Walnut Creek Water Quality – 1996 to 2001

City of Austin
Watershed Protection Department

May 2002 **DR-02-01**

I. Major Change – Wastewater Line
II. Site Differences
III. Trends
IV. Seasonal Differences
V. Relationship to Impervious Cover

Comments:

- With additional data the improvement in mid-creek is not as strong as we first though – it is visual but not significant – the envelope for the maximums is u shaped but the medians aren't. You do see that shape primarily for nutrients, which are also the parameters which are significantly related to impervious cover, and the impervious cover is lowest in mid-creek.
- TSS and turbidity are highest at Loyola and the Railroad Bridge – maybe there is construction near those sites.
- TSS is the only consistently increasing parameter and it only increased at two sites. TP increased in some locations and decreased in others. TKN and PO4 decreased at some locations.
- Only two parameters (besides flow and temperature) show seasonal differences: NH3 and NO3.

Comments related to sampling plan:

Ecoregions: (Lamar, Below IH35) vs. (Old Manor, Loyola, MLK, Railroad)

- None of the parameters showed differences from one region to the other – so sampling based on ecoregion is not appropriate.

Seasonality: Winter (December-February), Spring (March-May), Summer (June-August), and Fall (September-November).

- Flow, temperature and the two nitrogen parameters, NH3 and NO3 were different in different seasons. If we want to pick up the seasonal difference we need to sample during Winter&Spring and during Summer&Fall. The nitrogen parameters are higher during Winter&Spring.
- For water quality, I suggest either avoiding seasonal difference by sampling only in Winter&Spring, or if we want to pick up seasonal difference sampling twice per year during both Winter&Spring and Summer&Fall.

Development:

- Impervious cover is significantly related to nutrients, conductivity and fecals.
- The lowest impervious cover is mid-creek at Old Manor and Loyola. In addition parameter maximums are visually lower in mid-creek.
- Additional monitoring at Old Manor and Loyola as the area develops and impervious cover levels rise could help us determine the effects of regulations on water quality.

Trends:

- The only increasing trends are in TSS (Below IH35, Old Manor) and TP (Old Manor and Loyola). I think these both need watched to see if the trend continues or if it was a temporary increase.
- We should continue to look for trends mid-creek as the area developes.

Sites:

- Lamar and Below IH35 are similar for all parameters so one of them could be dropped.
- MLK has the highest fecals, and ammonia – perhaps there are or were sewage line problems – should be checked out.
- Turbidity and TSS are high at Loyola and Railroad (but not at MLK which is between them). Is the cause known? Construction? Soil type?

Recovery:

- The Railroad site demonstrated major improvement as soon as the wastewater line was removed. Since then only two parameters, NO3 and TKN have shown additional significant decreases. The only parameter currently significantly higher than at the MLK site is TP. MLK is slightly upstream of the location where the treated sewage was discharged, and has impervious cover and soil characteristics that are similar to the Railroad site. The high TP might be related to erosion of contaminated soil. Additional sampling at this site would determine if NO3 and TKN levels have fully recovered or not. Also TP should continue to be monitored.

