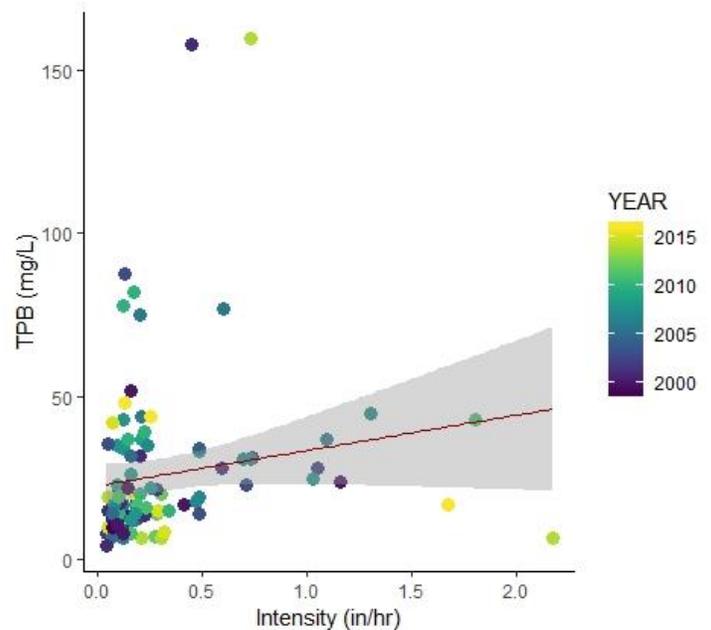
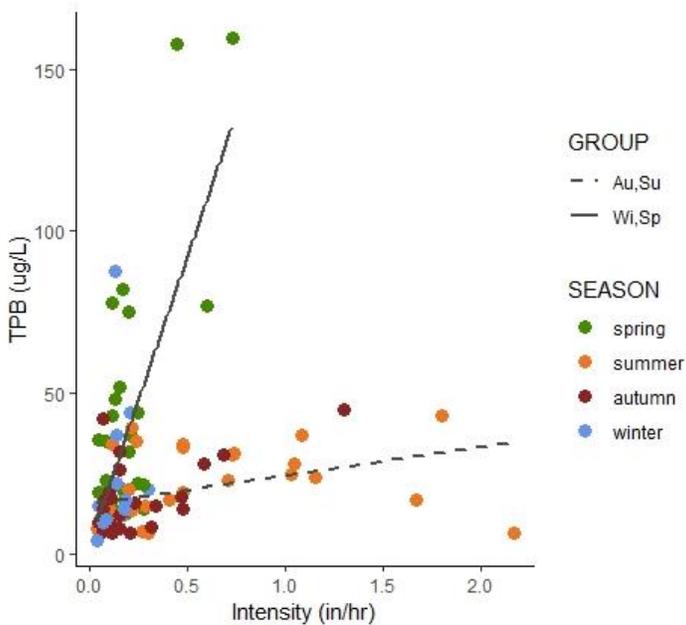
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values did not significantly change; trends were positive.
- Step trends found no difference between the three time periods in spring or summer stormflow.

Stormflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled, median adj.	Culled, median adj.	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	Neg.	NA	NA	Pos.	Pos.	Pos.
p-value	NS	NS	NS	NS	NS	NS	NS

Baseflow

Season
Data
Method
Direction/Periods
p-value



The most intense storms are associated with summer TPB values, except for an intense autumn storm. The highest TPB measurements occur during spring, with one high TPB value measured during a winter storm. There appears to be a TPB-vs-intensity relationship in winter and spring, with TPB increasing as intensity increases, but the relationship was not tested. The relationship between intensity and TPB does not appear to change over the years.

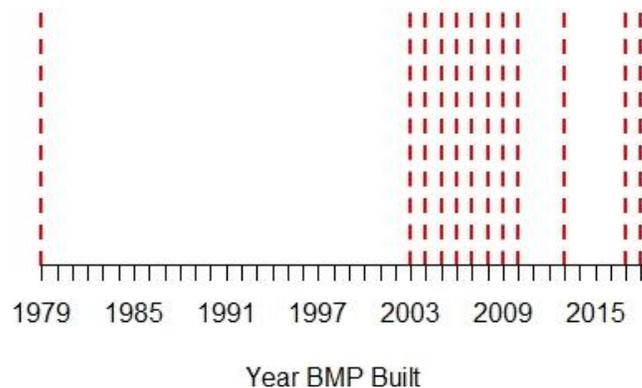
Airpark Business Center, Carroll County Instream Site: WPU02



Looking upstream at weir

Year	Total Imperv. Acres in Mon. Drainage Area from MDE Digitization	Impervious Acres Treated by 1970's Era Wet Pond	Impervious Acres Treated by Modern ED Wet Pond	Impervious Acres Treated by Shallow Marsh	Impervious Acres Treated by Other BMPs	Nested Impervious Acres Treated	% Monitoring Area Impervious Acres Treated ¹
2005	102.3	49.6	0.0	0.0	0.0	23.3	71.3% (22.8%)
2006	106.9	46.6	0.0	0.0	0.0	27.2	69.0% (25.4%)
2007	117.4	53.7	0.0	29.5	0.0	35.6	101.2% (55.5%)
2008	117.3	0.0	52.8	29.5	0.0	36.5	101.2%
2009	120.8	0.0	51.5	29.5	0.0	38.7	99.0%
2010	120.8	0.0	51.5	29.5	0.0	40.1	100.2%
2011	123.6	0.0	54.5	29.5	0.0	40.1	100.4%
2013	137.5	0.0	61.4	29.5	0.0	44.5	98.5%
2014	137.5	0.0	61.5	29.5	0.0	44.5	98.5%
2015	137.7	0.0	61.7	29.5	0.0	44.5	98.5%
2017	138.0	0.0	61.7	29.5	0.0	44.8	98.5%
2018	144.8	0.0	68.0	29.5	1.7	44.8	99.5%

1: Numbers in parentheses represent percent captured by Modern BMPs (i.e., does not include 1979 Wet Pond).



Airpark Business Center, Carroll County Instream Site: WPU02



April 1995

Image: Google, USGS



June 2005

Image: Google, USDA FSA



September 2008

Image: Google, USGS



May 2009

Image: Google, USDA FSA



October 2014

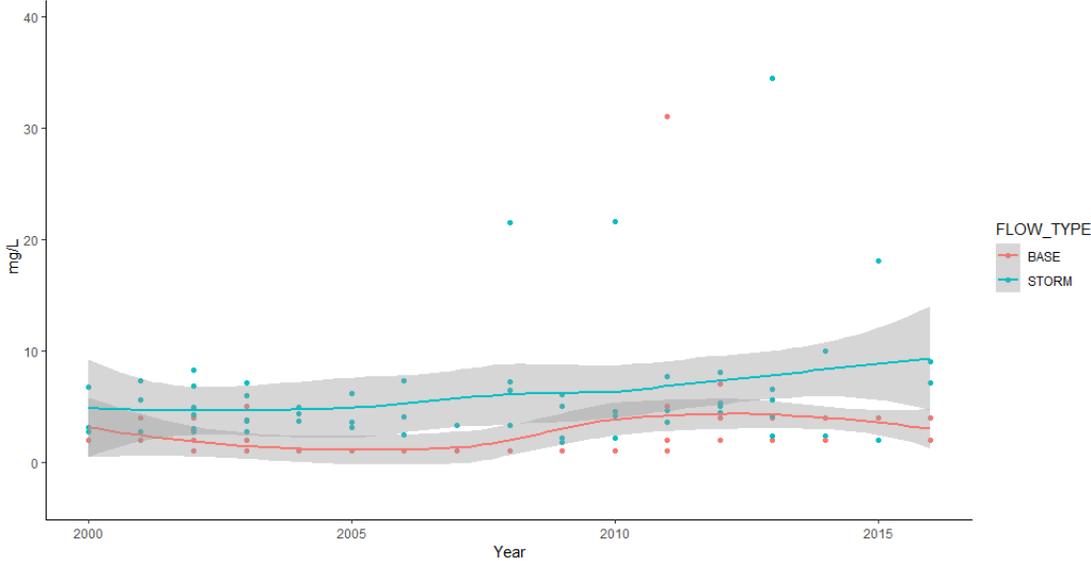
Image: Google,
Landsat/Copernicus



February 2017

Image: Google,
Landsat/Copernicus

Airpark Business Center, Carroll County - Instream BOD



Summary

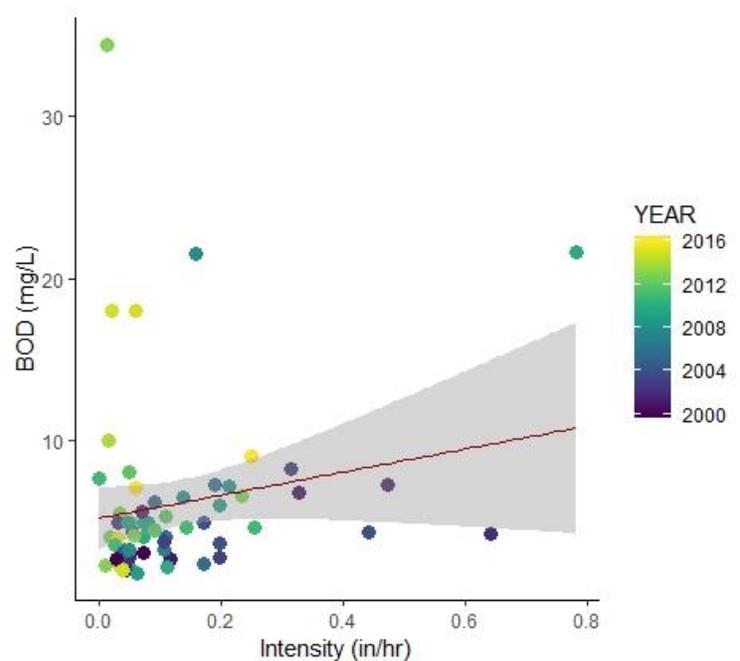
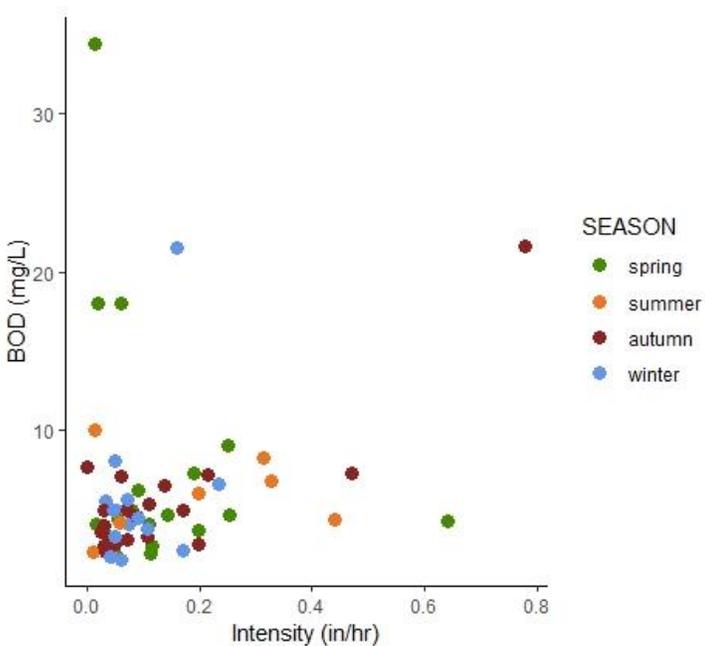
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values had non-significant increasing trends.
- Step trends found no difference between the three time periods.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Pos.	Pos.	Pos.
p-value	NS	NS	NS	NS	NS

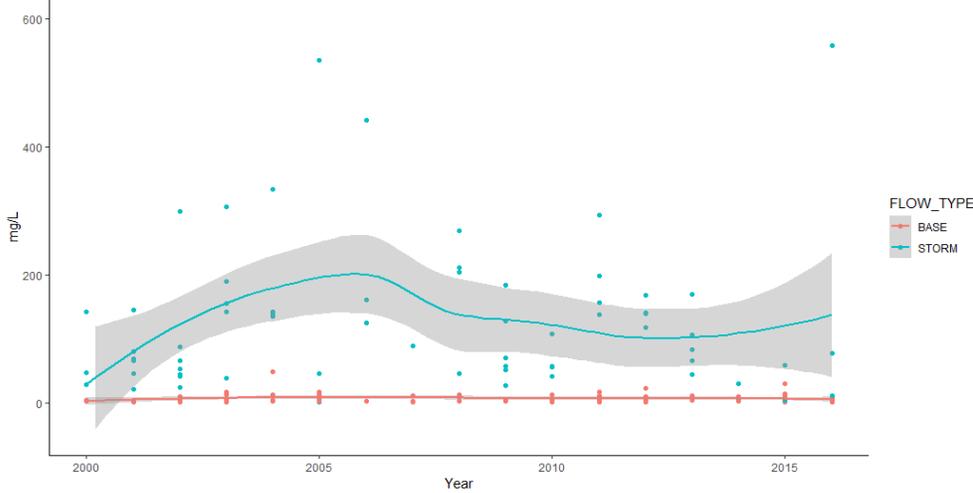
Baseflow

Season
Data
Method
Direction/Periods
p-value



There are few apparent seasonal patterns regarding BOD and intensity; three of the four storms producing the highest BOD values are during spring. There does not appear to be a BOD-vs-intensity relationship in the seasons. The relationship between intensity and BOD does not appear to change over the years.

Airpark Business Center, Carroll County - Instream TSS



Summary

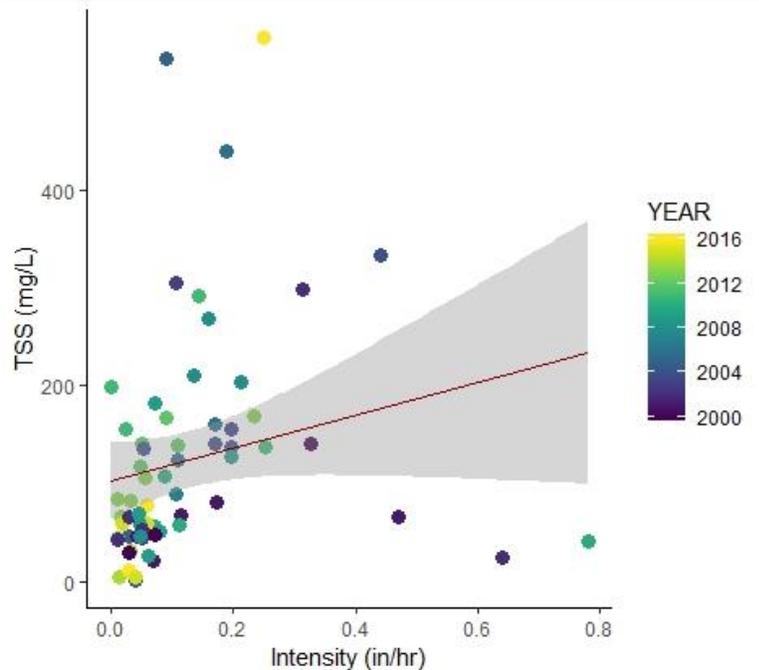
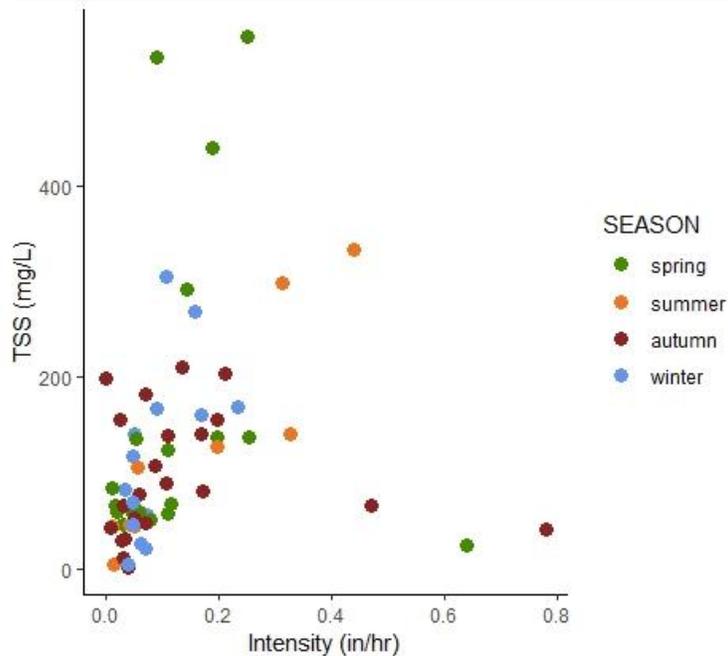
- Stormflow values had mixed direction non-significant trends.
- Baseflow values had non-significantly decreasing trends.
- Step trends found no difference between the three time periods in stormflow or baseflow.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Pos.
p-value	NS	NS	NS	NS	NS

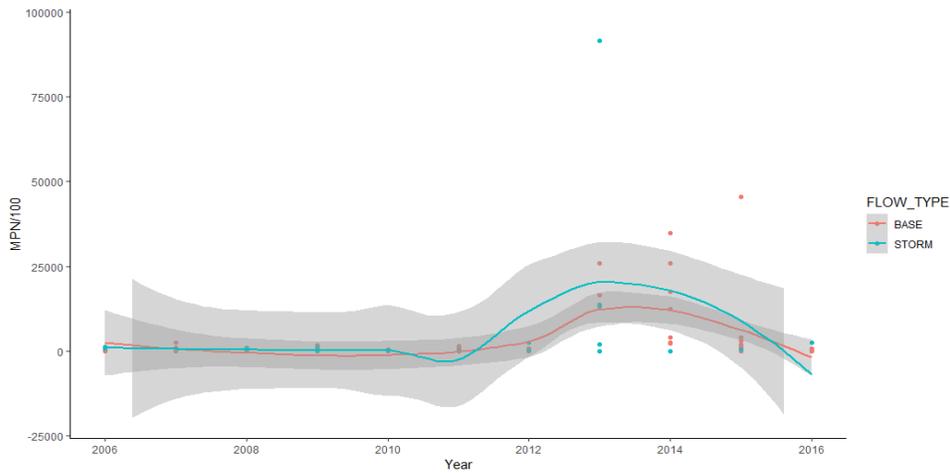
Baseflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled, median adj.	Culled	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS	NS	NS	NS	NS



There are few apparent seasonal patterns regarding TSS and intensity. The three storms producing the highest TSS values are during spring. Except for a few points, the more recent TSS measurements are low in value and came from storms with low intensities, although there are also several values from the beginning of the monitoring time period with this characteristic. Most of the more recent measurements are, however, not associated with high intensity storms or high values.

Airpark Business Center, Carroll County - Instream *E. coli*



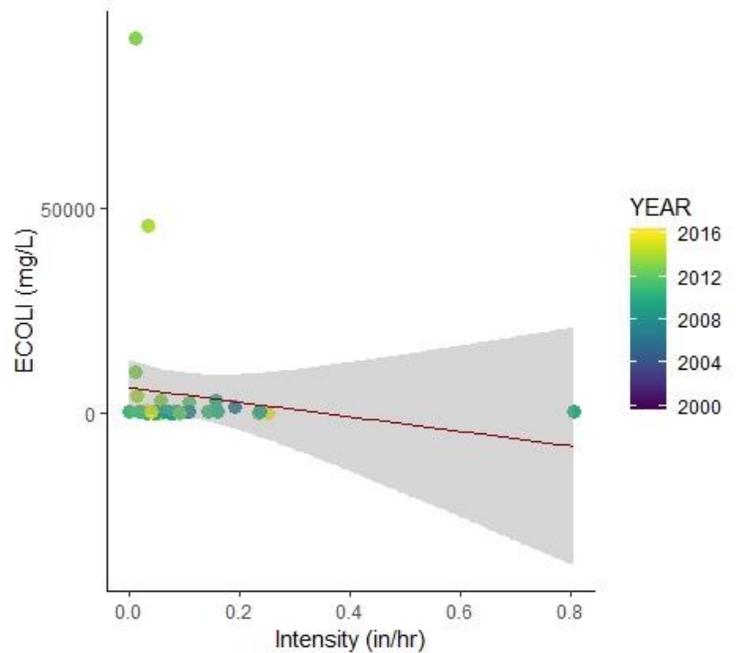
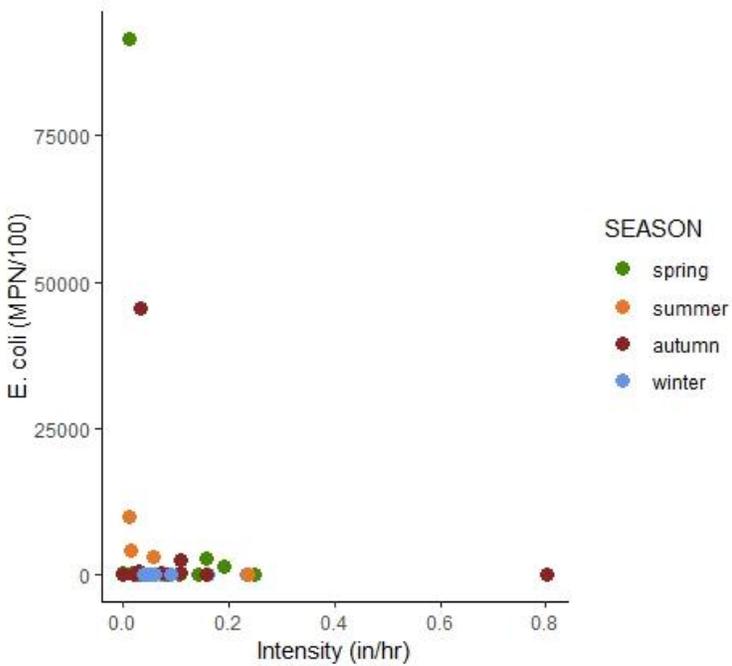
- Summary**
- Stormflow and baseflow values had non-significant positive trends.

Stormflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	Pos.
p-value	NS	NS	NS

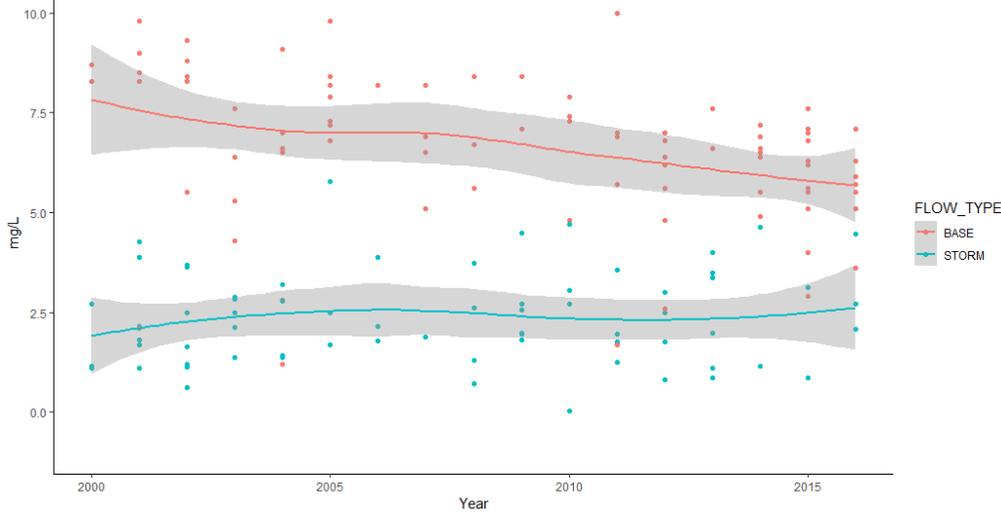
Baseflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	Pos.
p-value	NS	NS	NS



It is difficult to discern a seasonal or yearly pattern based on the above plots.