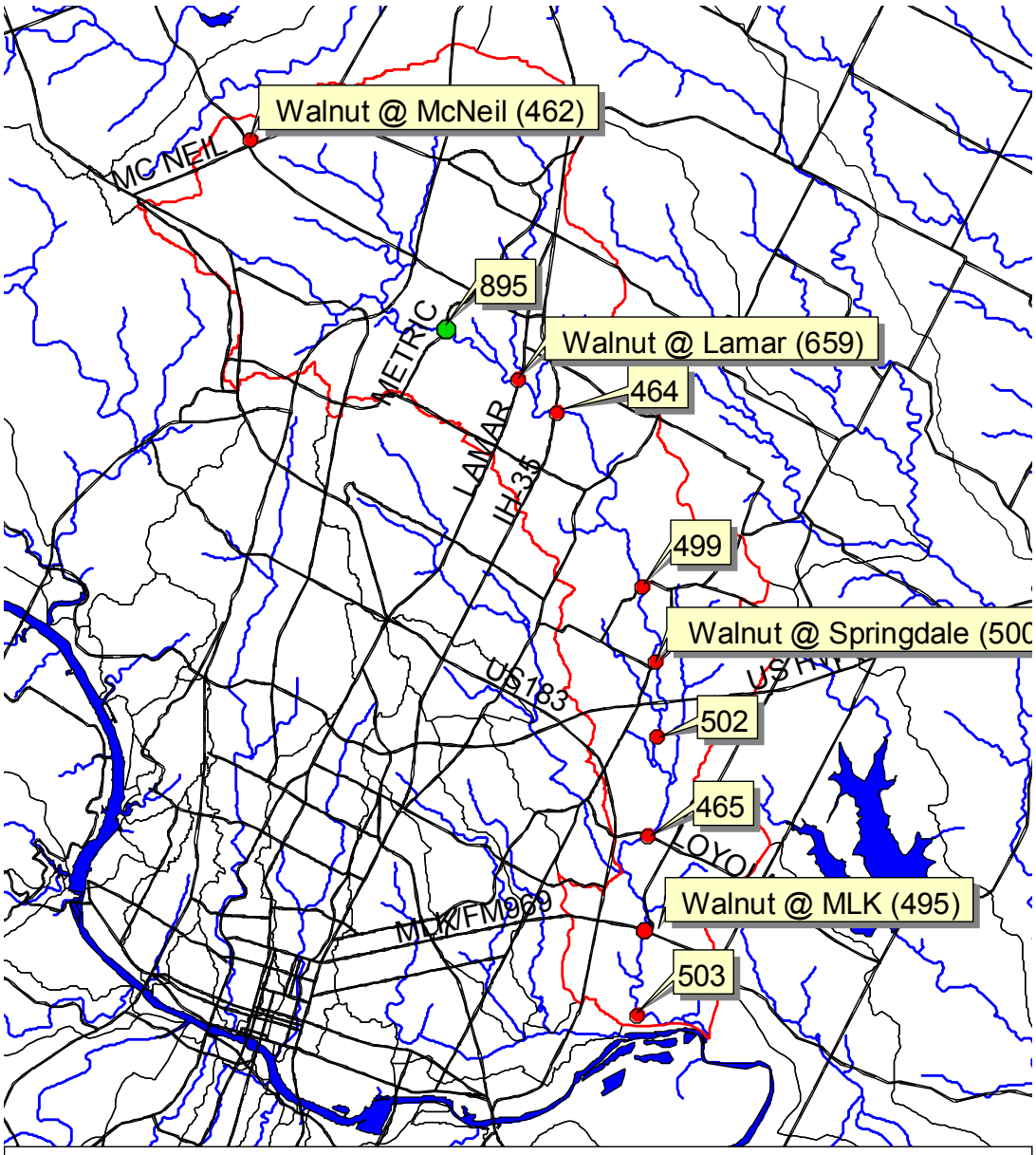
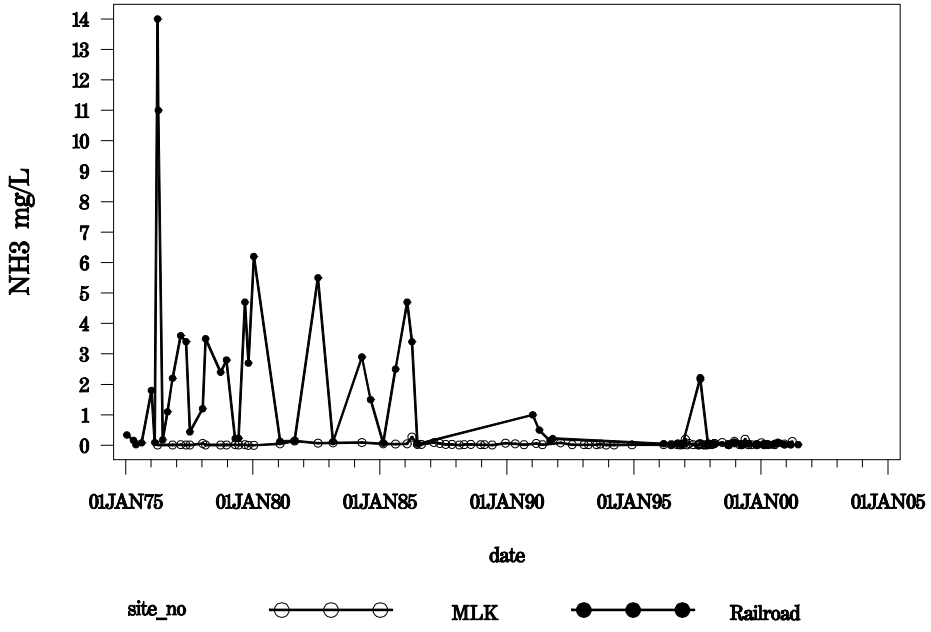
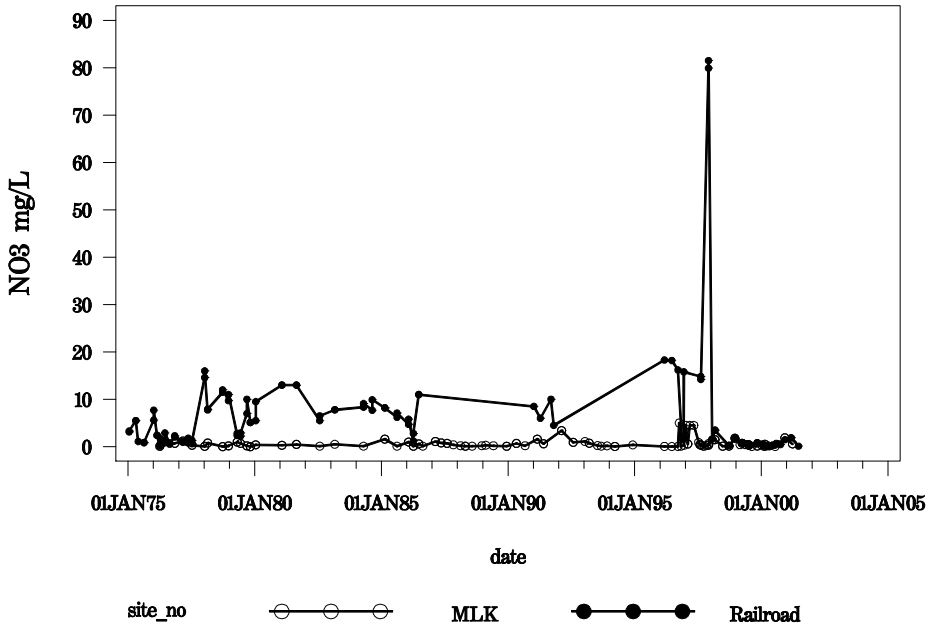


Figure 1. Location of primary sampling sites on Walnut Creek.

I. Major change/Recovery

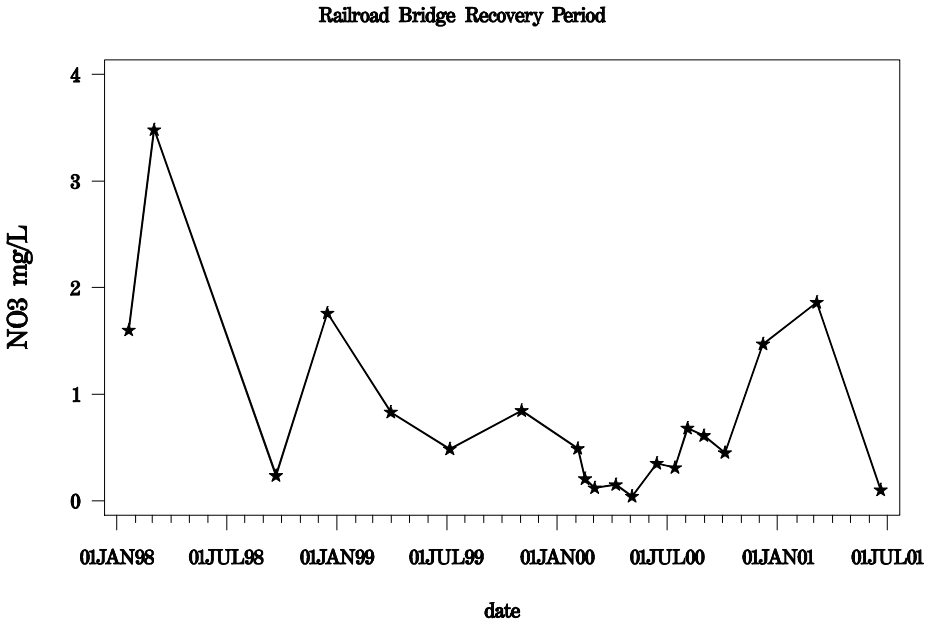
The wastewater line from the treatment plan was moved from Walnut Creek between MLK and the railroad bridge to the Colorado River around the beginning of 1998.