Airpark Business Center, Carroll County - Instream NO₂₃



Summary

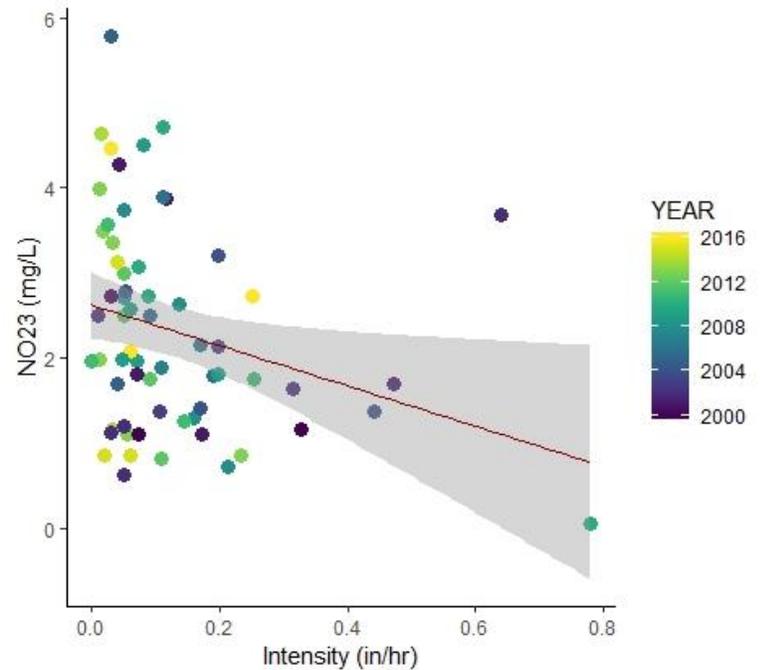
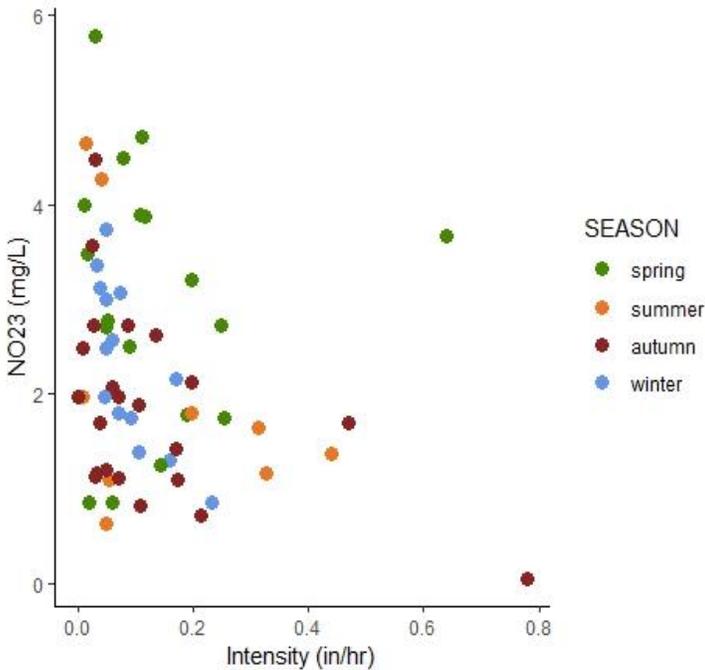
- Stormflow values did not significantly change; trends found were a mix of increasing, decreasing, and no direction.
- Baseflow values had decreasing trends for spring and all annual methods.
- Step trends found no difference between the three time periods in stormflow or baseflow.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Pos.	No direction	Neg.
p-value	NS	NS	NS	NS	NS

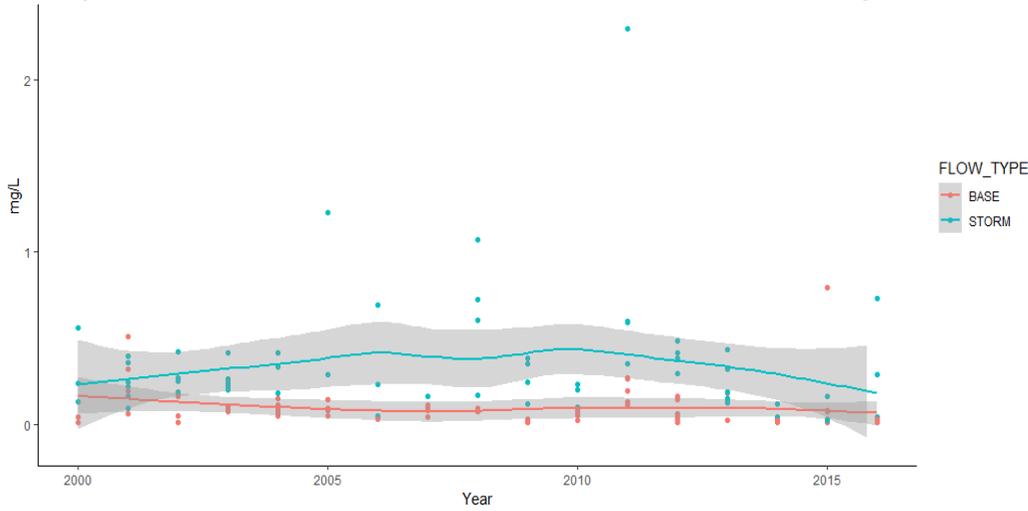
Baseflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled	Culled	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	NA	Neg.	Neg.	Neg.
p-value	< 0.001	NS	NS	NS	< 0.01	< 0.01	< 0.01



There does not appear to be a strong effect of season or year on the relationship between intensity and NO₂₃.

Airpark Business Center, Carroll County - Instream TP



Summary

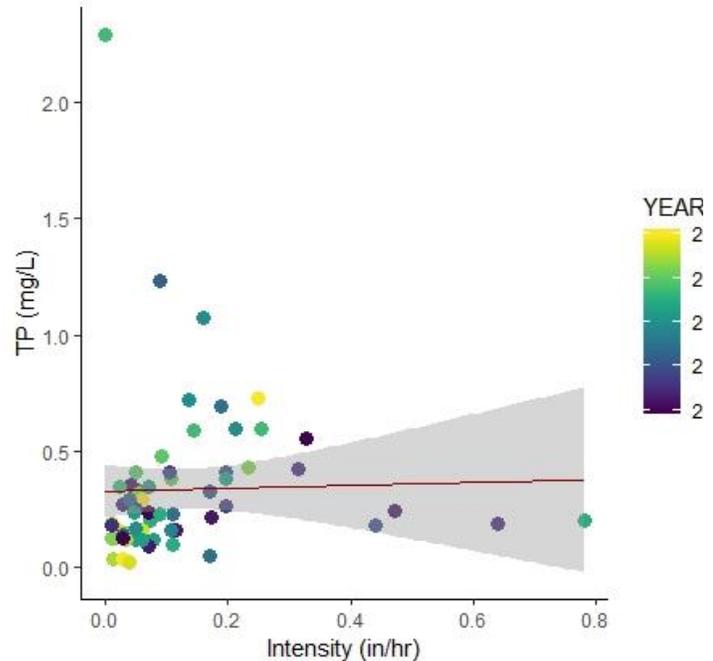
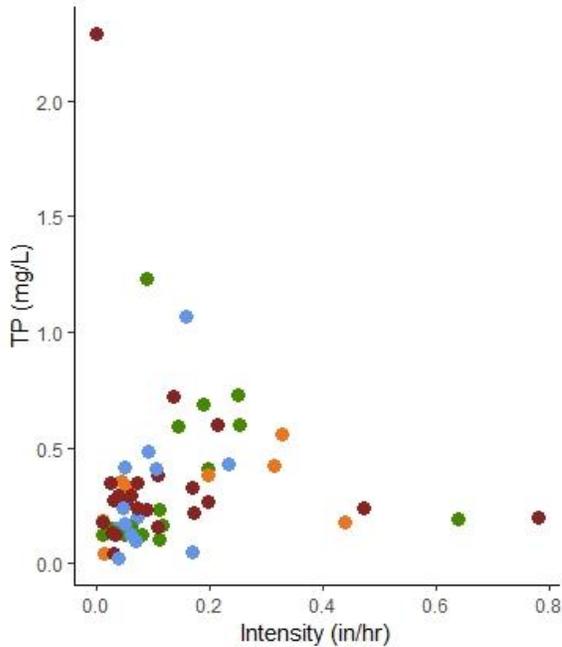
- Stormflow values did not significantly change; trends found were a mix of increasing and decreasing.
- Summer and one annual method had decreasing baseflow values; other methods found non-significant negative trends.
- Step trends found no difference between the three time periods in stormflow or baseflow.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS.	NS	NS

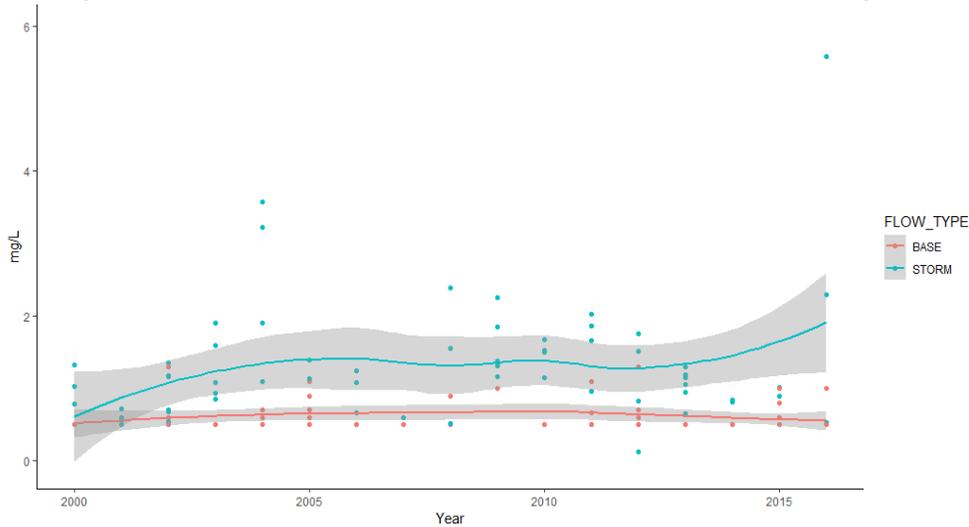
Baseflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled, median adj.	Culled	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	NA	Neg.	Neg.	Neg.
p-value	NS	< 0.001	NS	NS	NS	NS	< 0.01



There does not appear to be a strong effect of season or year on the relationship between intensity and TP.

Airpark Business Center, Carroll County - Instream TKN



Summary

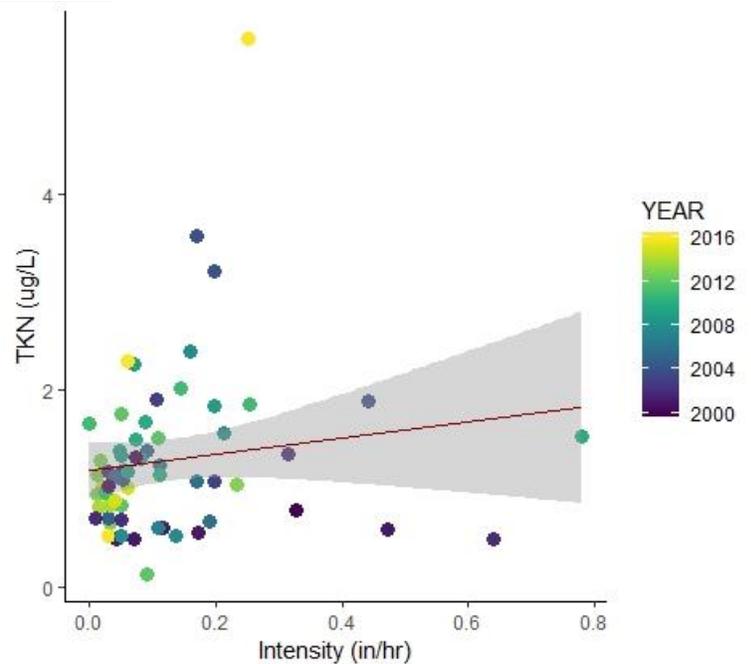
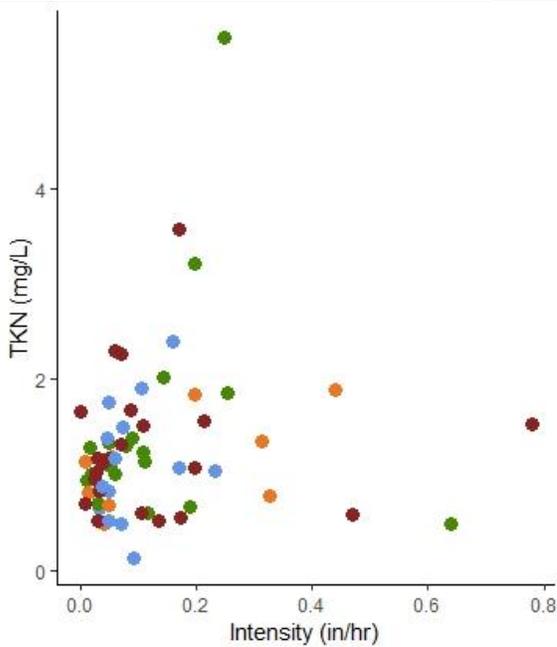
- Stormflow values had positive but non-significant trends.
- Baseflow values had non-significant negative or no direction trends.
- Step trends found no difference between the three time periods in stormflow.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Pos.	Pos.	Pos.
p-value	NS	NS	NS	NS	NS

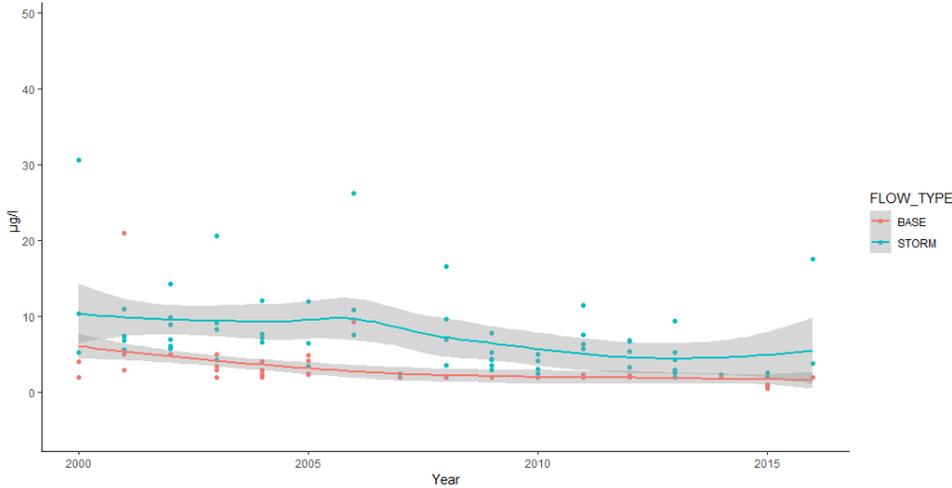
Baseflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	No direction
p-value	NS	NS	NS



There does not appear to be a strong effect of season or year on the relationship between intensity and TP.

Airpark Business Center, Carroll County - Instream TCU



Summary

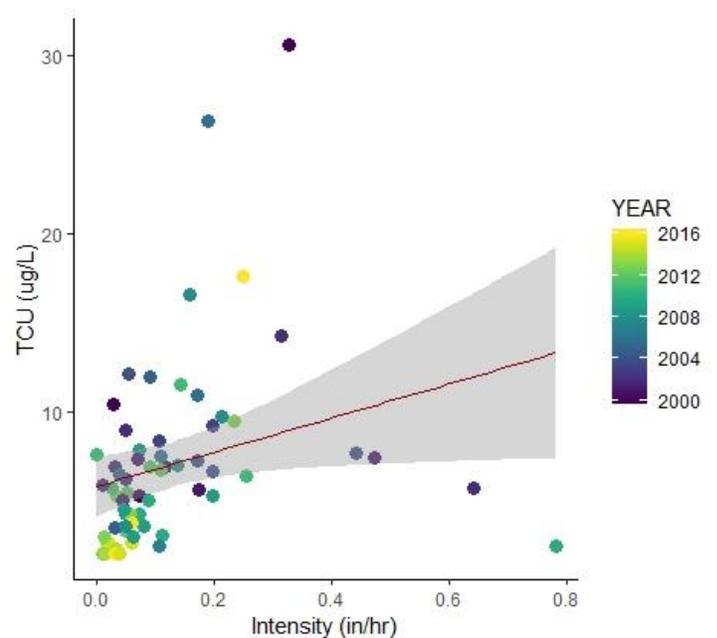
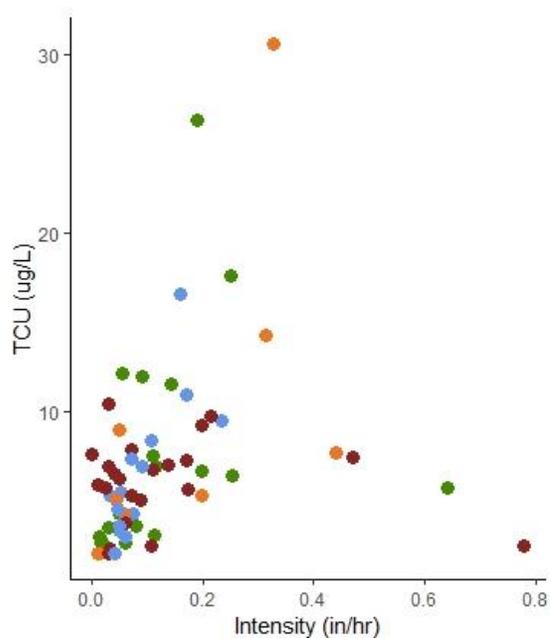
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values significantly decreased for annual data sets; autumn trend was negative but not significant.
- Step trends found no difference between the three time periods in stormflow.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	< 0.01	< 0.01	< 0.01

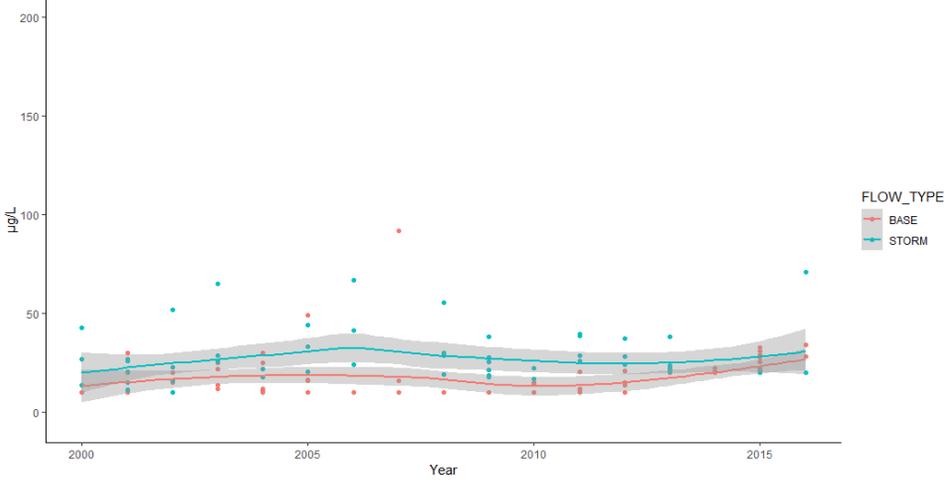
Baseflow

Season
Data
Method
Direction/Periods
p-value



There does not appear to be an effect of season on the relationship between intensity and TCU. Based on the year color-coded plot, many of the recent measurements of TCU are associated with low values and low-intensity storms.

Airpark Business Center, Carroll County - Instream TZN



Summary

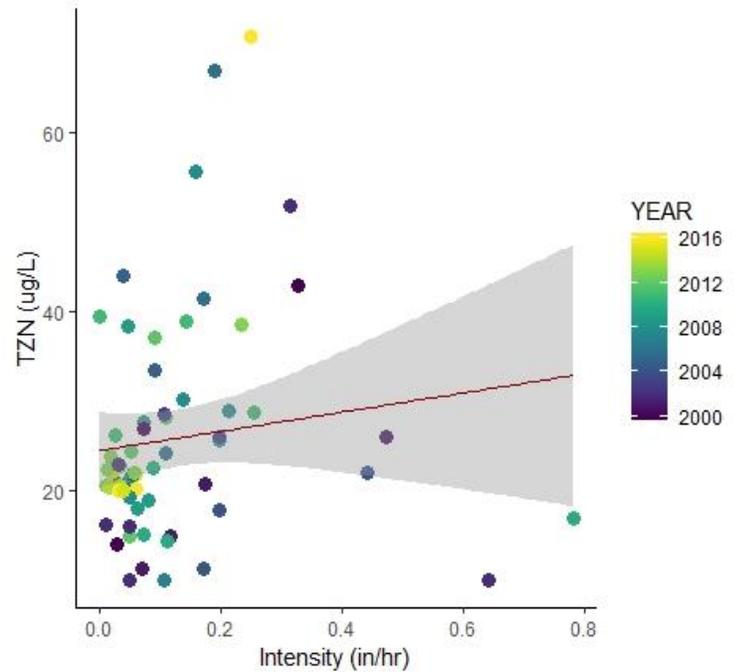
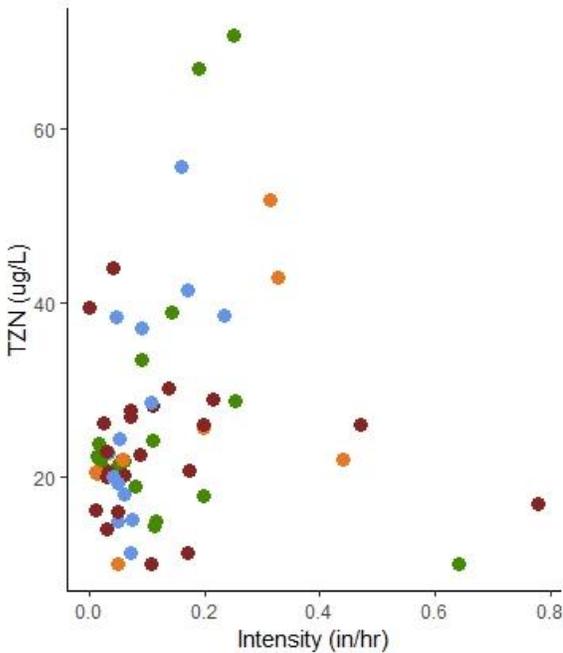
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values had a mix of non-significant increasing and decreasing trends.
- Step trends found no difference between the three time periods in stormflow.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Pos.	No direction	Neg.
p-value	NS	NS	NS	NS	NS

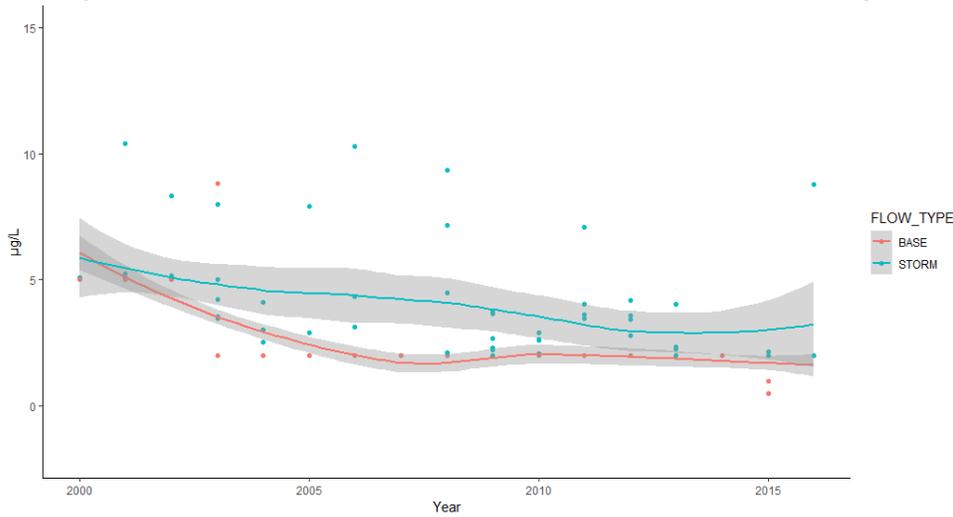
Baseflow

Season
Data
Method
Direction/Periods
p-value



There does not appear to be a strong effect of season or year on the relationship between intensity and TZN.

Airpark Business Center, Carroll County - Instream TPB



Summary

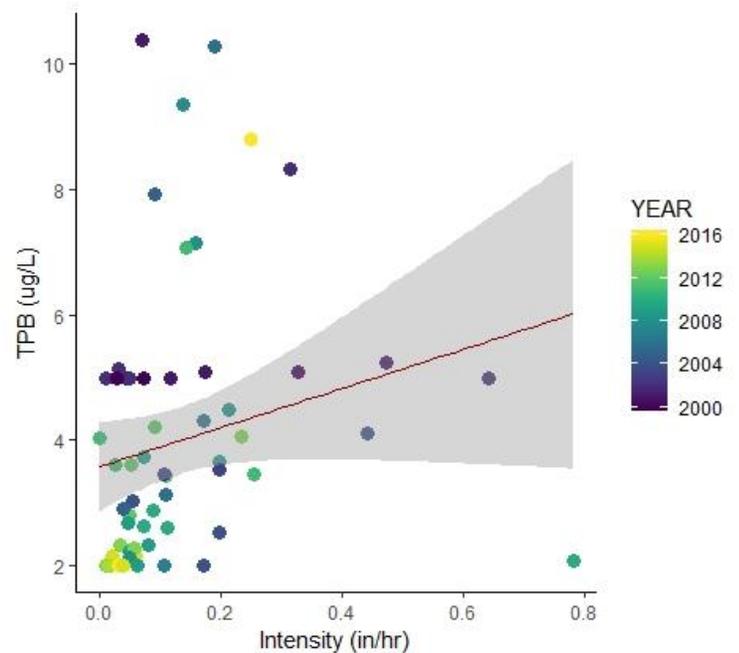
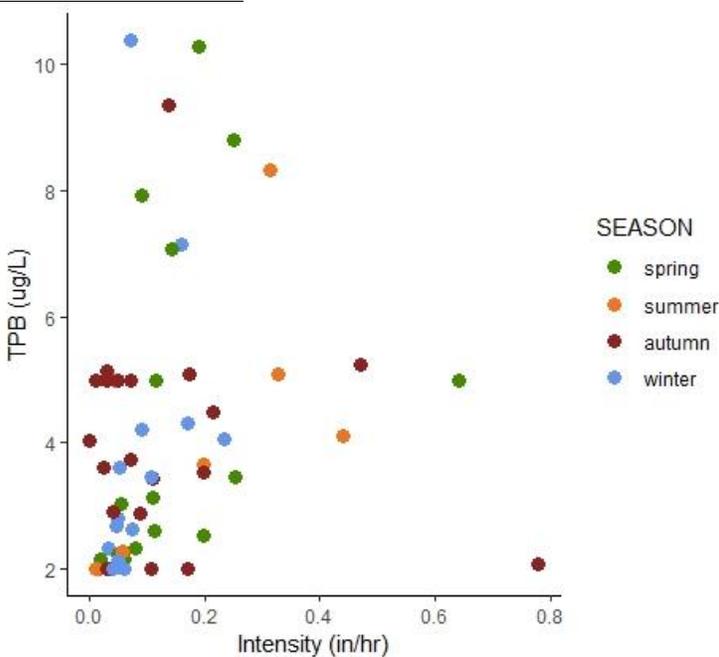
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values had non-significant decreasing trends.
- Step trends found no difference between the three time periods in stormflow.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS	NS	NS

Baseflow

Season
Data
Method
Direction/Periods
p-value



There does not appear to be a strong effect of season or year on the relationship between intensity and TPB. Based on the plot color-coded by year, many of the recent measurements of TPB are associated with low values and low-intensity storms.

Airpark Business Center, Carroll County Outfall Site: WPU01



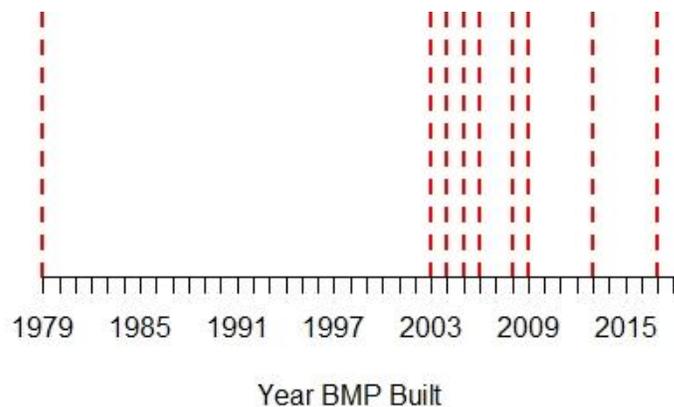
Outfall into stream



Stormwater pond

Year	Total Impervious Acres in Mon. Drainage Area from MDE Digitization	Impervious Acres Treated by 1970's Era Wet Pond	Impervious Acres Treated by Modern ED Wet Pond	Impervious Acres Treated by Other BMPs	Nested Impervious Acres Treated	% Monitoring Area Impervious Acres Treated ¹
2005	73.0	49.6	0.0	0.0	23.3	100.0% (31.9%)
2006	73.8	46.6	0.0	0.0	27.2	100.0% (36.9%)
2007	80.9	53.7	0.0	0.0	27.2	100.0% (33.6%)
2008	80.9	0.0	52.8	0.0	28.1	100.0%
2009	80.9	0.0	51.5	0.0	29.5	100.0%
2011	84.0	0.0	54.5	0.0	29.5	100.0%
2013	95.4	0.0	61.4	0.0	33.9	100.0%
2014	95.4	0.0	61.5	0.0	33.9	100.0%
2015	95.6	0.0	61.7	0.0	33.9	100.0%
2017	95.8	0.0	61.7	0.0	34.2	100.0%
2018	102.2	0.0	68.0	0.0	34.2	100.0%

1: Numbers in parentheses represent percent captured by Modern BMPs (i.e., does not include 1979 Wet Pond)



Airpark Business Center, Carroll County Outfall Site: WPU01



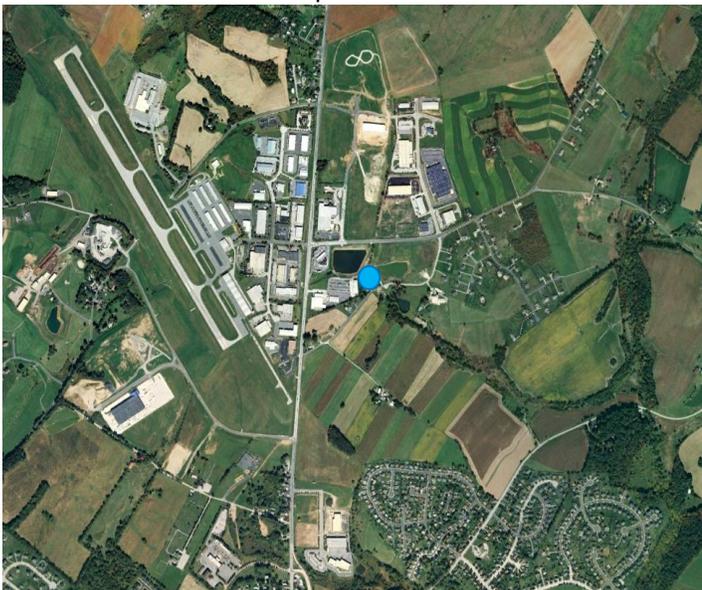
April 1995

Image: Google, USGS



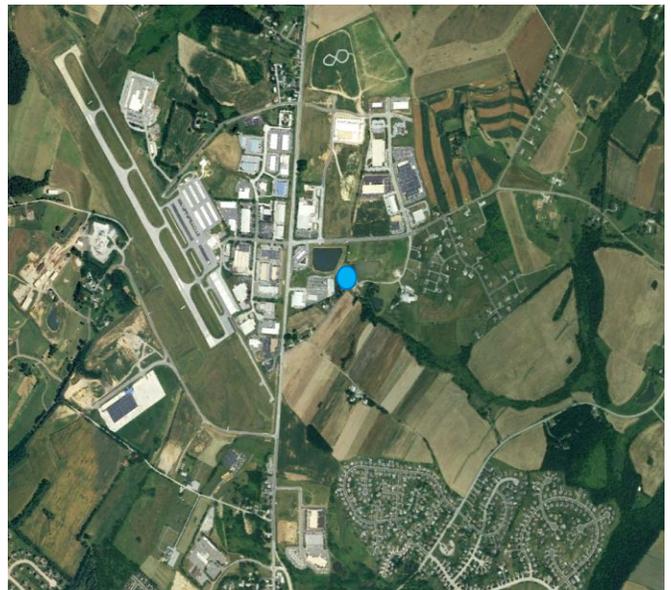
June 2005

Image: Google, USDA FSA



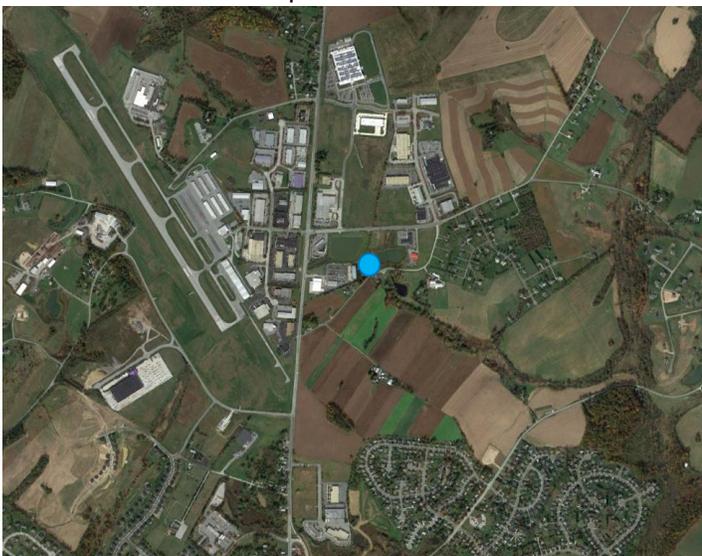
September 2008

Image: Google, USGS



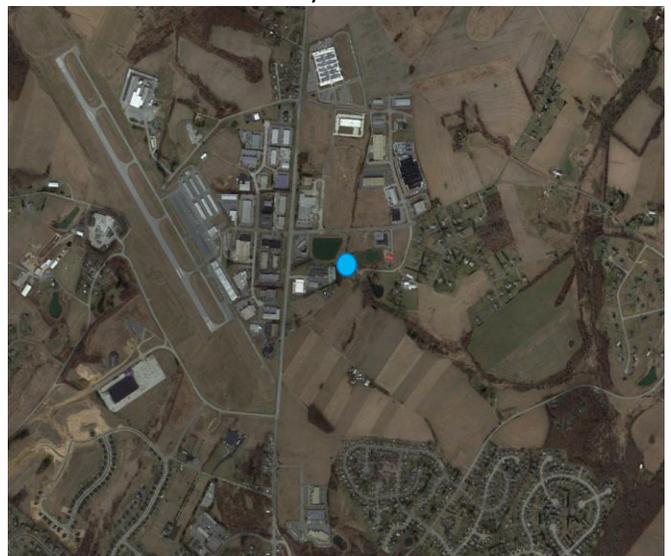
May 2009

Image: Google, USDA FSA



October 2014

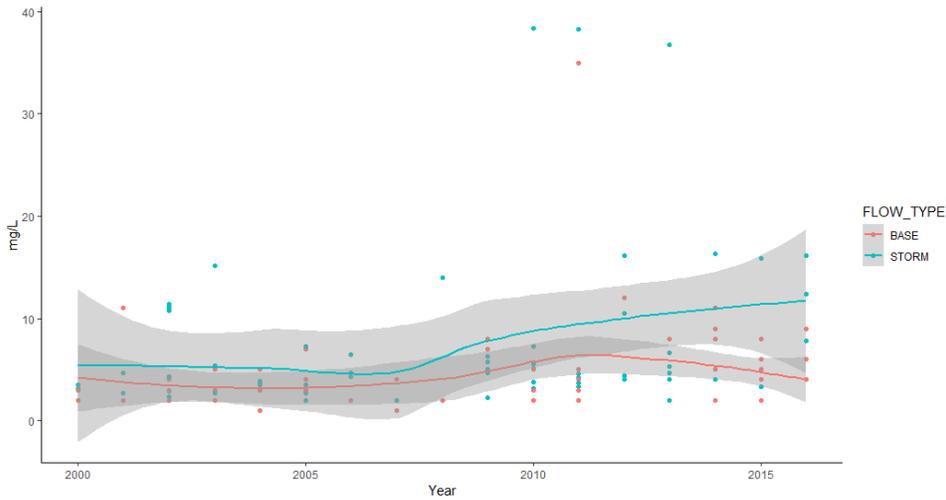
Image: Google,
Landsat/Copernicus



February 2017

Image: Google,
Landsat/Copernicus

Airpark Business Center, Carroll County - Outfall BOD



Summary

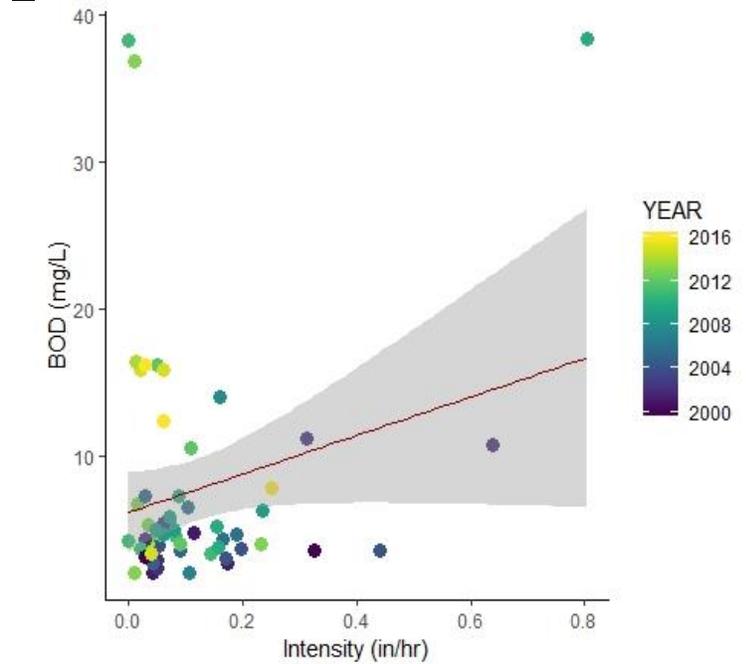
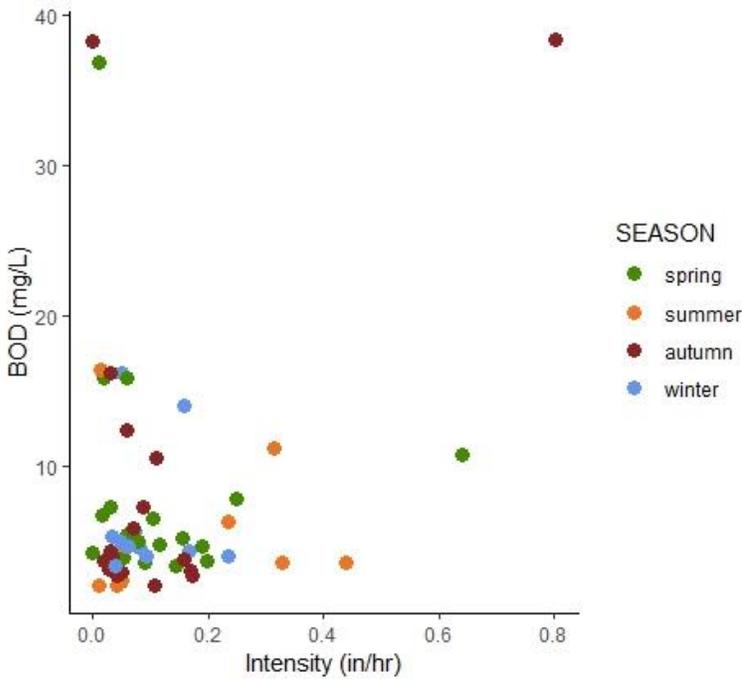
- Stormflow values increased significantly for all but one method.
- Baseflow values had non-significant increasing trends.
- Step trends found no difference between the three time periods in stormflow.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Pos.	Pos.	Pos.
p-value	0.017	NS	0.03	0.03	NS

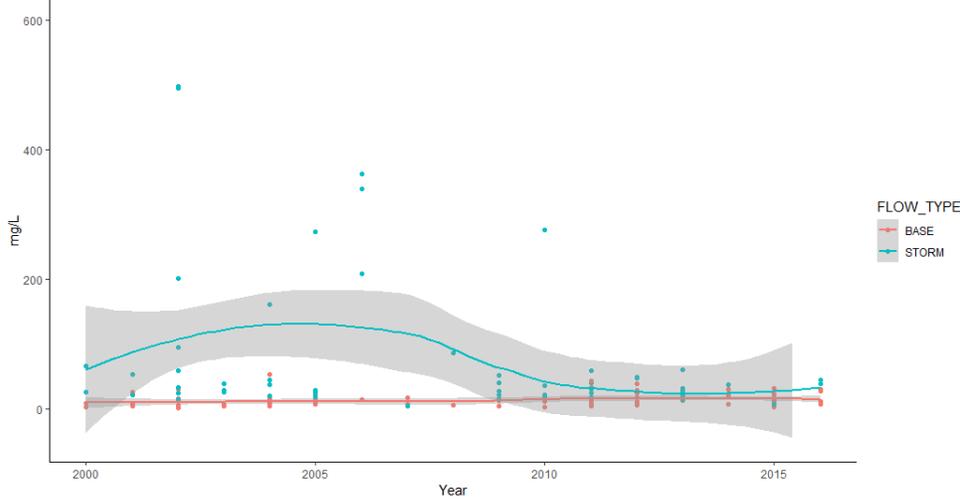
Baseflow

Season	Spring	Summer	Spring	Summer
Data	Culled, median adj.	Culled, median adj.	Culled	Culled
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis
Direction/Periods	Pos.	Pos.	NA	NA
p-value	NS	NS	NS	NS



There does not appear to be a strong effect of season or year on the relationship between intensity and BOD.

Airpark Business Center, Carroll County - Outfall TSS



Summary

- Autumn stormflow values had a non-significant increasing trend; annual stormflow values significantly decreased but for one method.
- Baseflow values significantly increased in summertime; annual and spring trends were non-significantly increasing.
- Step trends found differences in baseflow only; Periods II and III differed significantly in summer.

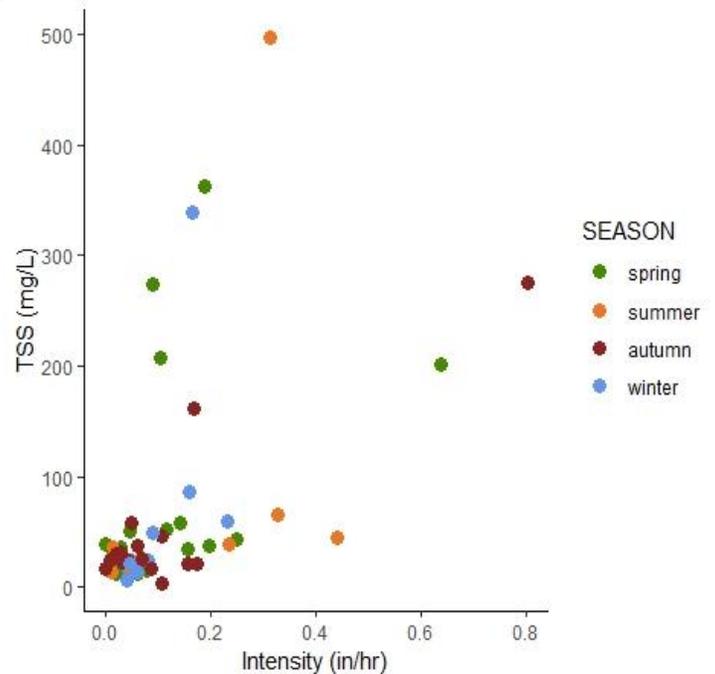
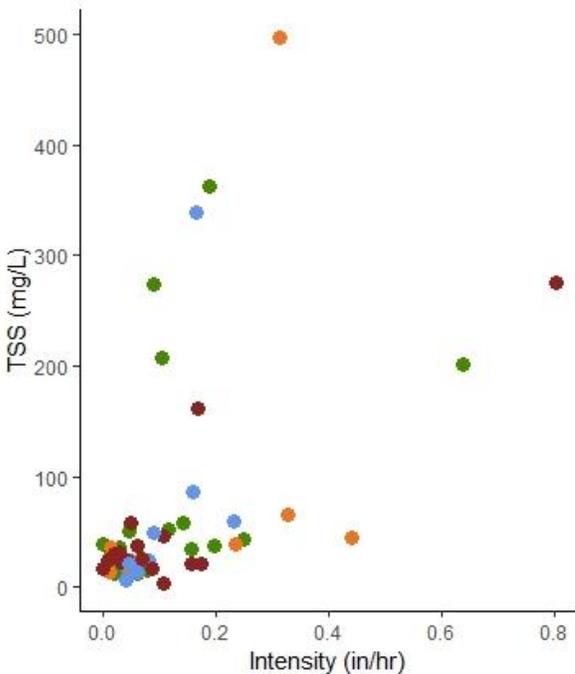
Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	0.01	0.05	NS

Baseflow

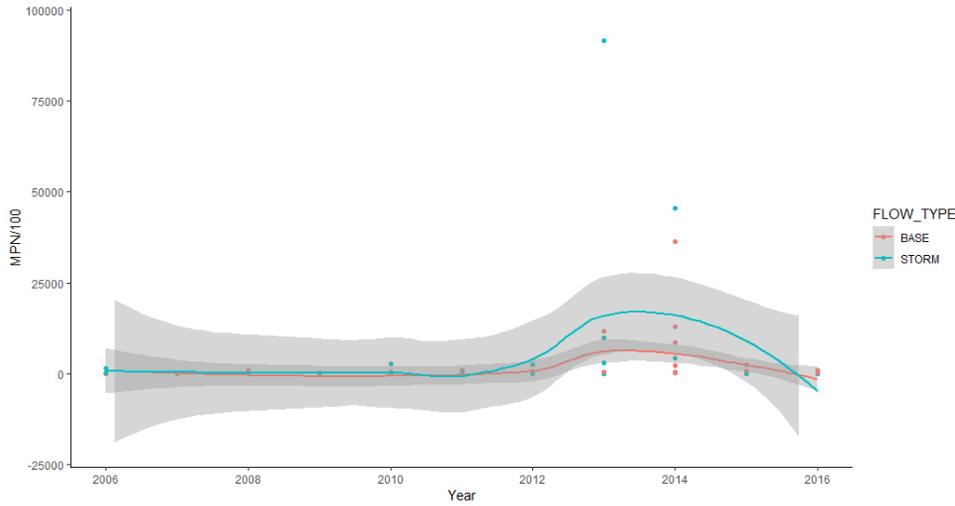
Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled, median adj.	Culled	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis*	Kruskal-Wallis*	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	II~III	II~III	Pos.	Pos.	Pos.
p-value	NS	0.011	NS	0.0042	NS	NS	NS

* Only two time periods (II and III) available for analysis



Season does not appear to have an impact on the relationship between TSS and intensity. Based on the year colored-coded plot, the highest TSS values are from earlier in the time period, and the more recent measurement of TSS are lower.

Airpark Business Center, Carroll County - Outfall *E. coli*



Summary

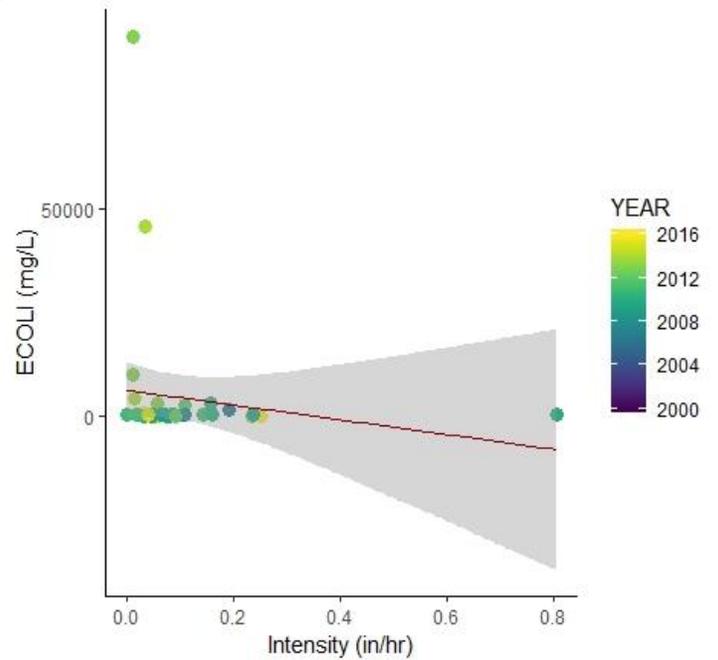
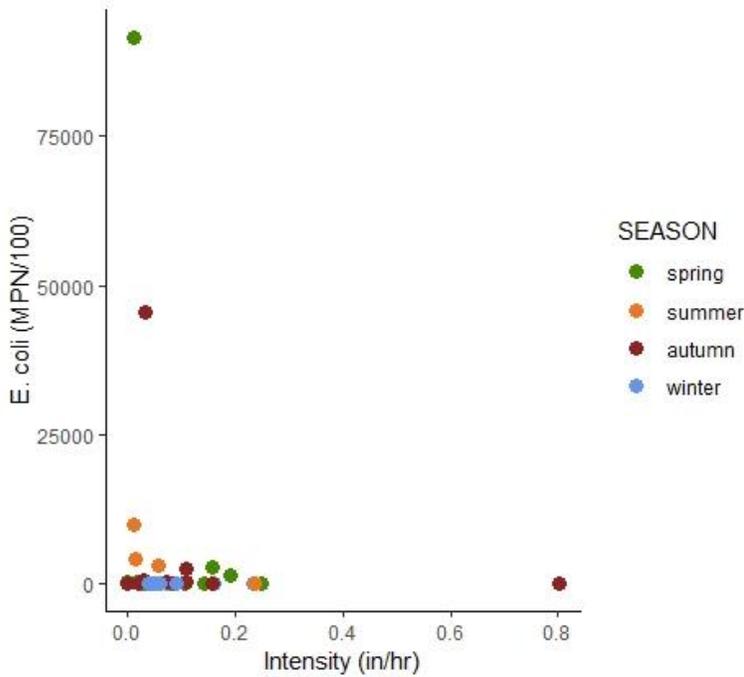
- Stormflow values had two positive trends and one negative, all non-significant.
- Baseflow values had a non-significant increasing trend and a trend with no direction.

Stormflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	Neg.
p-value	NS	NS	NS

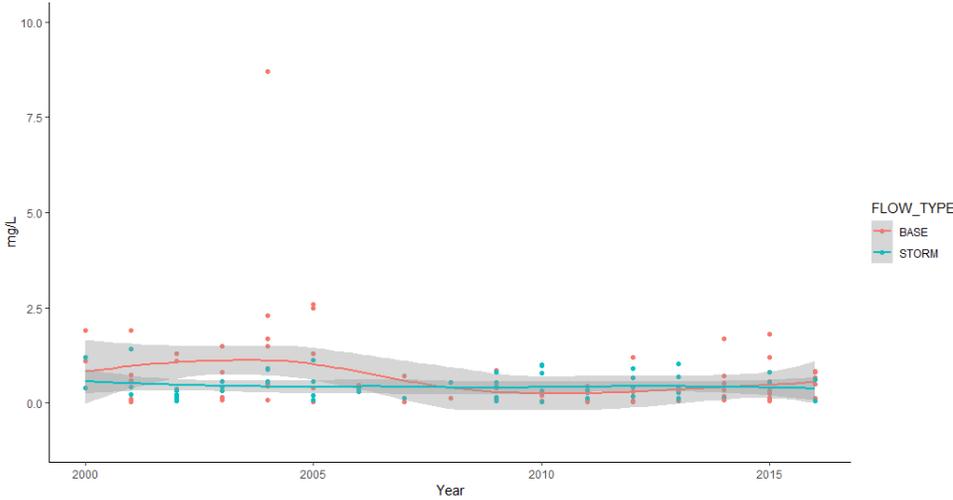
Baseflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	No direction
p-value	NS	NS	NS



The highest *E. coli* value is from a spring storm, followed by an autumn storm, and the most intense stormflow *E. coli* measurement occurred during autumn. It is difficult to discern a pattern regarding the year color-coded plot.