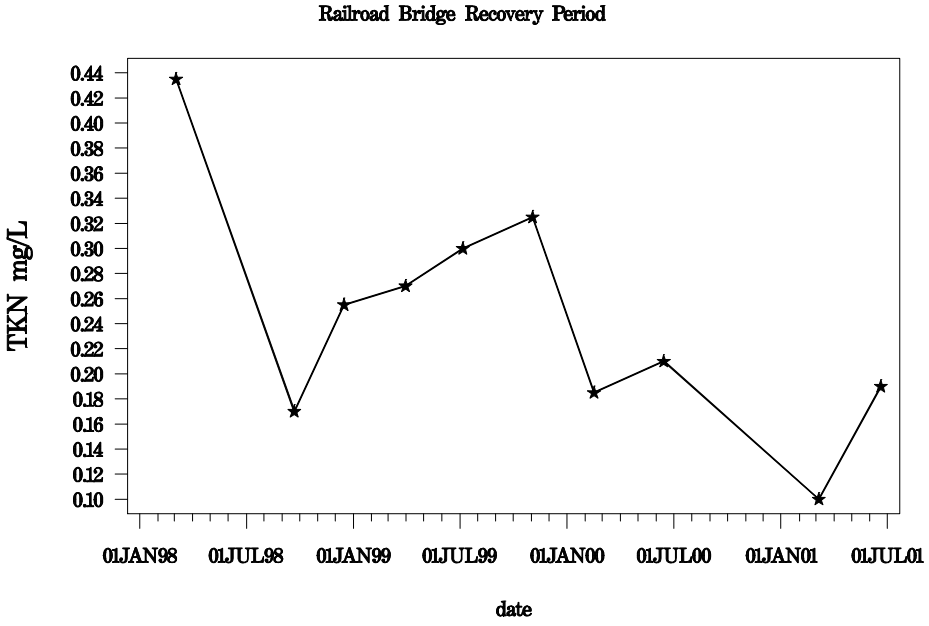




Non-storm flow data only for lower Walnut Creek

The Railroad site demonstrated major improvement as soon as the wastewater line was removed. Since then (1998-2001) only two parameters, NO3 (Pr>F=0.0331, R2=0.2283) and TKN (Pr>F=0.0371, R2=0.4380) have shown additional significant decreases. The only parameter currently significantly higher than at the MLK site is TP (Pr>F=0.0024). MLK is slightly upstream of the location where the treated sewage was discharged, and has impervious cover and soil characteristics that are similar to the Railroad site. The high TP might be related to erosion of contaminated soil.





II. Site Differences

The six sites with the most data were investigated using analysis of variance to find significant site differences during baseflow conditions.