Airpark Business Center, Carroll County - Outfall NO₂₃



Summary

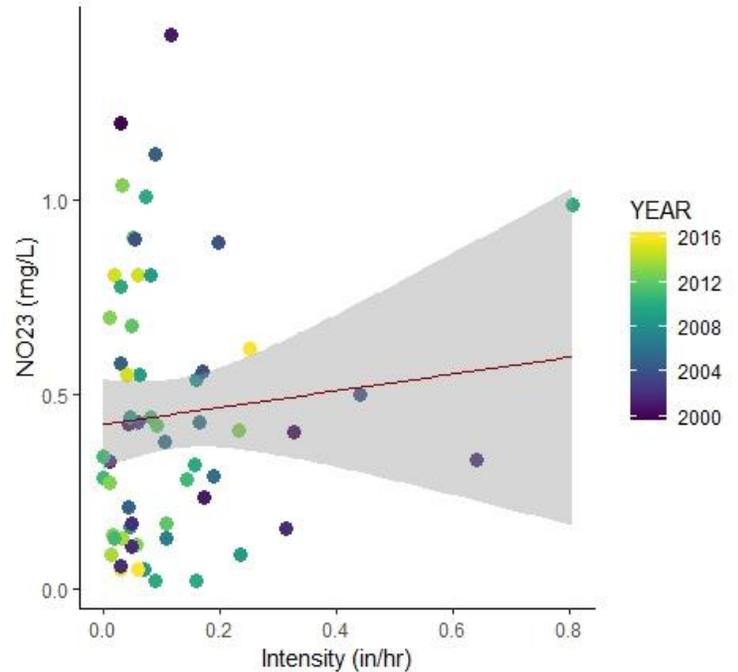
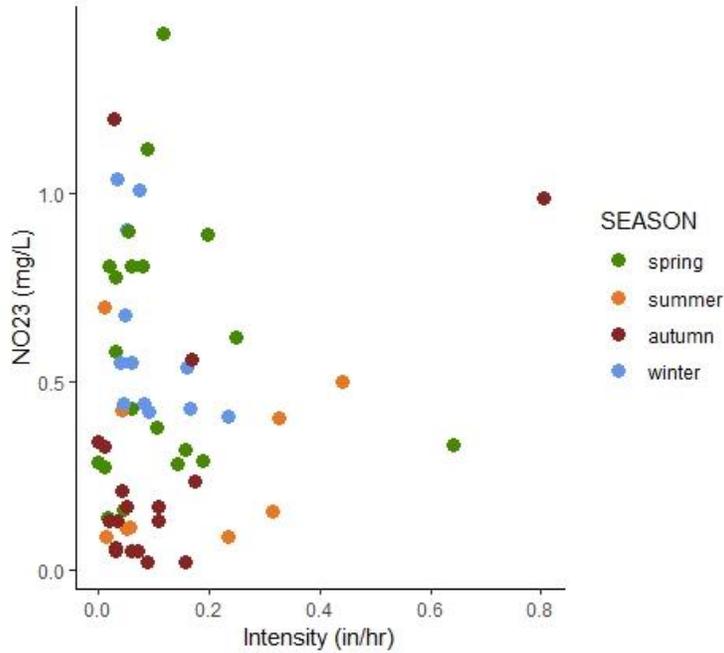
- Autumn stormflow values decreased significantly; annual values had mixed non-significant trends.
- Annual baseflow values significantly decreased; spring and summer baseflow values had non-significant increasing trends.
- Step trends found no difference between the three time periods in stormflow or baseflow.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Pos.
p-value	< 0.001	NS	NS	NS	NS

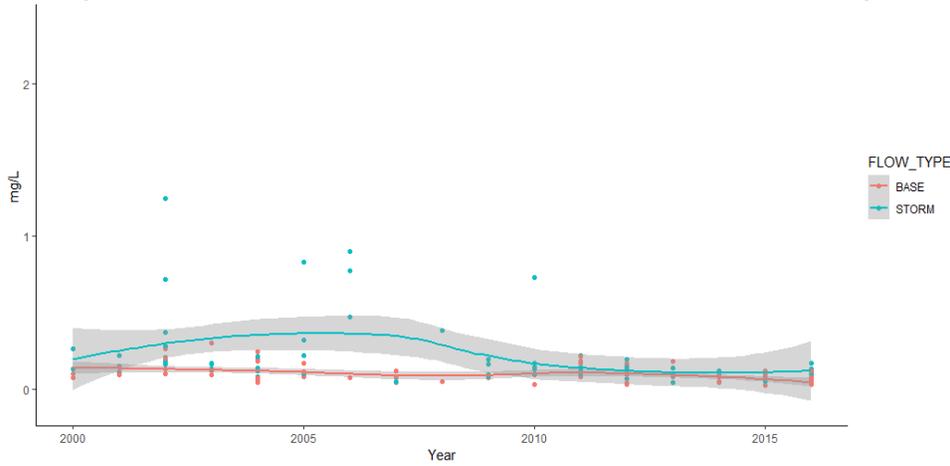
Baseflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled	Culled, median adj.	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	NA	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS	NS	0.01	0.02	0.05



Autumn and summer storms generally have lower amounts of NO₂₃ associated with them, whereas spring and winter storms tend to be associated with higher NO₂₃ measurements. Most of the values are recorded during mid to low intensity storms. The year does not seem to impact the relationship between NO₂₃ and intensity.

Airpark Business Center, Carroll County - Outfall TP



Summary

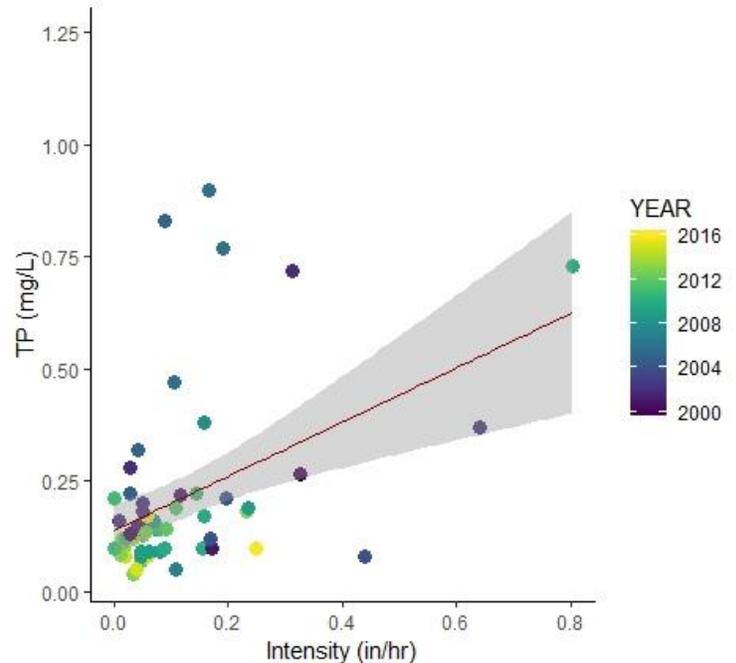
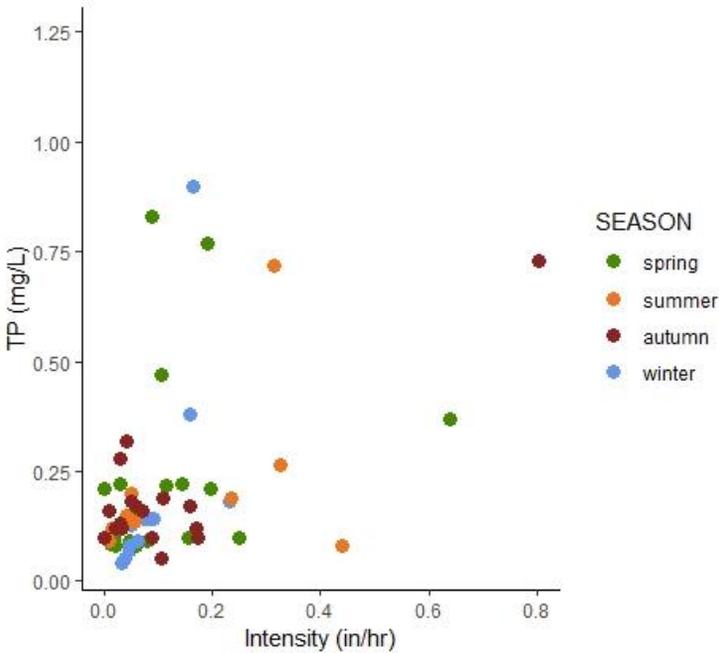
- Annual stormflow values significantly decreased; autumn values had a non-significant increasing trend.
- Annual and spring baseflow values significantly decreased; summer values had a non-significant negative trend.
- Step trends found no difference between the three time periods in stormflow or baseflow.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	0.01	0.02	< 0.01

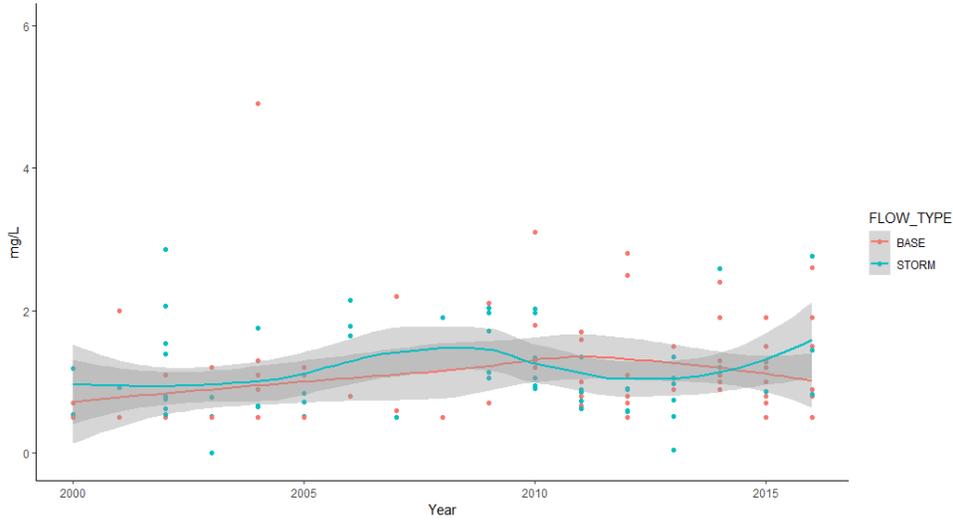
Baseflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled	Culled	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	NA	Neg.	Neg.	Neg.
p-value	0.027	NS	NS	NS	< 0.01	< 0.01	< 0.01



Season does not appear to have an impact on the relationship between TP and intensity. Based on the year colored-coded plot, the highest TP values are from earlier in the time period, and the more recent measurements of TP are lower.

Airpark Business Center, Carroll County - Outfall TKN



Summary

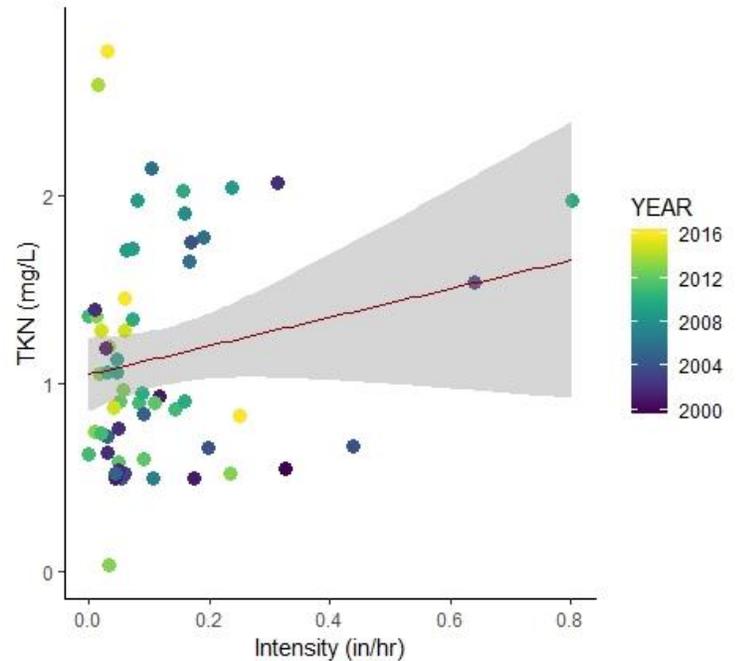
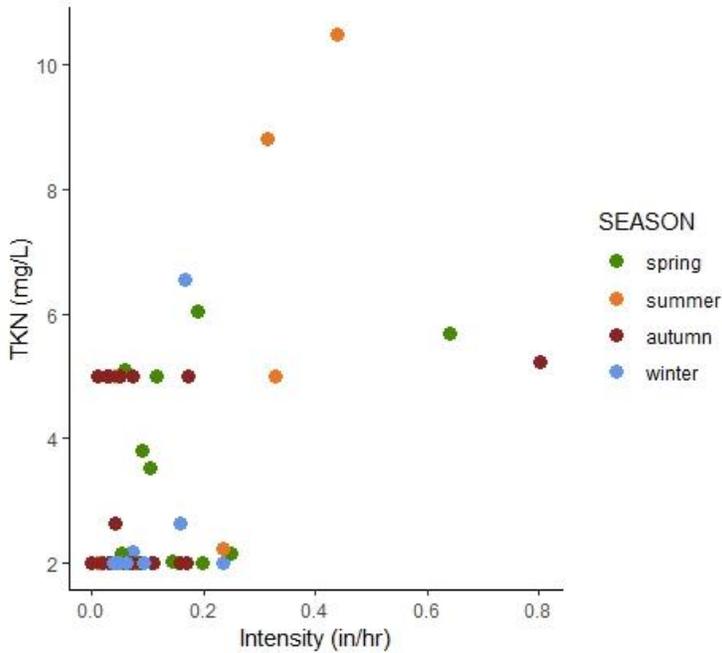
- Stormflow and baseflow values had non-significant increasing trends.
- Step trends found no difference between the three time periods in baseflow.

Stormflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	Pos.
p-value	NS	NS	NS

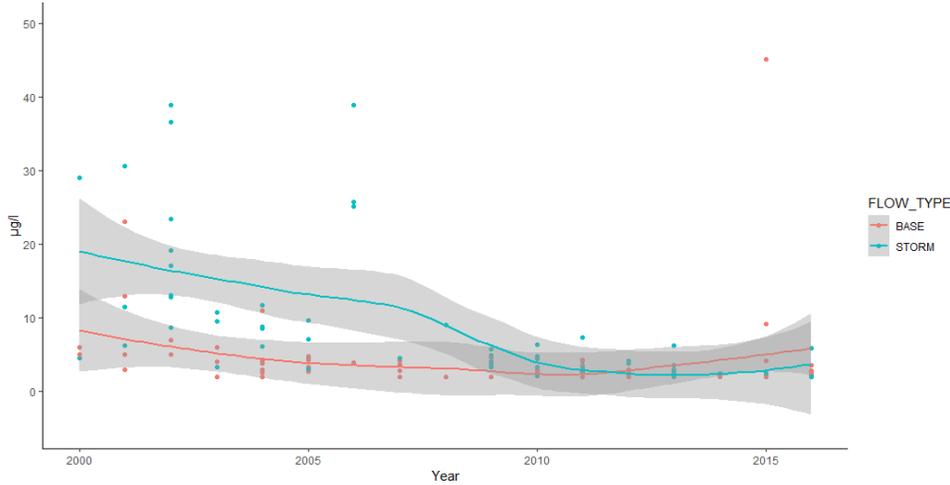
Baseflow

Season	Spring	Summer	Spring	Summer	Annual	Annual	Annual
Data	Culled, median adj.	Culled, median adj.	Culled	Culled	All	All	All
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	NA	NA	Pos.	Pos.	Pos.
p-value	NS	NS	NS	NS	NS	NS	NS



There does not appear to be a strong effect of season or year on the relationship between intensity and TKN.

Airpark Business Center, Carroll County - Outfall TCU



Summary

- Stormflow and spring baseflow values significantly decreased.
- Step trends found a significant difference between time periods II and III in autumn stormflow values and spring baseflow values.

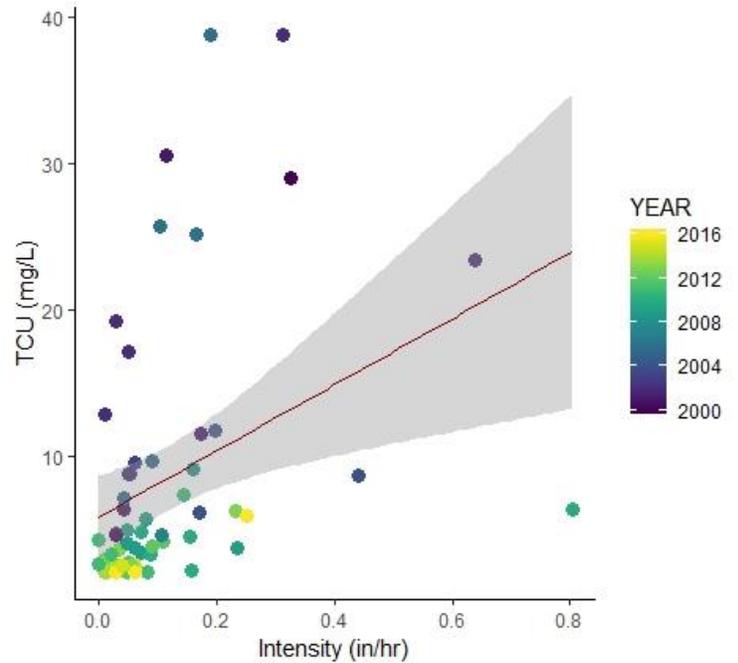
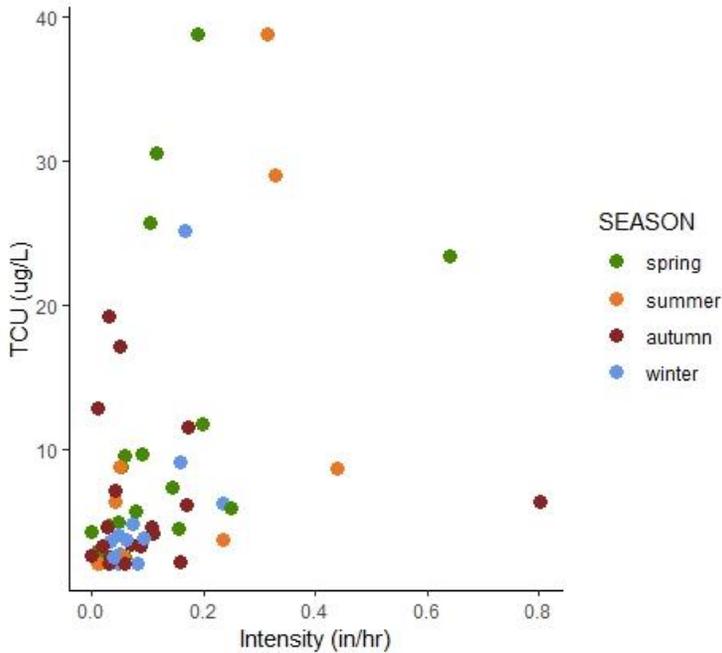
Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis*	Permutation	LSR	LOGR
Direction/Periods	Neg.	II~III	Neg.	Neg.	Neg.
p-value	< 0.001	0.03	< 0.01	< 0.01	< 0.01

Baseflow

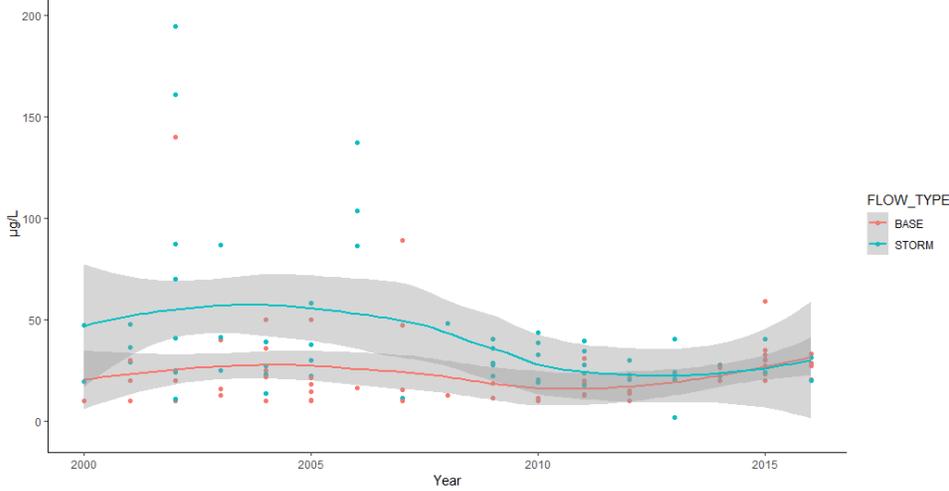
Season	Spring	Spring
Data	Culled, median adj.	Culled
Method	Mann-Kendall	Kruskal-Wallis*
Direction/Periods	Neg.	II~III
p-value	0.01	0.006

* Only two time periods (II and III) available for analysis



The greatest values of TCU are measured during medium to low intensity storms during spring and summer. More recent measurements of TCU are associated with low intensity storms and are lower in value than older measurements.

Airpark Business Center, Carroll County - Outfall TZN



Summary

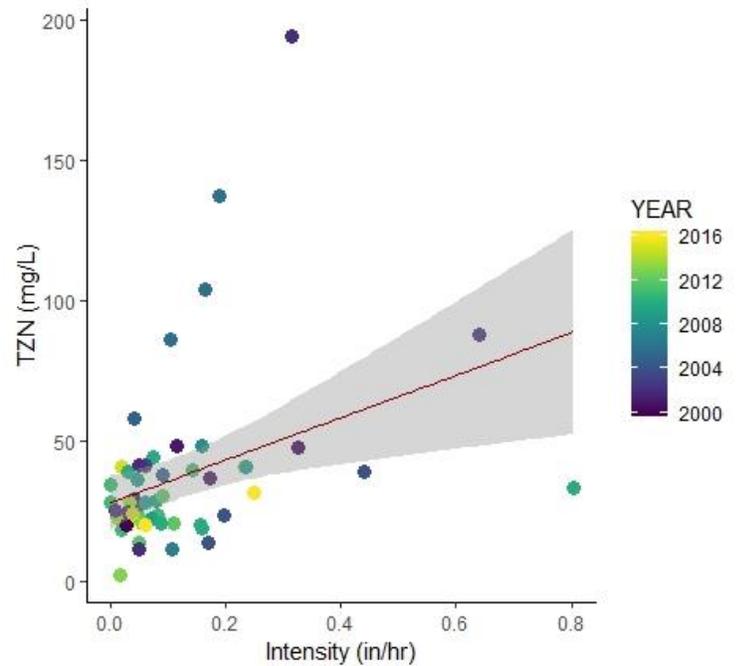
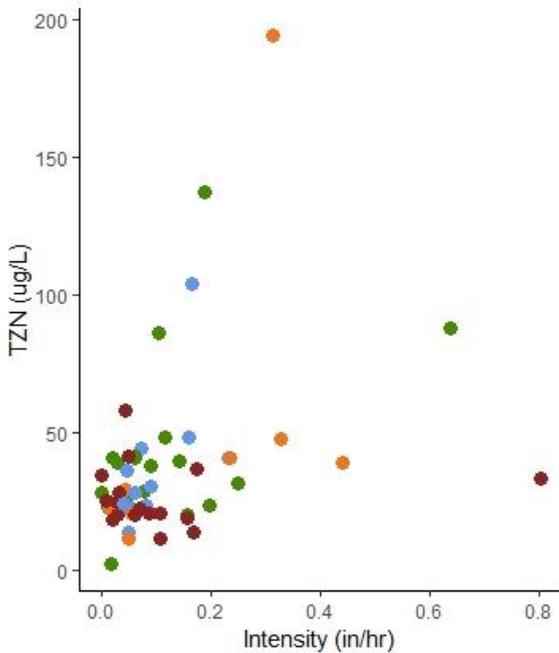
- Annual stormflow values significantly decreased; autumn values had a non-significant decrease.
- Baseflow values had non-significantly increasing trends.
- Step trends found no significant differences between the three time periods in stormflow or baseflow.

Stormflow

Season	Autumn	Autumn	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	< 0.01	< 0.01	0.02

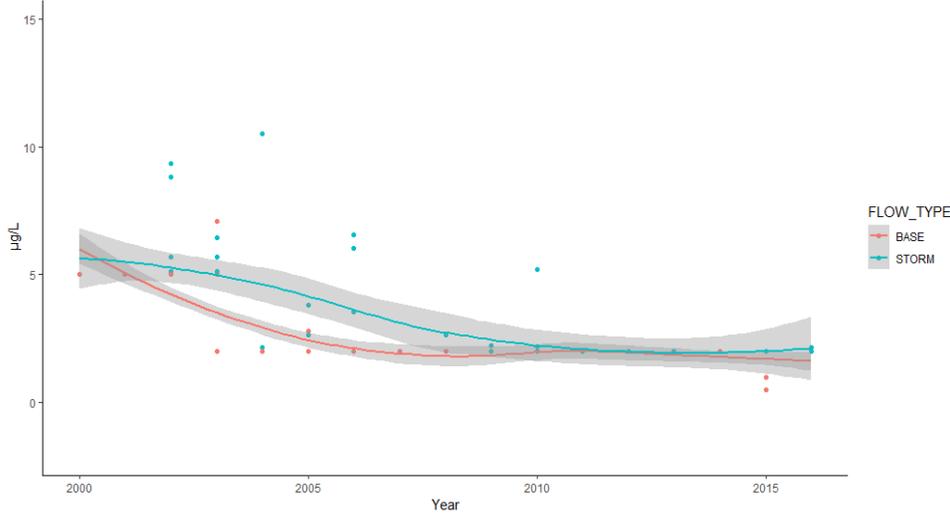
Baseflow

Season	Spring	Summer	Spring	Summer
Data	Culled, median adj.	Culled, median adj.	Culled	Culled
Method	Mann-Kendall	Mann-Kendall	Kruskal-Wallis	Kruskal-Wallis
Direction/Periods	Pos.	Pos.	NA	NA
p-value	NS	NS	NS	NS



There does not appear to be a strong effect of season on the relationship between intensity and TZN. More recent measurements of TZN are associated with low intensity storms and are lower in value than older measurements.

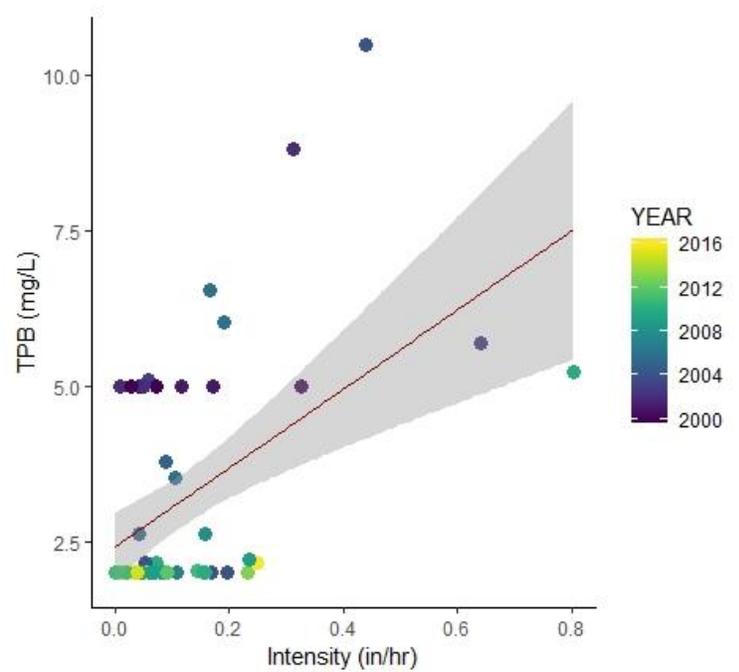
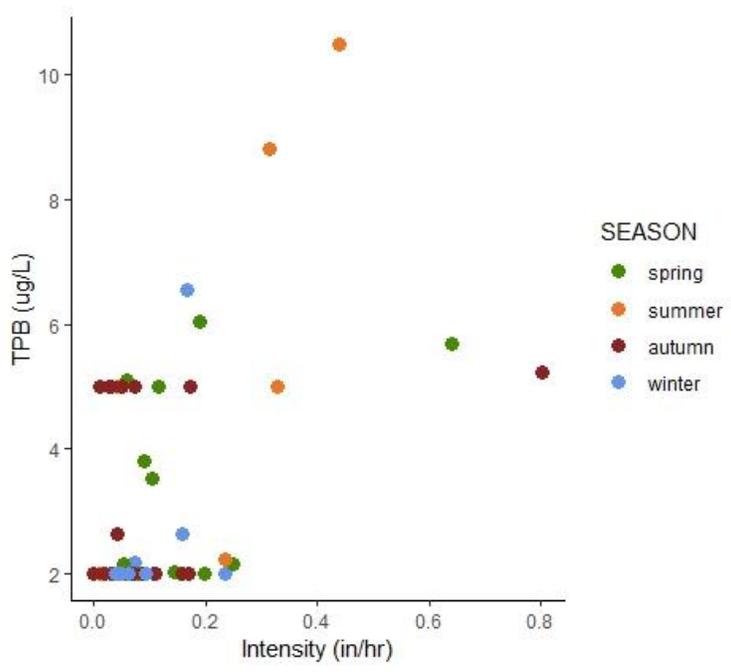
Airpark Business Center, Carroll County - Outfall TPB



- Summary**
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
 - Stormflow values significantly decreased.

Stormflow			
Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	Neg.
p-value	<0.01	< 0.01	< 0.01

Baseflow
 Season
 Data
 Method
 Direction/Periods
 p-value



There does not appear to be a strong effect of season or year on the relationship between intensity and TPB. More recent measurements of TPB are associated with low intensity storms and are lower in value than older measurements.

Urbana, Frederick County Instream Site: Peter Pan Run



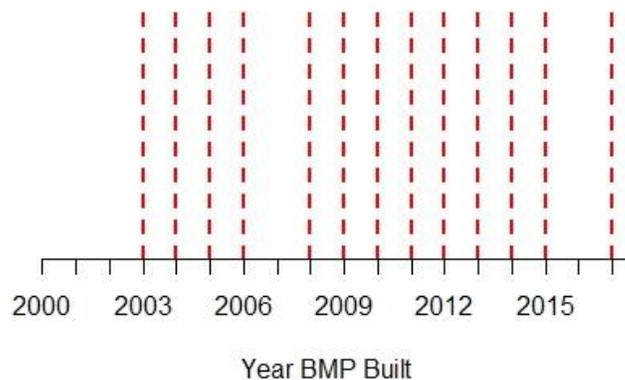
Sampling equipment



Bank condition

Year	Total Impervious Acres in Mon. Drainage Area from MDE Digitization	Impervious Acres Treated by Dry ED Ponds ¹	Impervious Acres Treated by Micropool ED Ponds	Impervious Acres Treated by Wet ED Ponds	Impervious Acres Treated by Shallow Marsh	Impervious Acres Treated by Other BMPs	Impervious Acres Treated by Combined Dry ED Pond + Sand Filter	% Monitoring Area Impervious Acres Treated
2005	246.9	51.6	0.0	18.8	0.0	0.0	0.0	28.5%
2006	246.9	60.4	0.0	18.8	0.0	0.0	0.0	32.1%
2008	330.0	62.3	0.0	73.8	0.0	0.0	0.0	41.2%
2009	372.6	62.3	0.0	82.9	0.0	1.3	0.0	39.3%
2010	372.6	62.3	0.0	87.6	0.0	13.1	8.9	46.1%
2011	390.4	62.3	0.0	104.9	22.3	18.9	10.4	56.0%
2012	390.4	62.3	0.0	104.9	22.3	23.1	10.4	57.1%
2013	395.7	102.0	0.0	114.5	22.3	23.1	23.2	72.0%
2014	397.9	102.0	0.0	114.5	22.3	23.3	23.2	71.7%
2015	404.8	102.0	0.0	114.5	22.3	26.6	23.2	71.3%
2017	409.3	102.0	0.0	114.5	22.3	26.7	23.2	70.5%
2018	409.8	102.0	15.9	114.5	22.3	26.7	23.2	74.3%

1: 1.2 treated acres were added to the dry ED ponds starting in 2005 to account for the change made in the Frederick Co outfall calculations (FR02MDA000059) calculations above in Table 5.



Urbana, Frederick County Instream Site: Peter Pan Run



April 1988

Image: Google, USGS



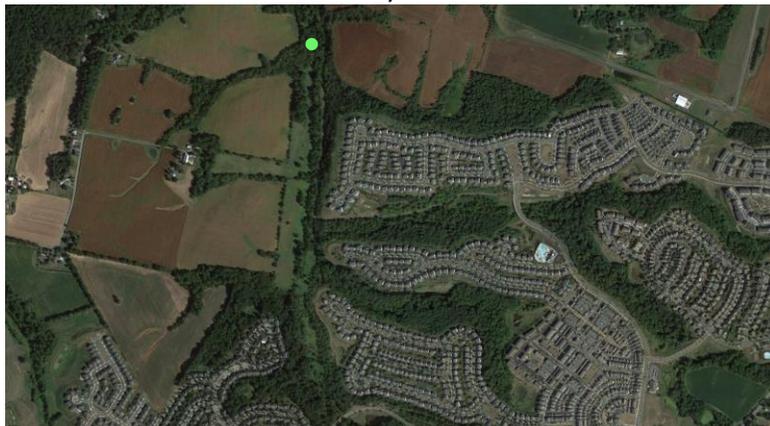
June 2005

Image: Google, USDA FSA



February 2007

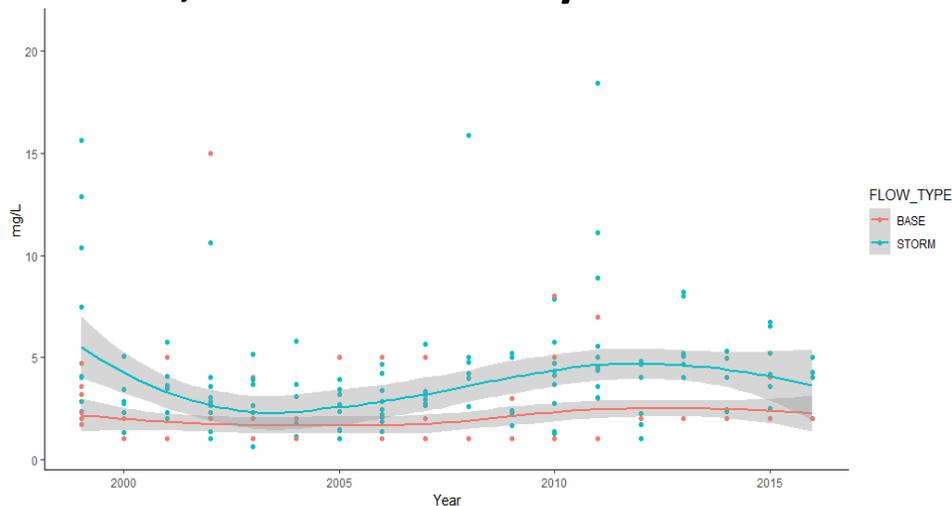
Image: Google, USGS



September 2015

Image: Google,
Landsat/Copernicus

Urbana, Frederick County - Instream BOD



Summary

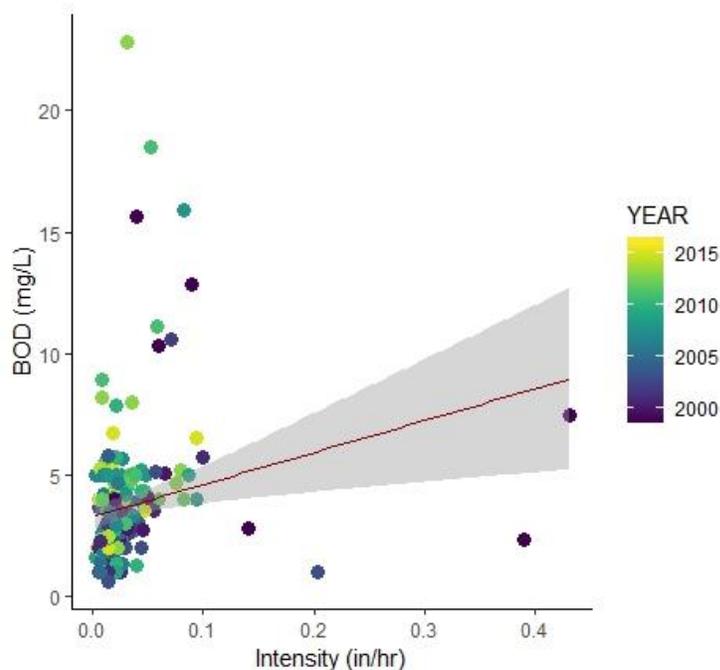
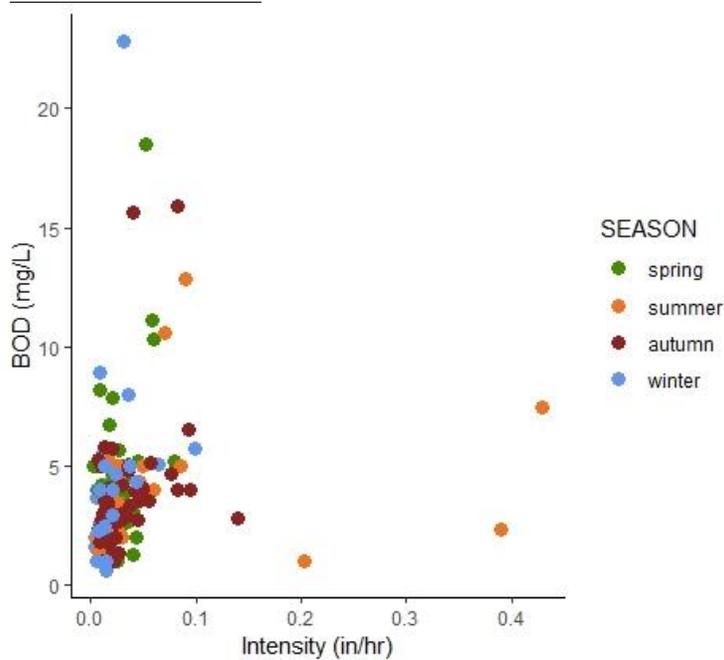
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values had non-significant increasing trends and one non-significant negative trend.
- Step trends found no significant differences between the three time periods in stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Pos.	Pos.	Neg.
p-value	NS	NS	NS	NS	NS

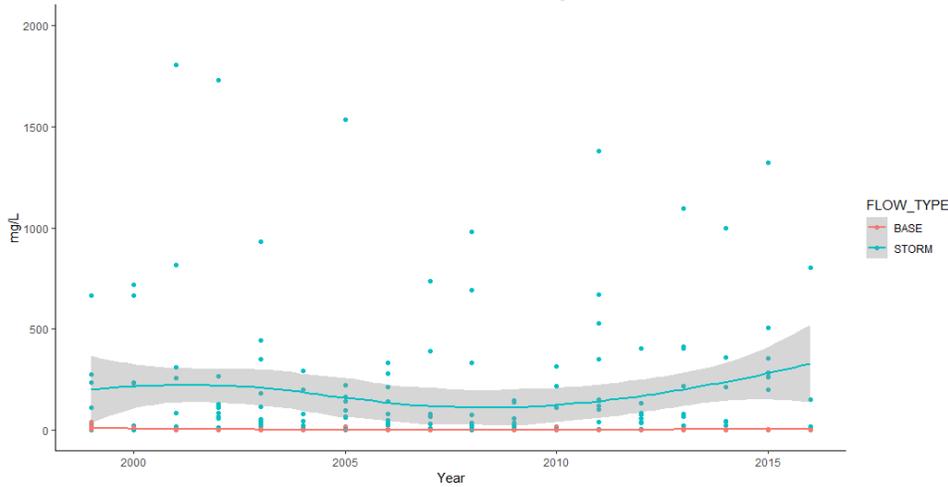
Baseflow

Season
Data
Method
Direction/Periods
p-value



The most intense storms are associated with summertime BOD. Aside from that, season does not appear to strongly affect the relationship between intensity and the greatest values of BOD. The relationship between BOD and intensity does not appear to be impacted by the year.

Urbana, Frederick County - Instream TSS



Summary

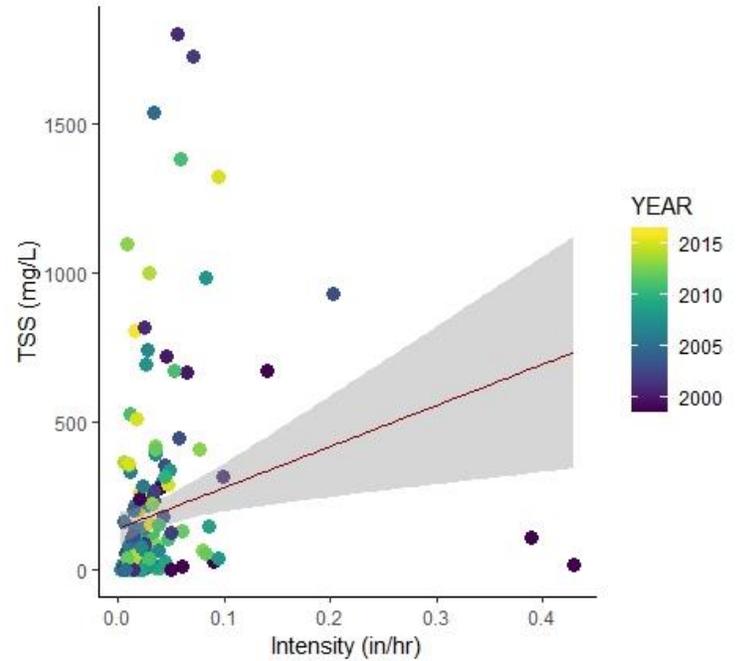
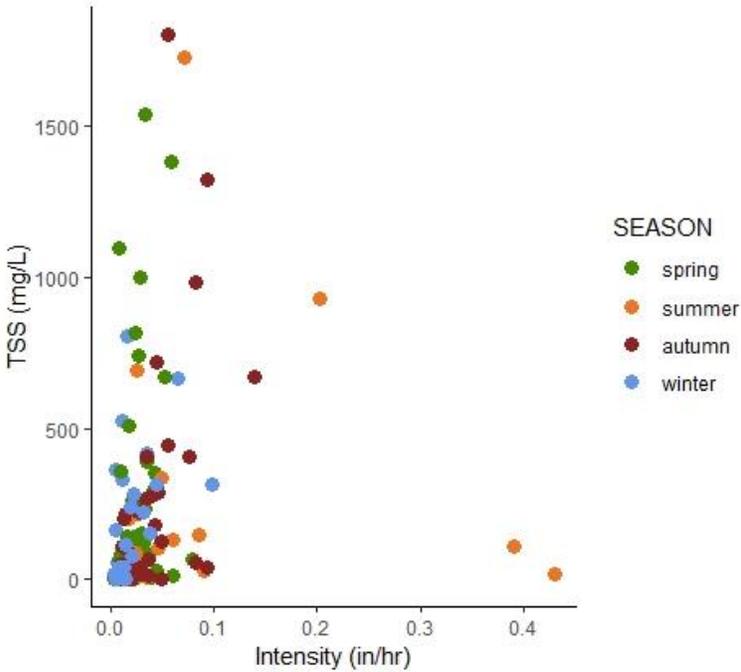
- Stormflow values had a mix of increasing and decreasing trends, none significant.
- Baseflow values significantly decreased.
- Step trends found a significant difference between the three time periods in baseflow only; all periods were significantly different.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS	NS	NS

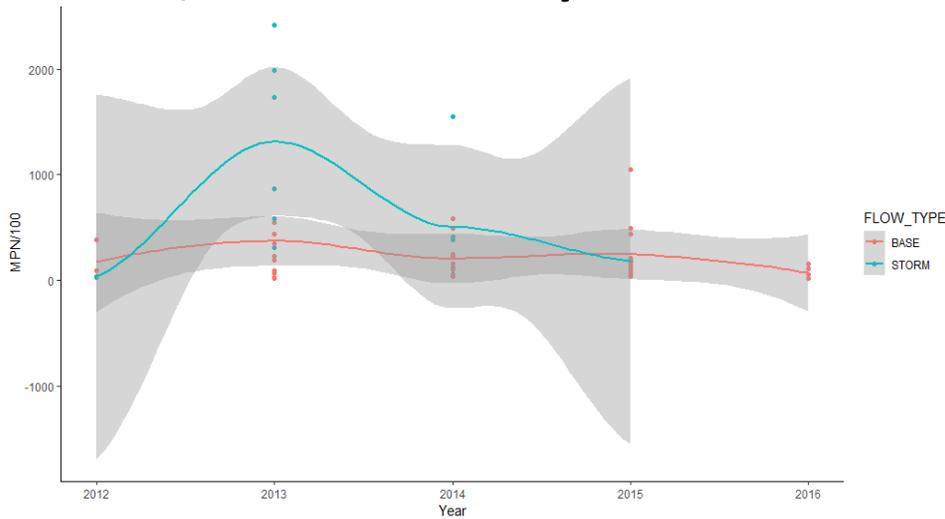
Baseflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Mann-Whitney	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	I~II, I~III, II~III	Neg.	Neg.	Neg.
p-value	< 0.001	< 0.001	0.01, 0.01, < 0.001	< 0.01	< 0.01	< 0.01



Other than the most intense stormflow TSS being measured during summer months, there is not a strong seasonal effect on the relationship between TSS and intensity. Likewise, the relationship between intensity and TSS does not seem to change over the monitoring time period.

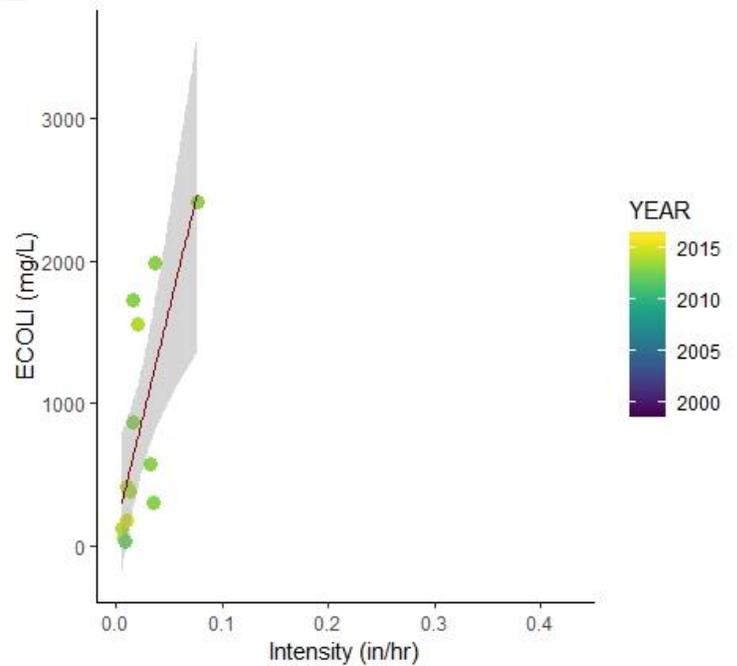
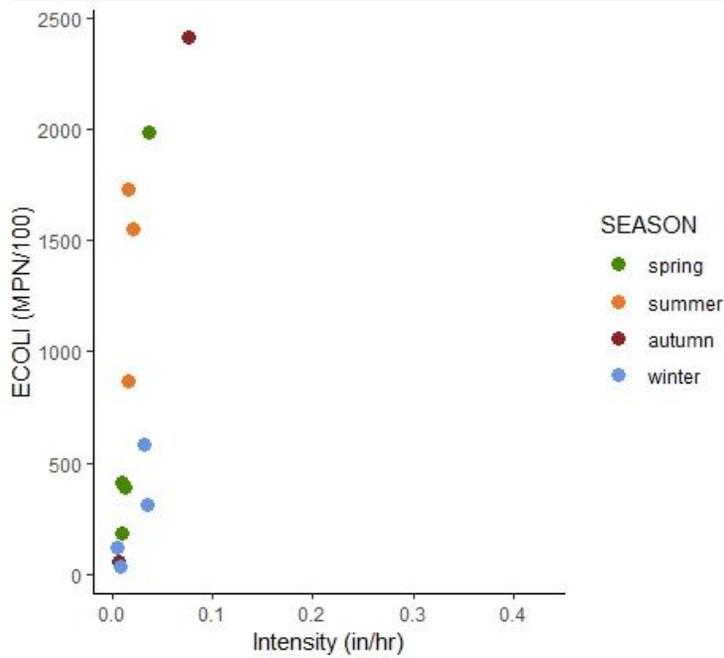
Urbana, Frederick County - Instream *E. coli*



- Summary**
- Stormflow values had non-significantly decreasing trends.
 - Baseflow values had non-significantly decreasing trends and one increasing trend.

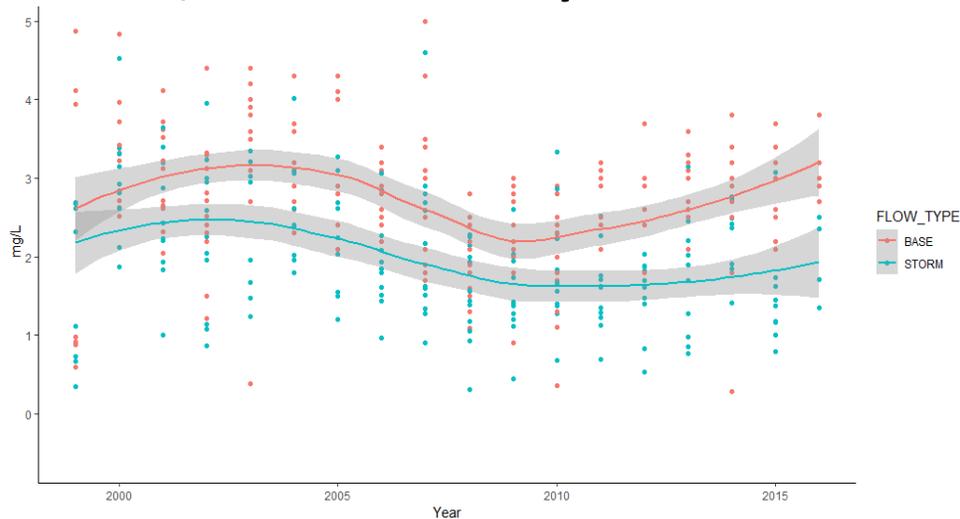
Stormflow			
Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	Neg.
p-value	NS	NS	NS

Baseflow			
Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	Pos.
p-value	NS	NS	NS



There does not appear to be a strong effect of season or year on the relationship between intensity and *E. coli*.

Urbana, Frederick County - Instream NO₂₃



Summary

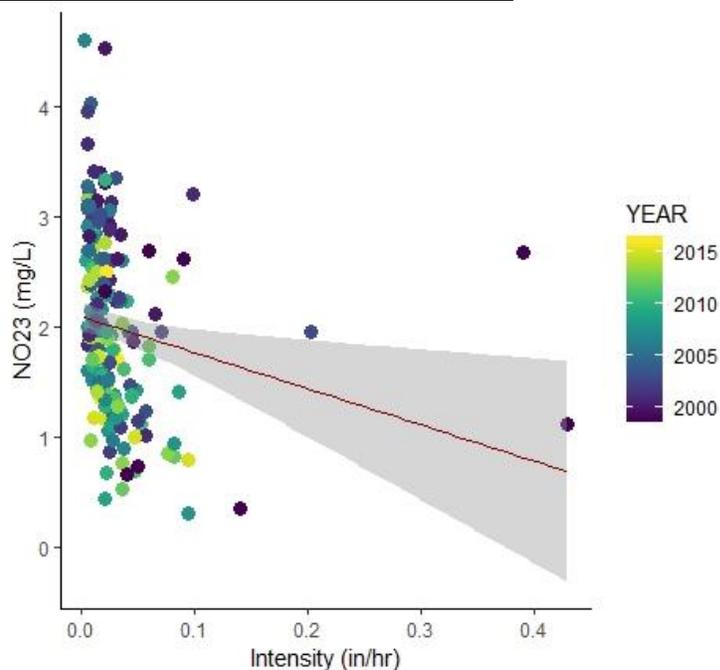
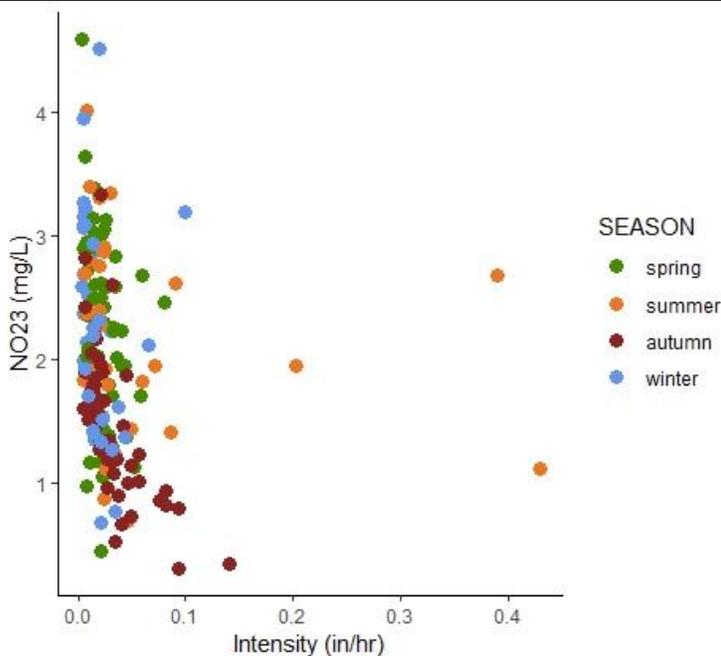
- Stormflow values significantly decreased.
- Baseflow values had decreasing trends; two methods found the trend significant.
- Step trends found no significant differences between the three time periods in stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled, MFC	Culled	All	All	All
Method	Seasonal Kendall	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	Neg.	Neg.	Neg.
p-value	< 0.001	< 0.001	NS	< 0.01	< 0.01	< 0.01

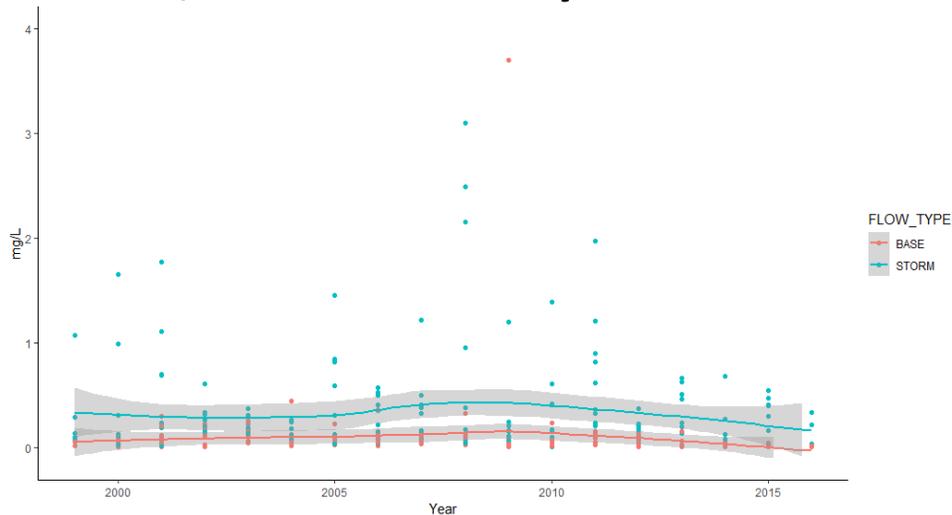
Baseflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled	All	All	All
Method	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	0.01	0.01	NS



There does not appear to be a strong seasonal influence between intensity and NO₂₃, other than the most intense storms are associated with summer NO₂₃. More recent measurements of NO₂₃ appear to be lower in value than older measurements but occur at similar storm intensities.

Urbana, Frederick County - Instream TP



Summary

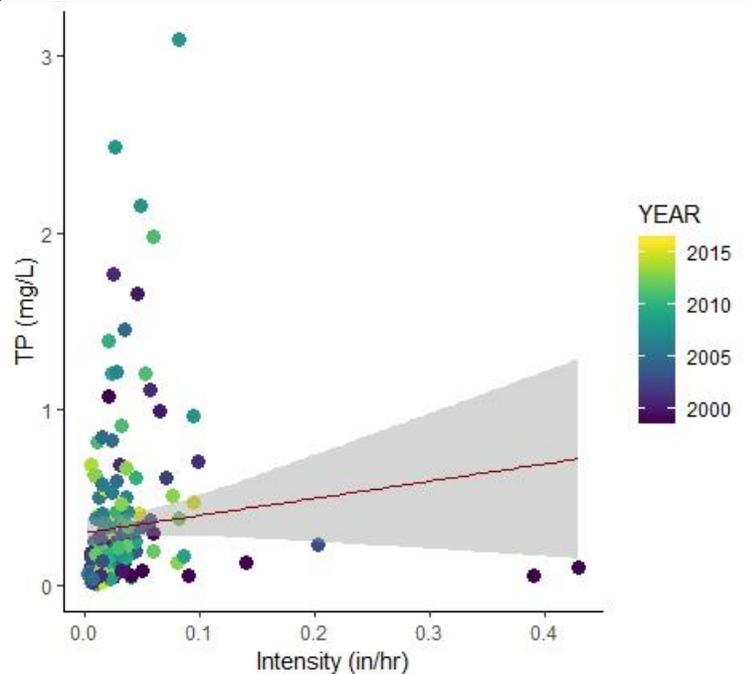
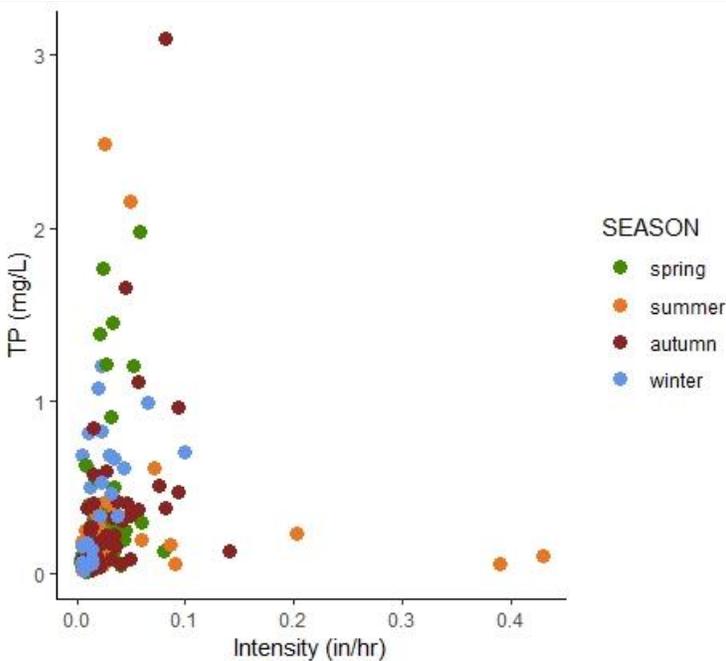
- Stormflow values had non-significantly decreasing trends and one no direction trend.
- Baseflow values decreased, but only two methods found the trend to be significant.
- Step trends found a significant difference between the three time periods in baseflow only; Periods II and III were significantly different.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled, MFC	Culled	All	All	All
Method	Seasonal Kendall	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	Neg.	Neg.	No direction
p-value	NS	NS	NS	NS	NS	NS

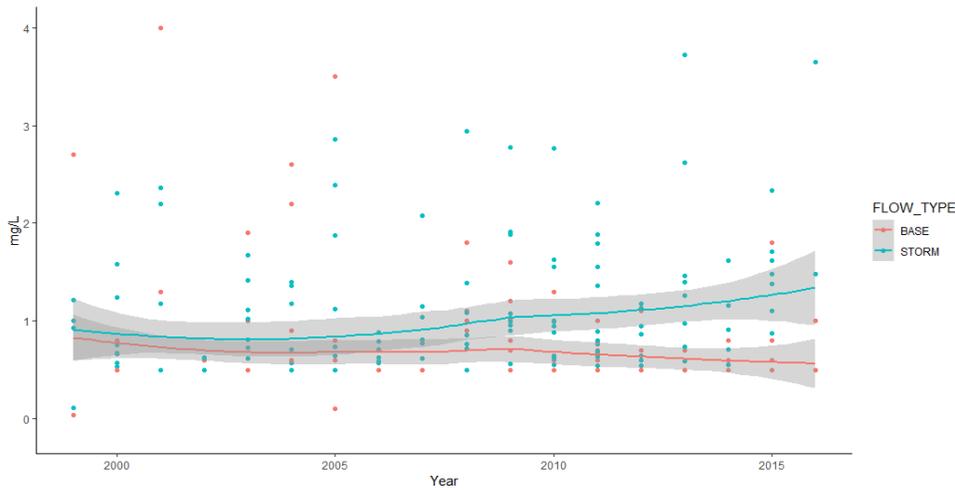
Baseflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Mann-Whitney	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	II~III	Neg.	Neg.	Neg.
p-value	NS	0.002	< 0.001	NS	NS	< 0.01



There does not appear to be a strong seasonal or yearly influence on the relationship between TP and intensity, other than summertime TP being associated with the most intense storms.

Urbana, Frederick County - Instream TKN



Summary

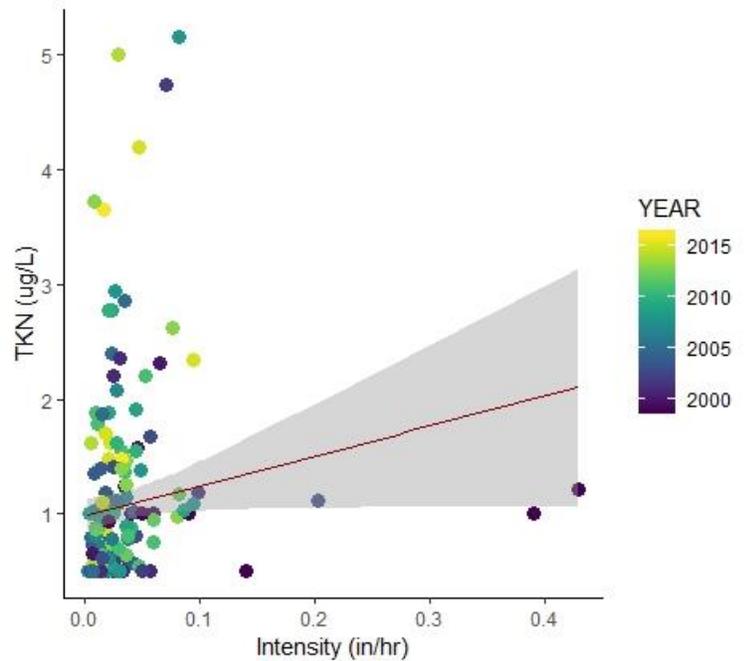
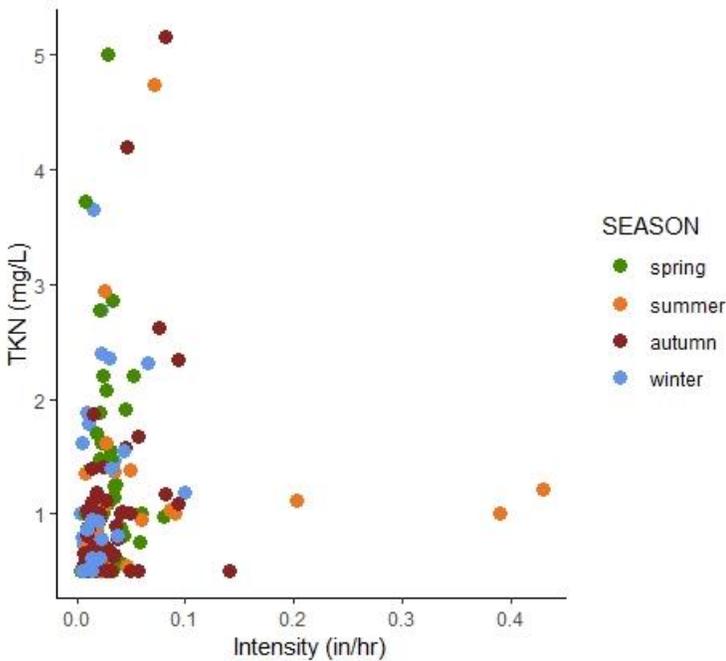
- Stormflow values significantly increased.
- Baseflow values had a non-significant decreasing or no direction trend.
- Step trends found no significant differences between the three time periods for stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	NA	Pos.	Pos.	Pos.
p-value	< 0.001	NS	< 0.01	< 0.01	< 0.01

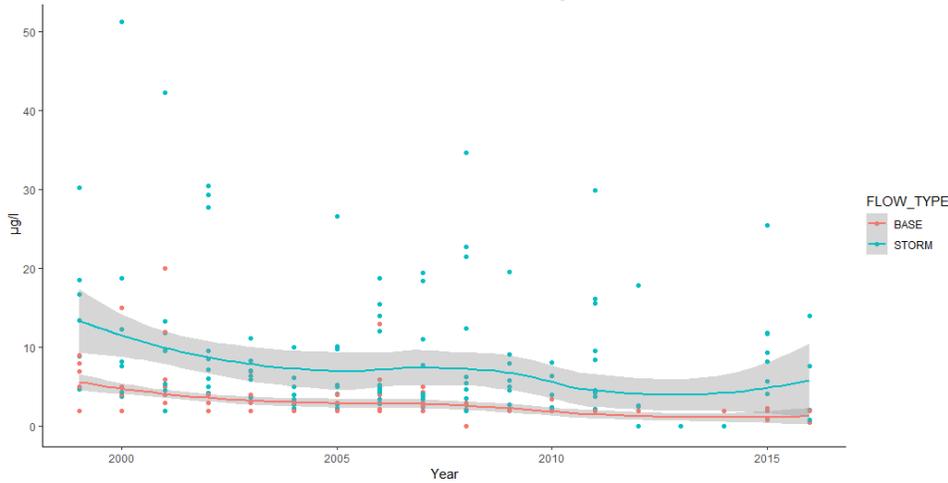
Baseflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	No direction
p-value	NS	NS	NS



There does not appear to be a strong seasonal or yearly influence on the relationship between TKN and intensity, other than summertime TKN being associated with the most intense storms.

Urbana, Frederick County - Instream TCU



Summary

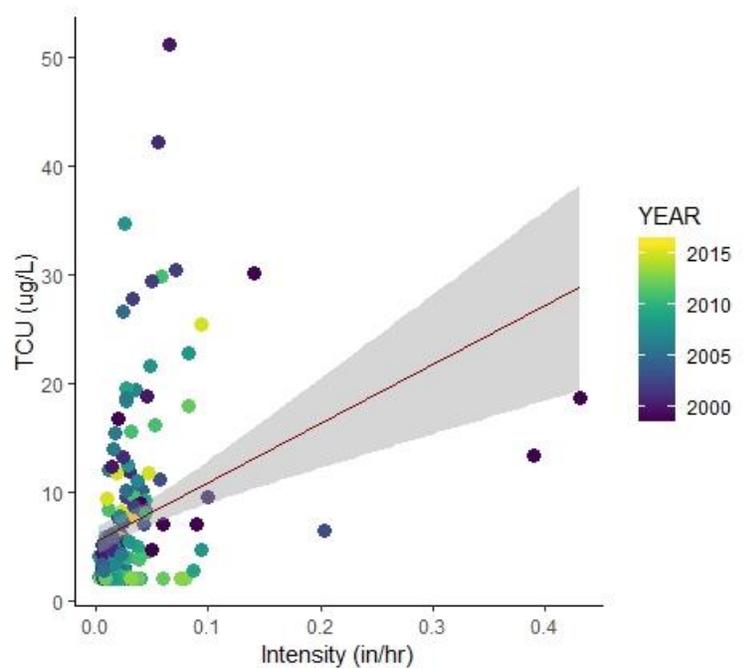
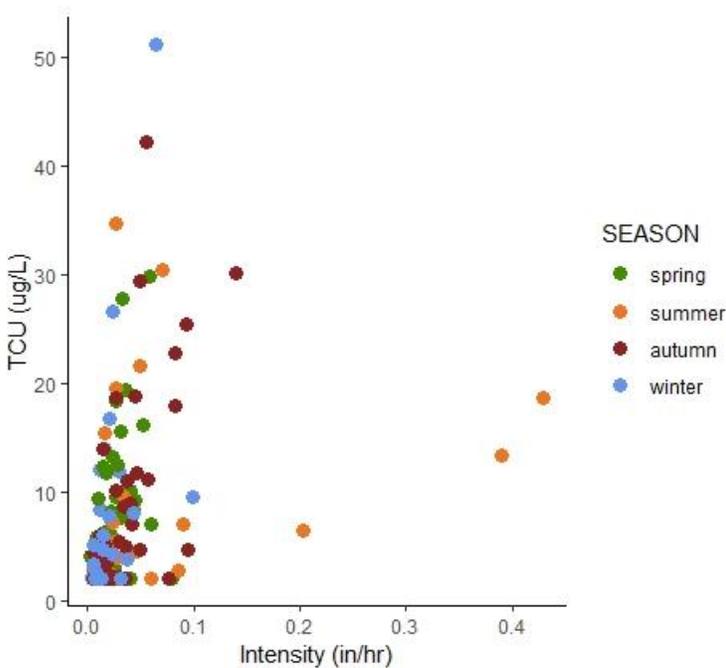
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values significantly decreased.
- Step trends found a significant difference between the three time periods for stormflow; Periods I and III differed significantly.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Mann-Whitney	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	I~III	Neg.	Neg.	Neg.
p-value	0.009	0.04	0.02	< 0.01	< 0.01	< 0.01

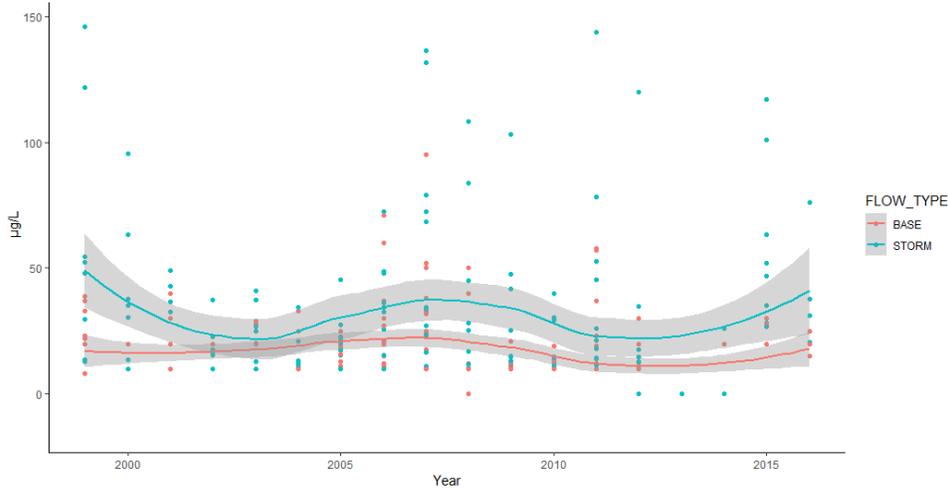
Baseflow

Season
Data
Method
Direction/Periods
p-value



There does not appear to be a strong seasonal influence on the relationship between TCU and intensity, other than summertime TCU being associated with the most intense storms. Over the monitoring time period, the highest TCU values and ones associated with the most intense storms were recorded in the beginning of the monitoring effort.

Urbana, Frederick County - Instream TZN



Summary

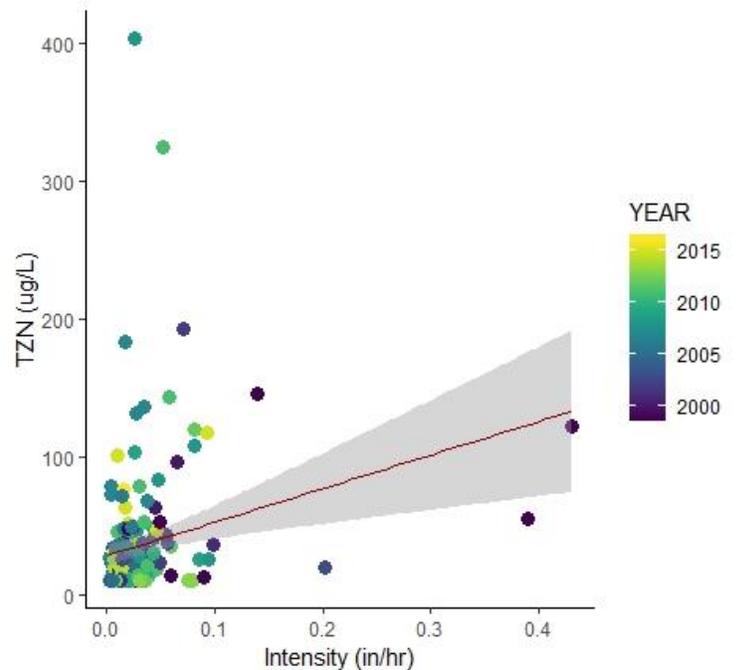
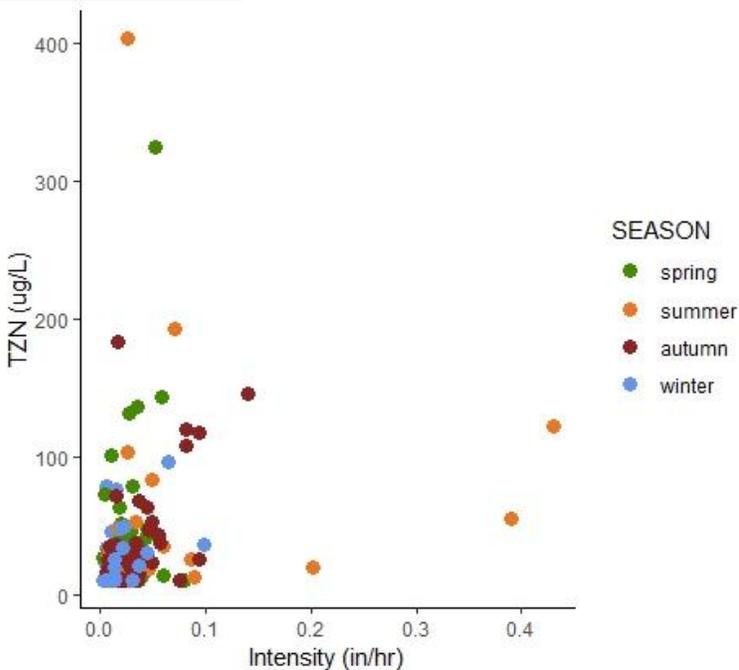
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values had a mix of non-significant increasing, decreasing, and no direction trends.
- Step trends found no significant differences between the three time periods for stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Pos.	No direction	Pos.
p-value	NS	NS	NS	NS	NS

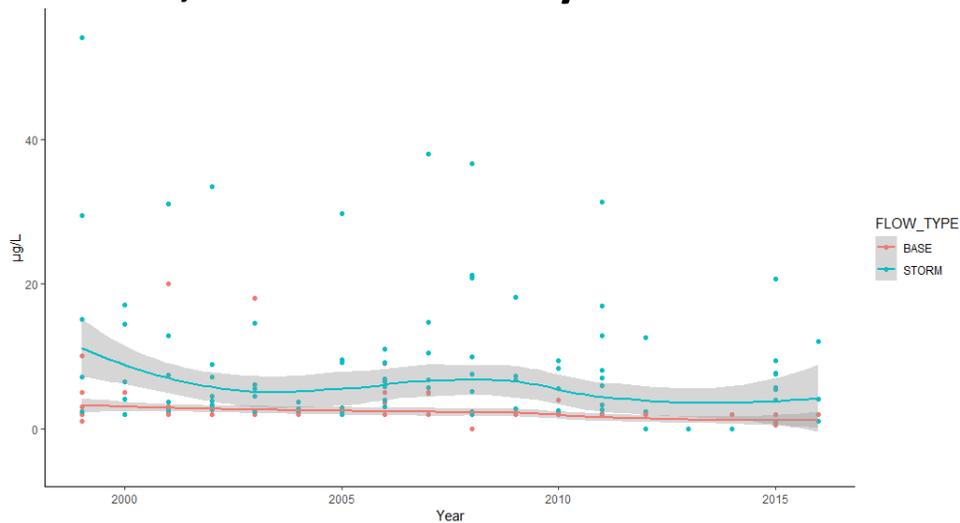
Baseflow

Season
Data
Method
Direction/Periods
p-value



There does not appear to be a strong seasonal or yearly influence on the relationship between TZN and intensity, other than summertime TZN being associated with the most intense storms.

Urbana, Frederick County - Instream TPB



Summary

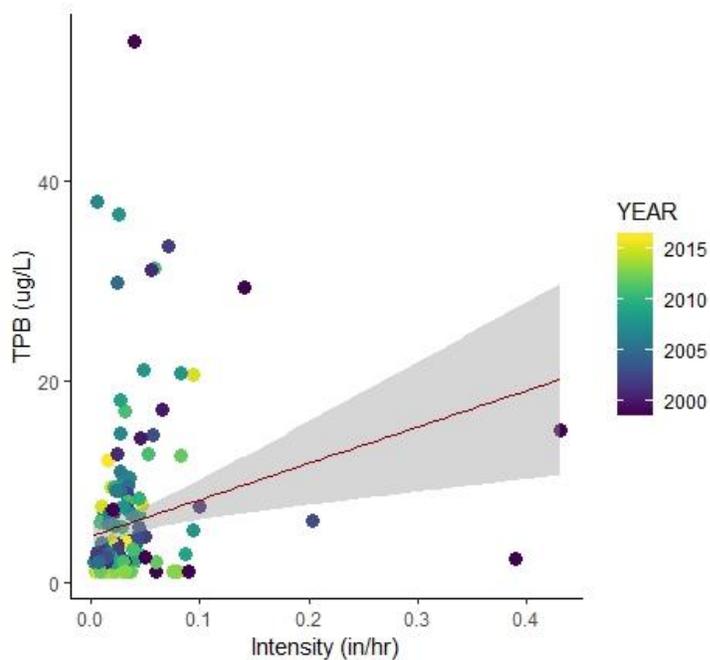
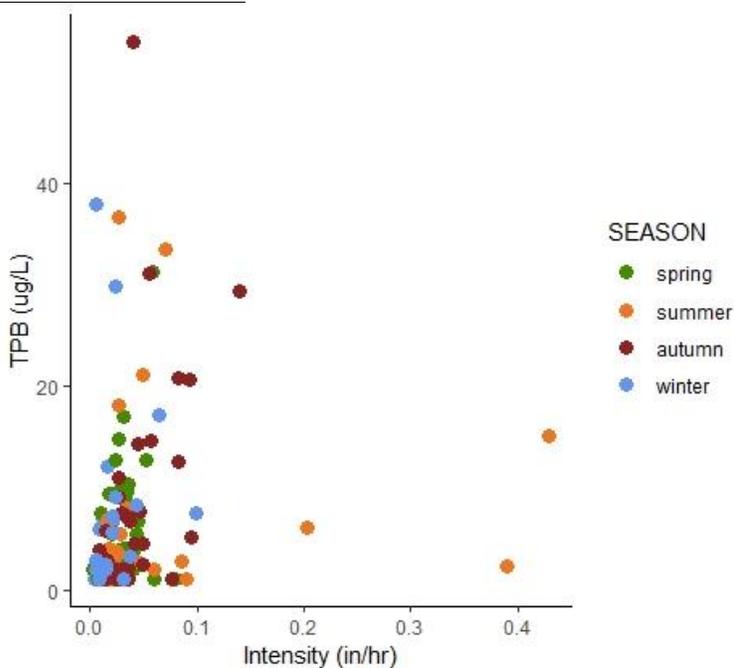
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values decreased, but only half the methods found the trend significant.
- Step trends found no significant differences between the three time periods for stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	0.03	< 0.01	NS

Baseflow

Season
Data
Method
Direction/Periods
p-value



There does not appear to be a strong seasonal influence on the relationship between TPB and intensity, other than summertime TPB being associated with the most intense storms. Over the monitoring time period, the highest TPB values and ones associated with the most intense storms were recorded in the beginning of the monitoring effort.

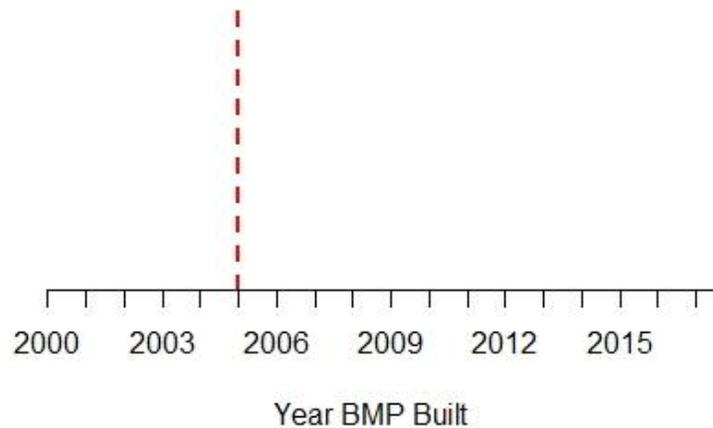
Urbana, Frederick County Outfall Site: Pond-R



August 2019

Year	Total Impervious Acres in Monitoring Drainage Area from MDE Digitization	Impervious Acres Treated by Dry ED Pond ¹	Impervious Acres Treated by Other BMPs	% Monitoring Area Impervious Acres Treated
2005	13.1	13.1	0.0	100.0%

1: The dry ED pond at the outfall captures everything in the monitoring area and the impervious acres treated should always be 100%. The impervious acres treated by the pond were adjusted from 11.9 acres in the MS4 data to 13.1 acres so that the % monitoring area impervious acres treated was 100%.

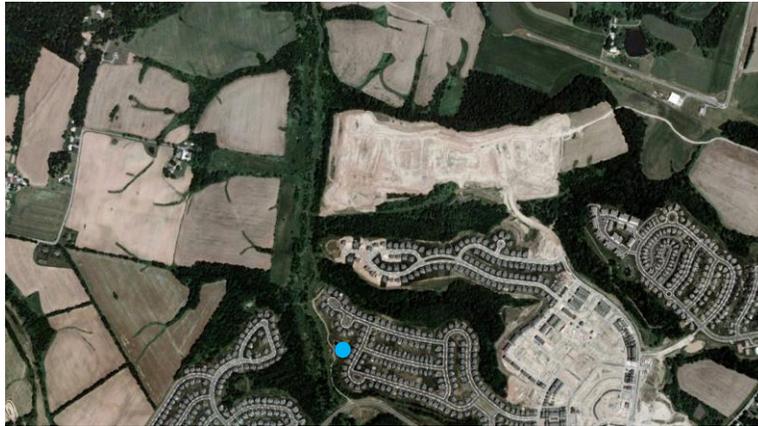


Urbana, Frederick County Outfall Site: Pond-R



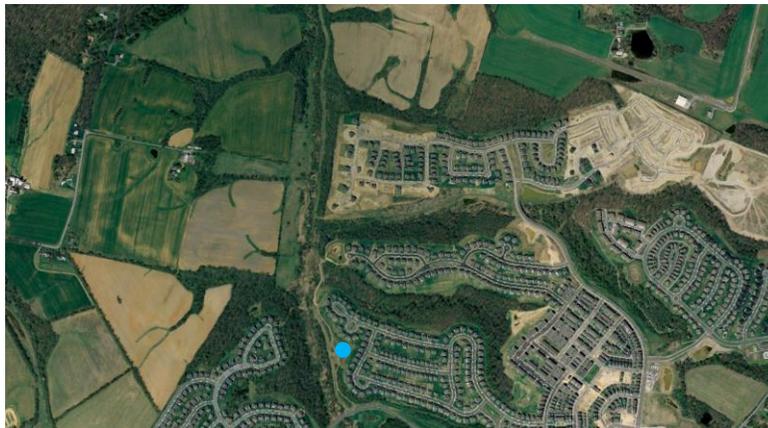
April 1988

Image: Google, USGS



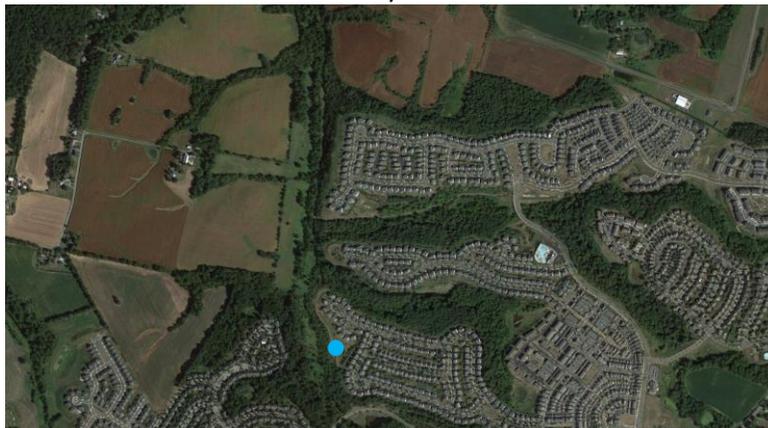
June 2005

Image: Google, USDA FSA



February 2007

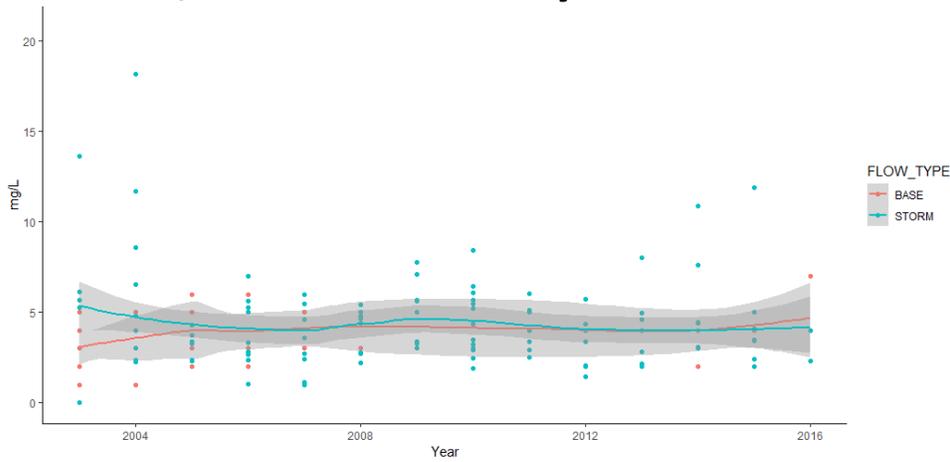
Image: Google, USGS



September 2015

Image: Google,
Landsat/Copernicus

Urbana, Frederick County - Outfall BOD



Summary

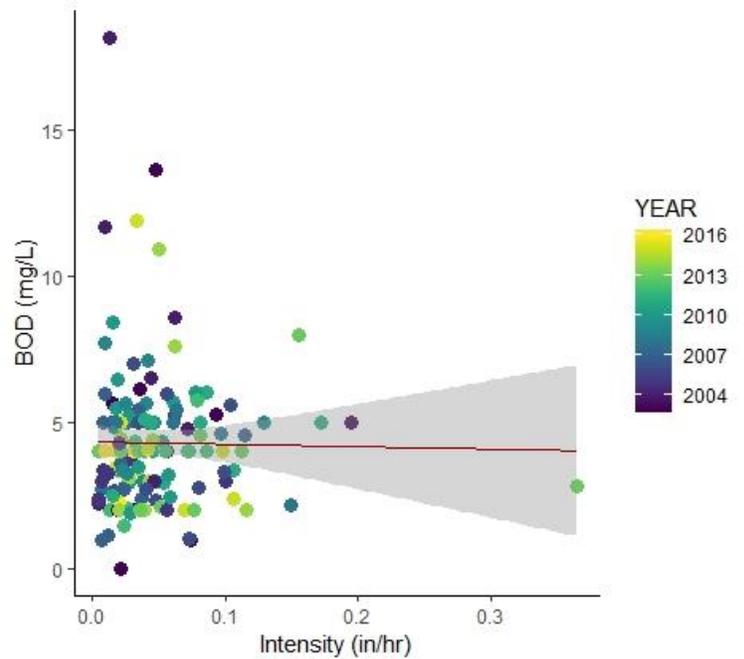
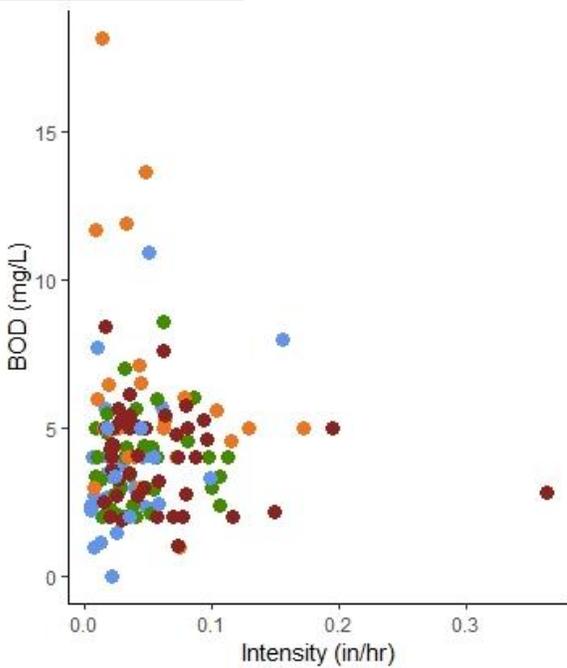
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values had a non-significant decreasing trend.
- Step trends found no significant differences between the three time periods for stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS	0.02	NS

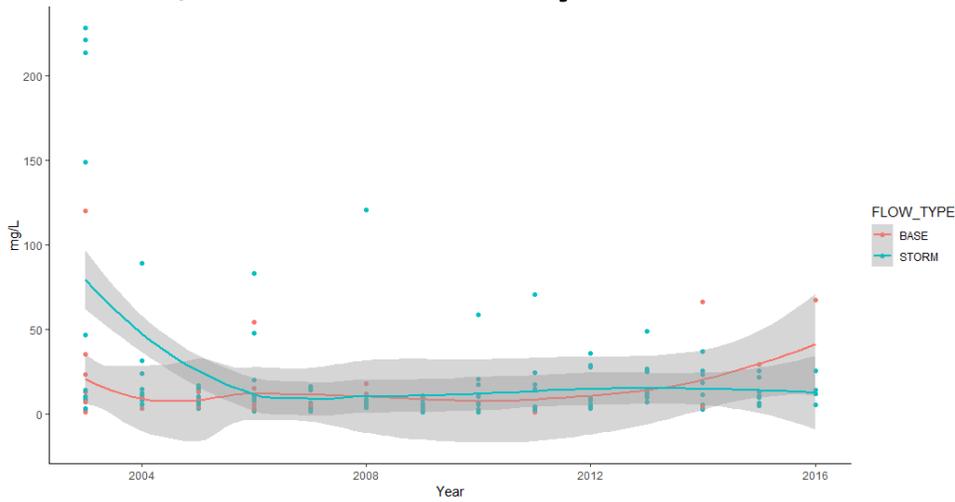
Baseflow

Season
Data
Method
Direction/Periods
p-value



There does not appear to be a strong seasonal or yearly influence on the relationship between BOD and intensity, other than summertime BOD having the highest recorded values.

Urbana, Frederick County - Outfall TSS



Summary

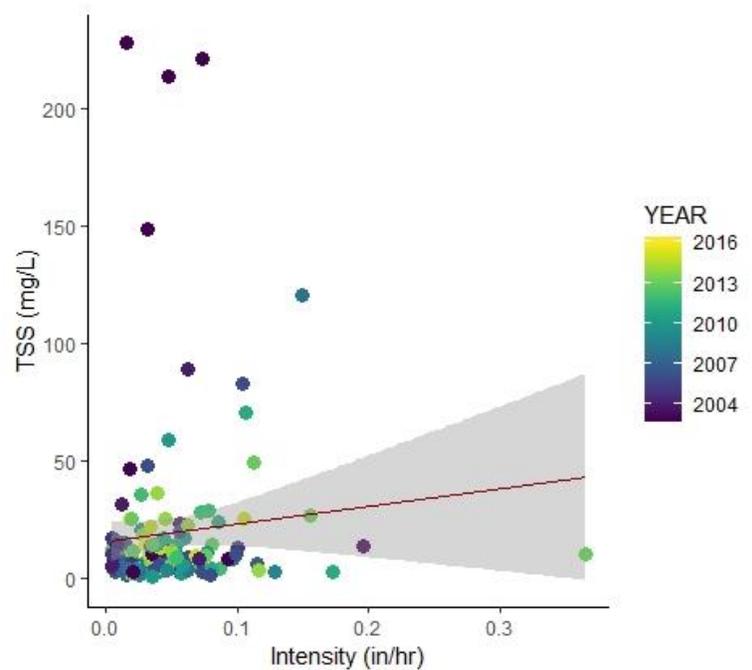
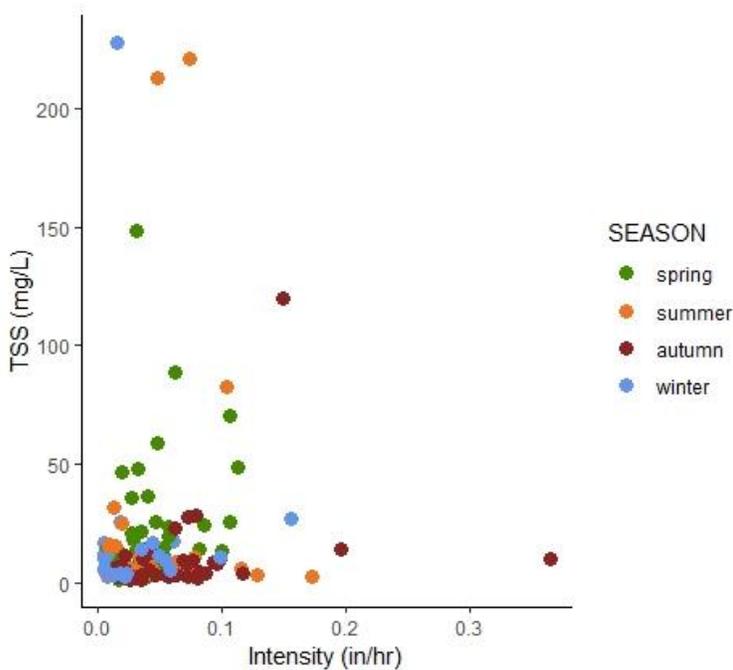
- Stormflow values had a mix of increasing and decreasing trends; only the decreasing trends are significant.
- Baseflow values non-significantly increased.
- Step trends found no significant differences between the three time periods for stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled, MFC	Culled	All	All	All
Method	Seasonal Kendall	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	NA	Neg.	Neg.	Pos.
p-value	NS	NS	NS	< 0.01	< 0.01	NS

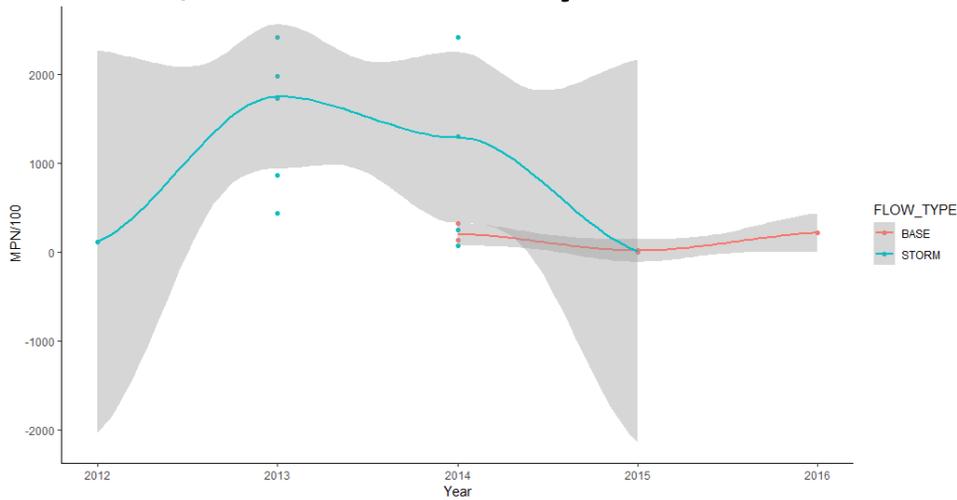
Baseflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	Neg.
p-value	NS	NS	NS



There is not a strong effect of seasonality on the relationship between TSS and intensity. The TSS values that are the highest are from the beginning of the monitoring time period.

Urbana, Frederick County - Outfall *E. coli*



Summary

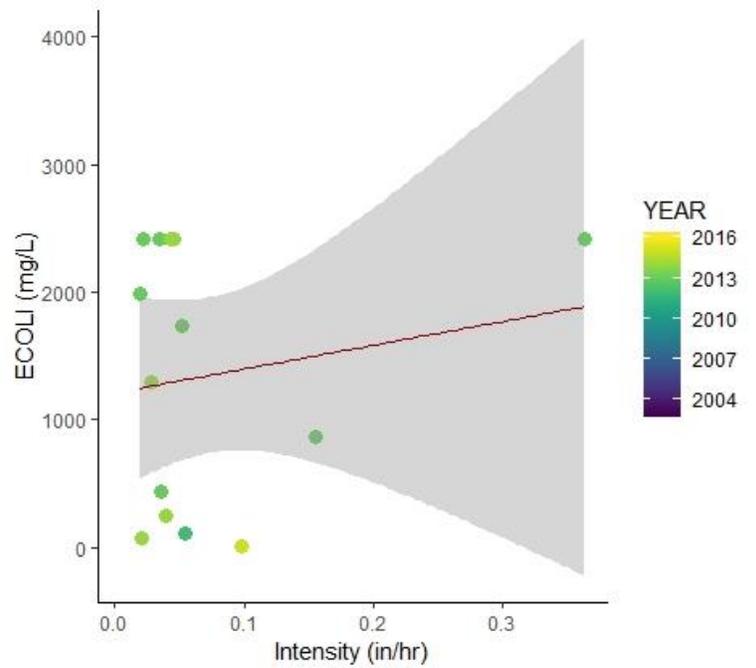
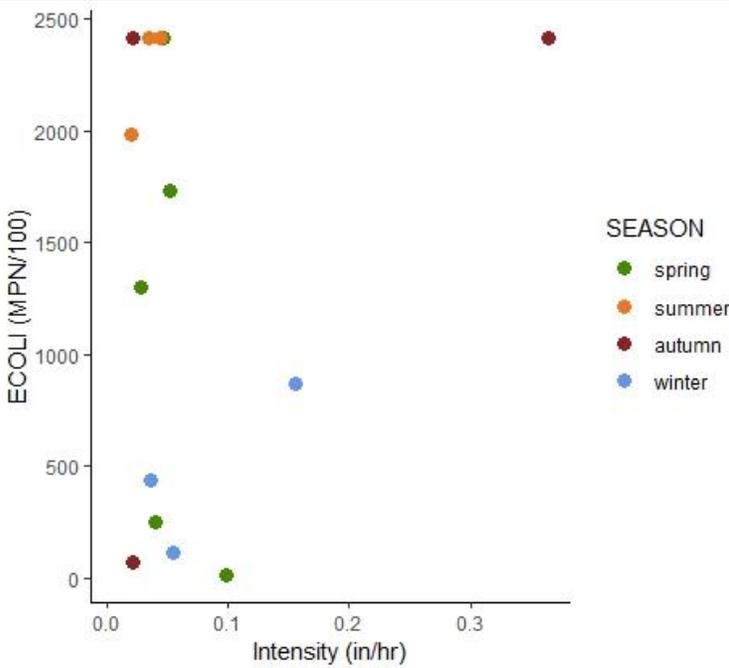
- Stormflow values had a non-significant decreasing trend.
- Baseflow values had a non-significant increasing trend.

Stormflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	Neg.
p-value	NS	NS	NS

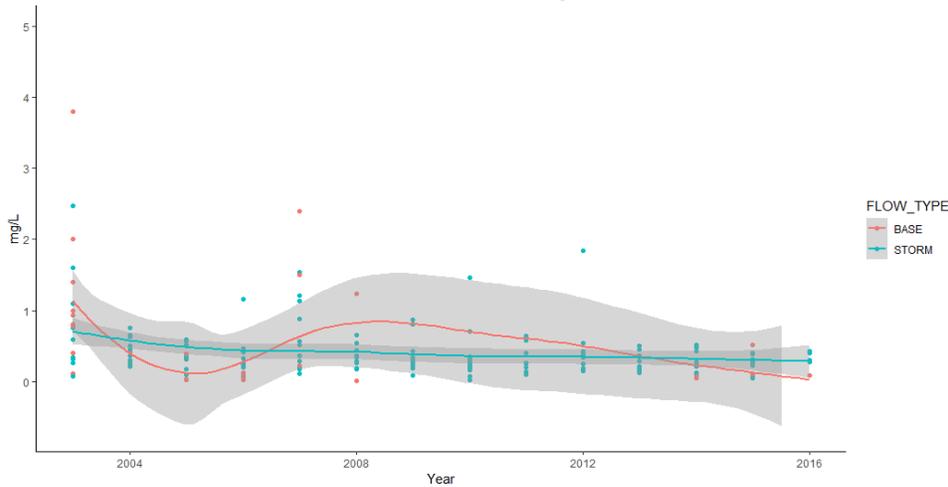
Baseflow

Season	Annual	Annual
Data	All	All
Method	Permutation	LSR
Direction/Periods	Pos.	Pos.
p-value	NS	NS



There does not appear to be a strong seasonal or yearly influence on the relationship between *E. coli* and intensity.

Urbana, Frederick County - Outfall NO₂₃



Summary

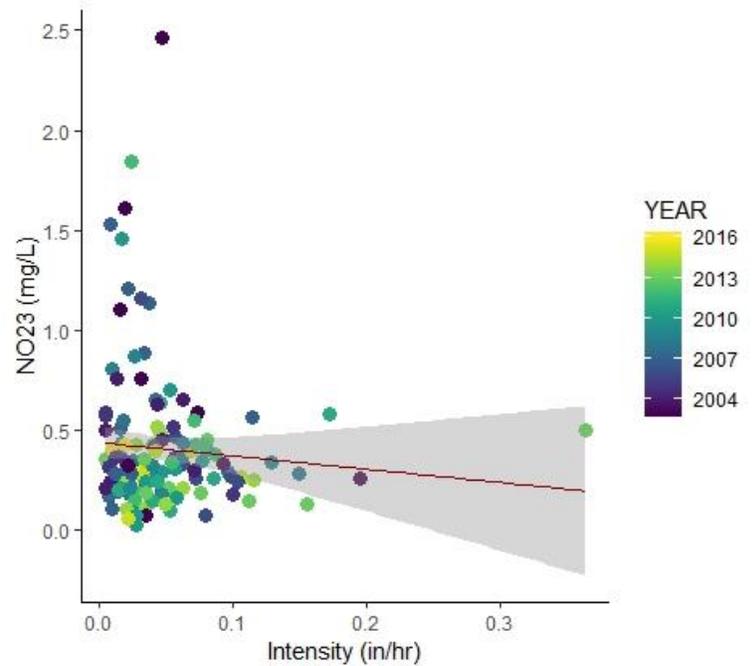
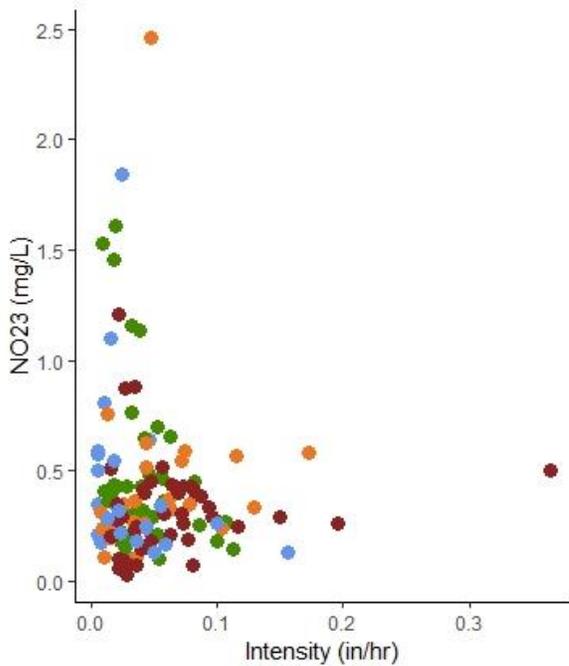
- Stormflow values decreased; three methods found this decrease to be significant.
- Baseflow values significantly decreased for two out of three methods.
- Step trends found no significant differences between the three time periods for stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled, MFC	Culled	All	All	All
Method	Seasonal Kendall	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	NS	< 0.01	< 0.01	0.01

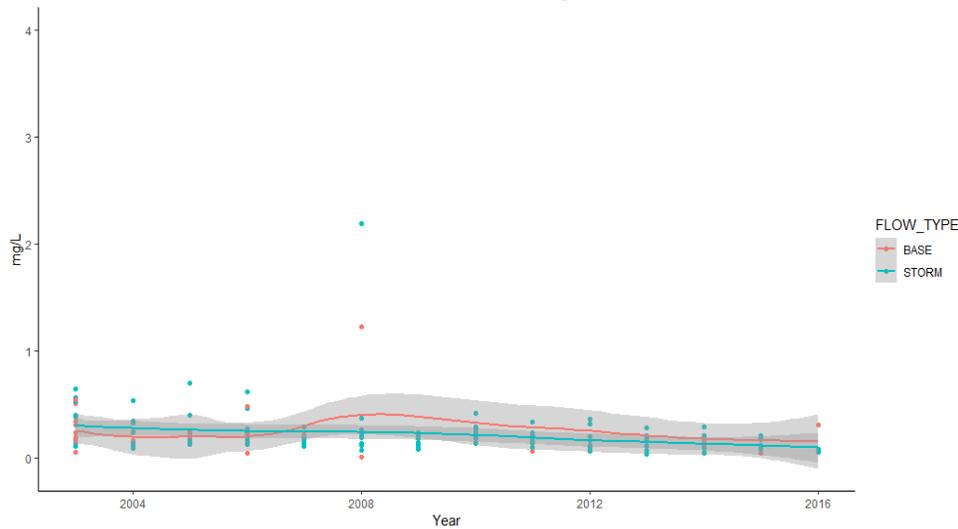
Baseflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	Neg.
p-value	0.04	NS	0.04



There does not appear to be a strong seasonal or yearly influence on the relationship between NO₂₃ and intensity.

Urbana, Frederick County - Outfall TP



Summary

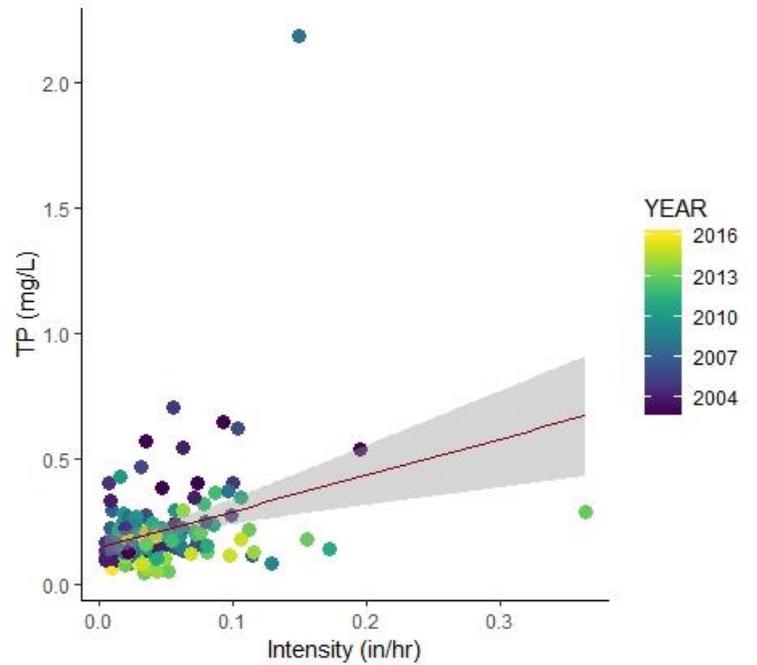
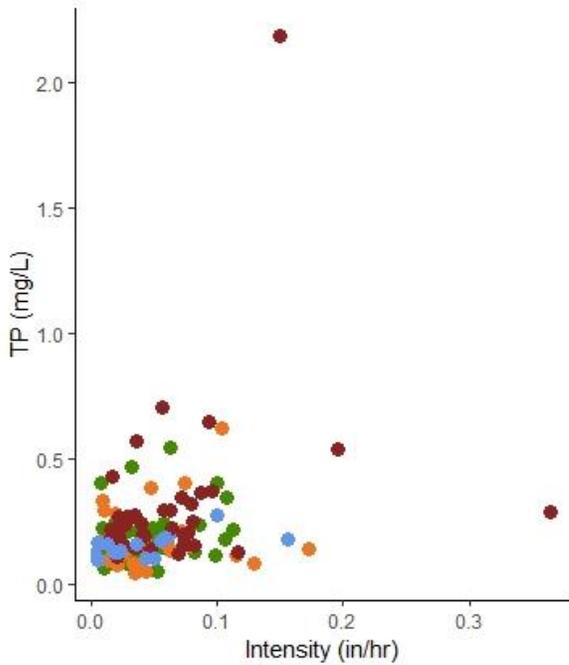
- Stormflow values significantly decreased.
- Baseflow values had a non-significant decreasing trend.
- Step trends found no significant differences between the three time periods for stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled, MFC	Culled	All	All	All
Method	Seasonal Kendall	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	Neg.	Neg.	Neg.
p-value	< 0.001	< 0.001	NS	< 0.01	< 0.01	0.04

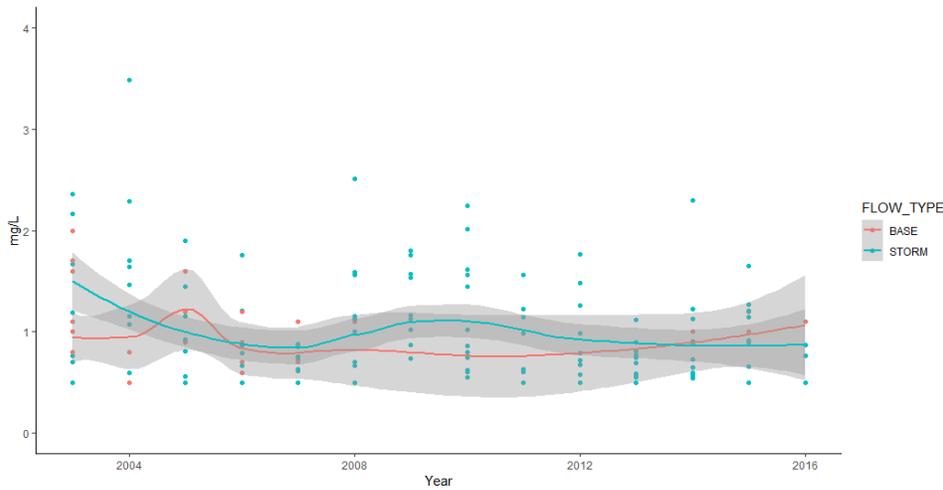
Baseflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	Neg.
p-value	NS	NS	NS



The most intense storms and the highest measured values are associated with autumn TP. Generally, more recently measured TP is lower in value than older measurements, but is associated with low to high intensity storms.

Urbana, Frederick County - Outfall TKN



Summary

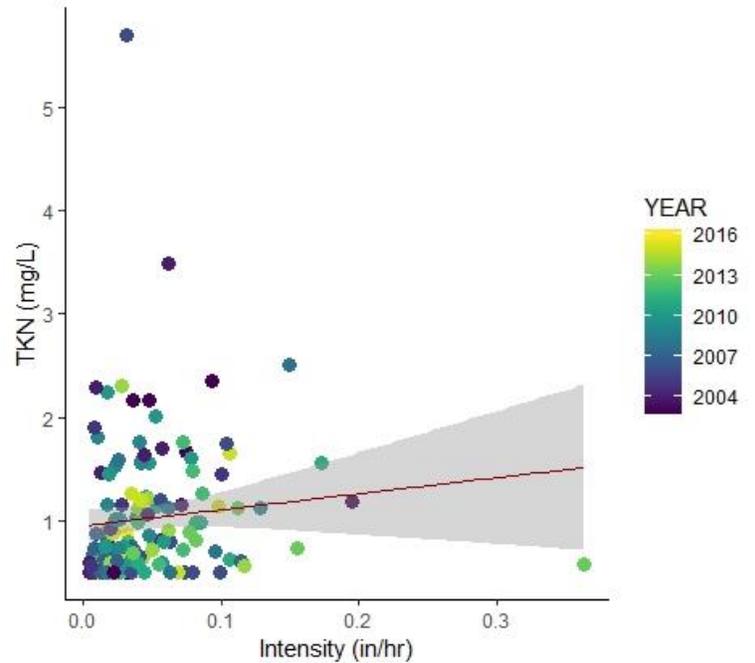
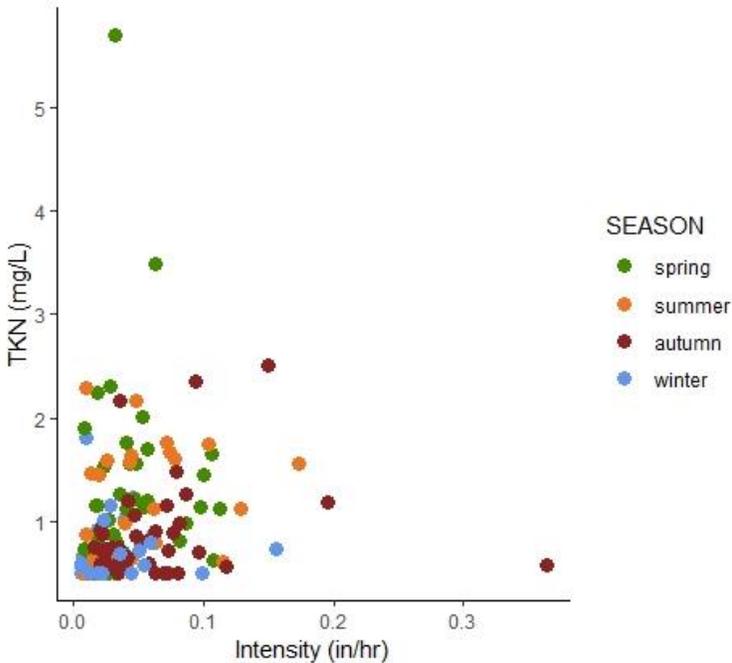
- Stormflow values decreased; two methods found the decrease to be significant.
- Baseflow values had a non-significant increasing trend.
- Step trends found no significant differences between the three time periods for stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual
Data	Culled, median adj.	Culled	All	All	All
Method	Mann-Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	NA	Neg.	Neg.	Neg.
p-value	NS	NS	0.03	0.03	NS

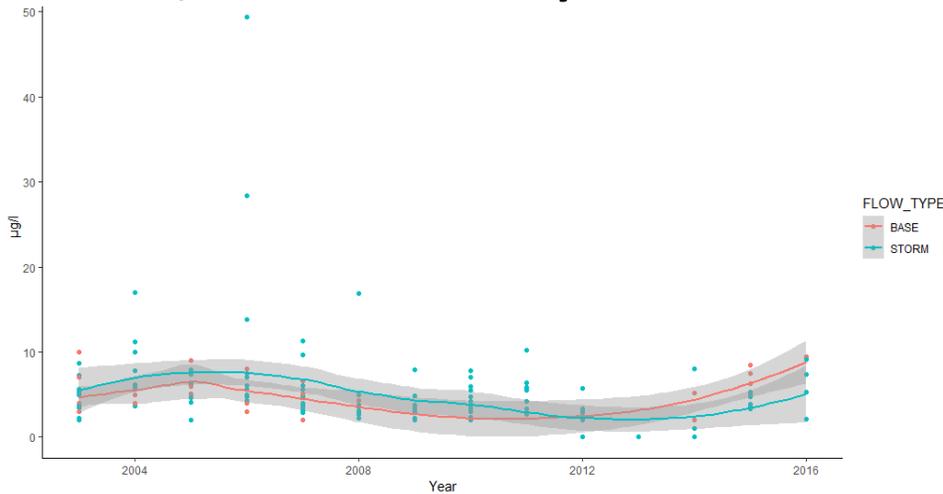
Baseflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction/Periods	Pos.	Pos.	Pos.
p-value	NS	NS	NS



There does not appear to be a strong seasonal or yearly influence on the relationship between TKN and intensity.

Urbana, Frederick County - Outfall TCU



Summary

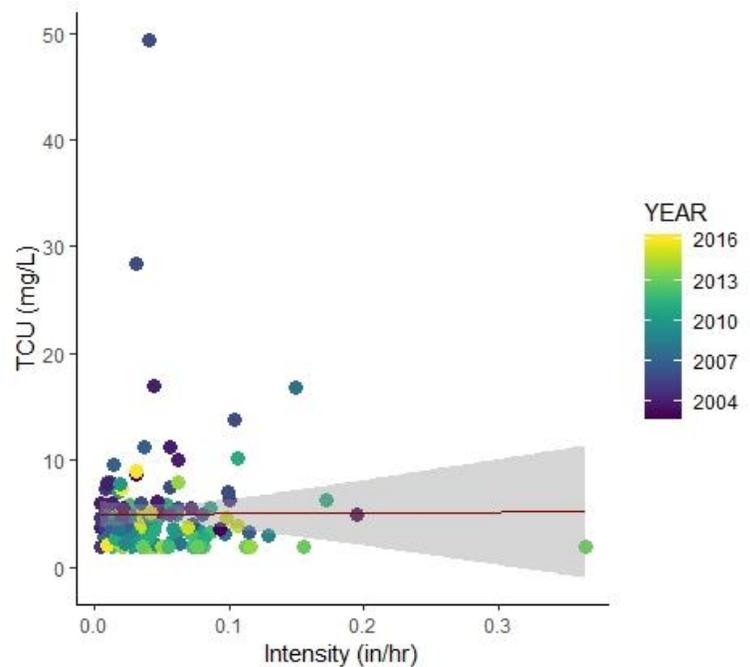
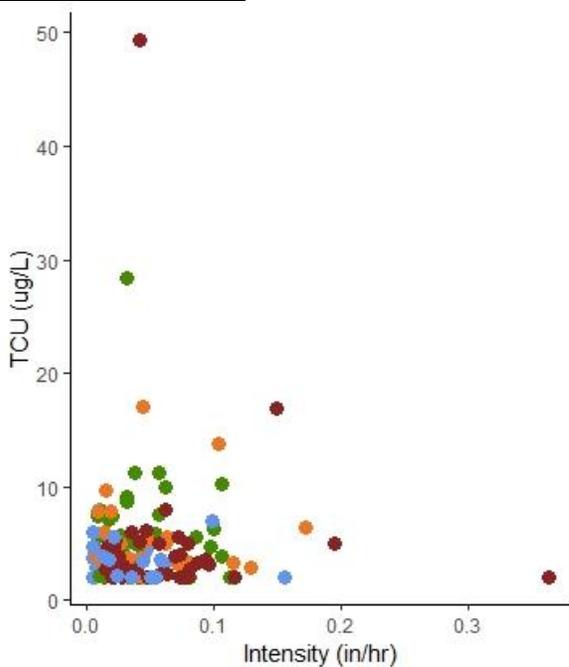
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values significantly decreased.
- Step trends found no significant differences between the three time periods for stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled, MFC	Culled	All	All	All
Method	Seasonal Kendall	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	Neg.	Neg.	Neg.
p-value	0.05	0.05	NS	0.01	0.01	0.02

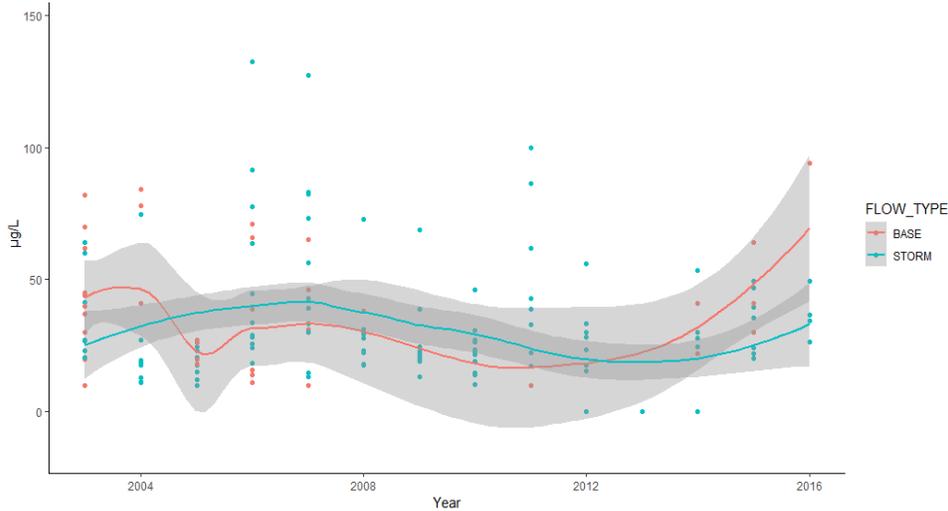
Baseflow

Season
Data
Method
Direction/Periods
p-value



The most intense storms and the highest measured values are associated with autumn TCU. Many of the lowest values of TCU are measured more recently, and the most elevated values occur towards the beginning of the monitoring time period.

Urbana, Frederick County - Outfall TZN



Summary

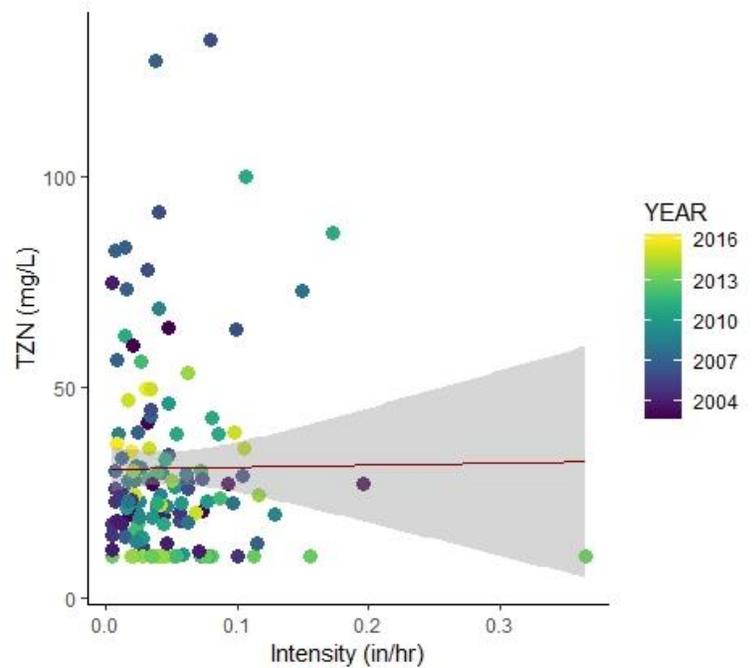
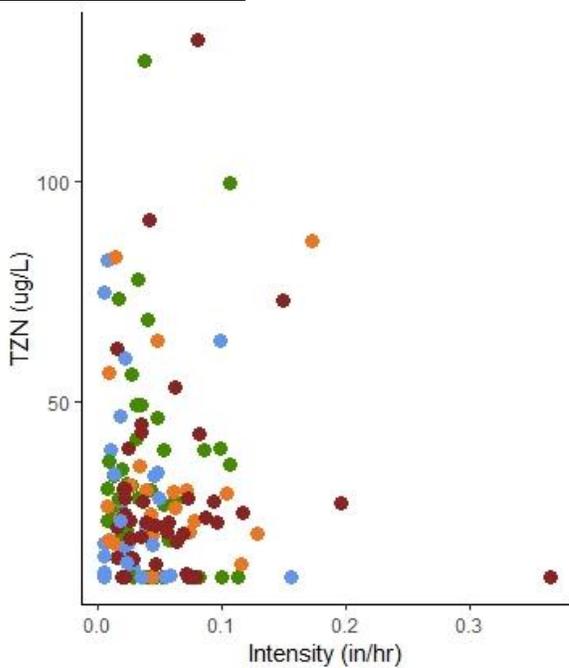
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
- Stormflow values mainly had non-significant decreasing trends, but one method found a positive trend.
- Step trends found no significant differences between the three time periods for stormflow.

Stormflow

Season	Annual	Annual	Annual	Annual	Annual	Annual
Data	Culled	Culled, MFC	Culled	All	All	All
Method	Seasonal Kendall	Seasonal Kendall	Kruskal-Wallis	Permutation	LSR	LOGR
Direction/Periods	Neg.	Neg.	NA	Neg.	Neg.	Pos.
p-value	NS	NS	NS	NS	NS	NS

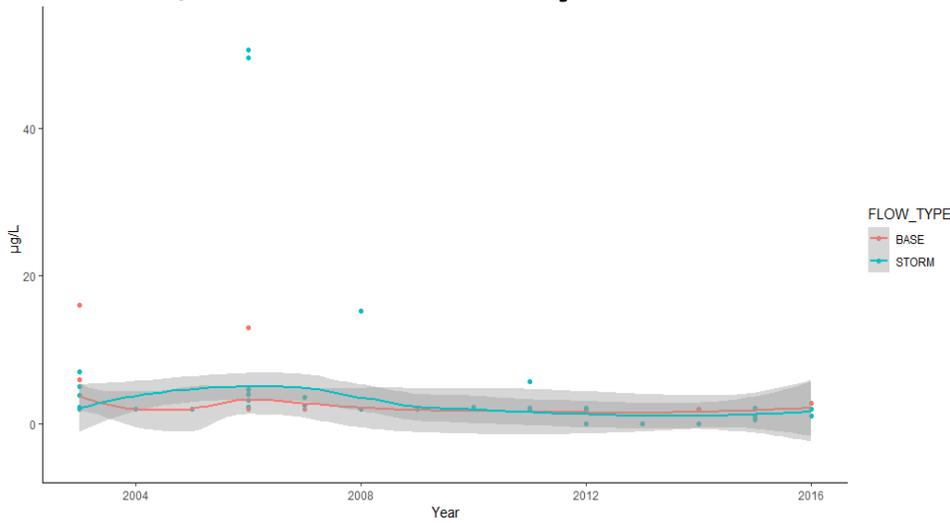
Baseflow

Season
Data
Method
Direction/Periods
p-value



There does not appear to be a strong seasonal or yearly influence on the relationship between TZN and intensity.

Urbana, Frederick County - Outfall TPB



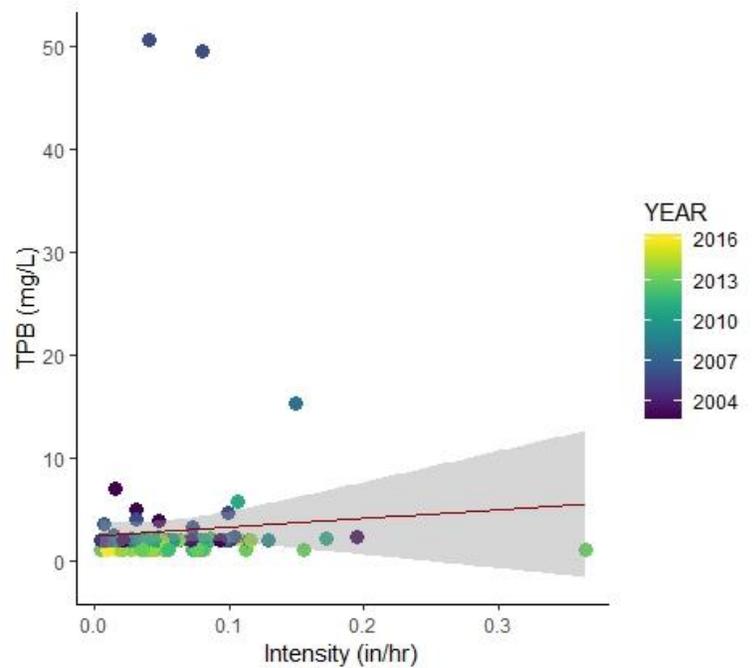
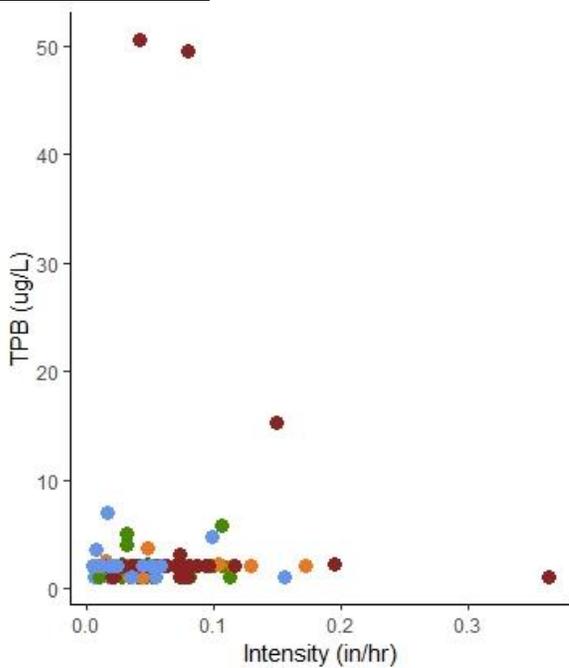
- Summary**
- Baseflow analysis could not be completed due to issues with data availability and/or censoring.
 - Stormflow values decreased; one method found the trend significant.

Stormflow

Season	Annual	Annual	Annual
Data	All	All	All
Method	Permutation	LSR	LOGR
Direction	Neg.	Neg.	Neg.
p-value	NS	NS	< 0.01

Baseflow

Season
Data
Method
Direction
p-value



There does not appear to be a strong seasonal or yearly influence on the relationship between TPB and intensity.