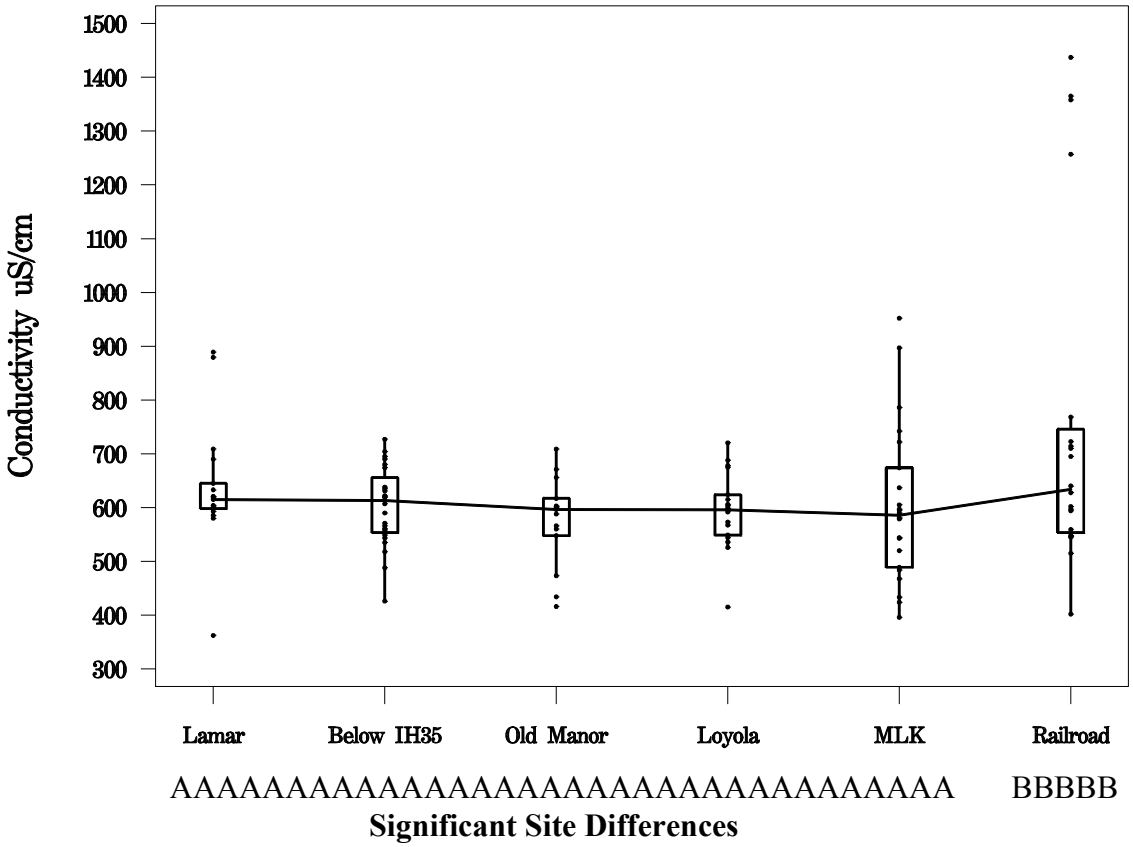
Sites

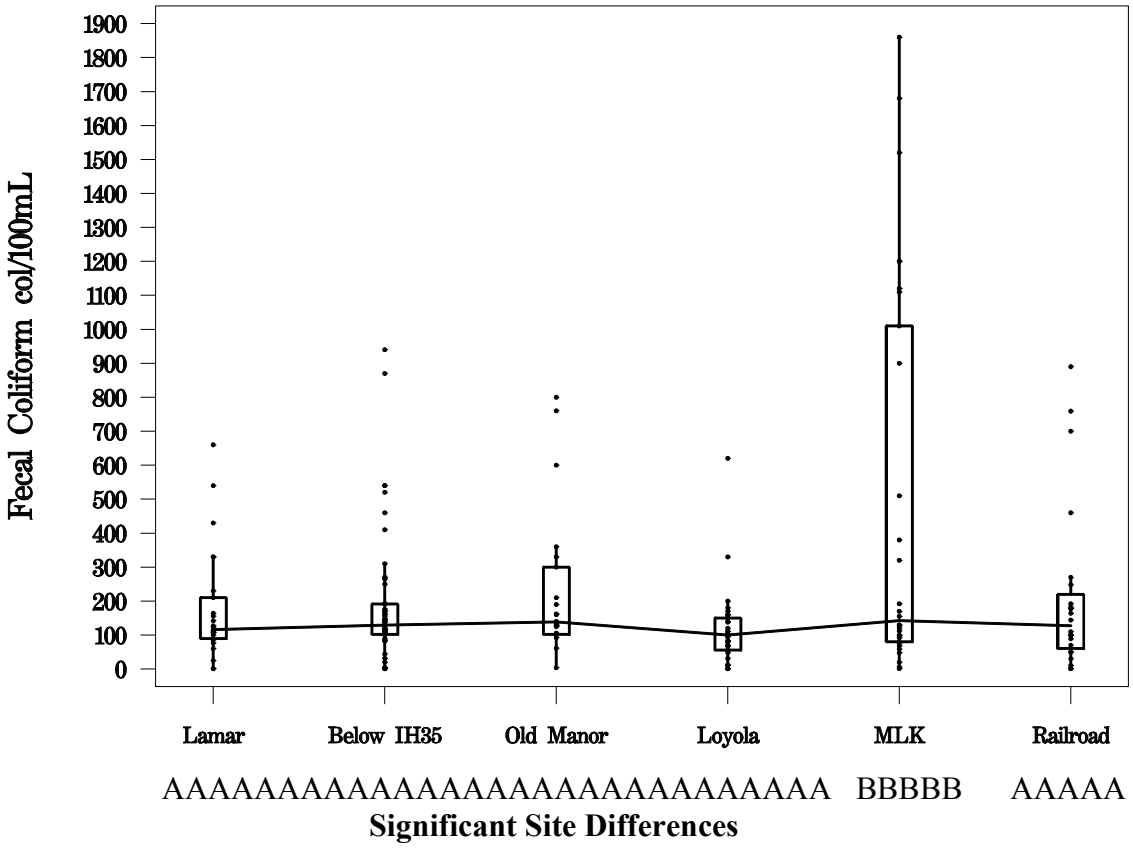
Site Name	Site Label	Site Number	Distance from Mouth	Impervious Cover
Walnut Creek @ Lamar Blvd	Lamar	659	14.3	22.59
Walnut Creek Below IH35	Below IH35	464	13.2	21.93
Walnut Creek @ Old Manor Road	Old Manor	502	6.8	19.78
Walnut Creek @ Loyola	Loyola	465	5.0	18.43
Walnut Creek @ MLK/Webberville Road	MLK	495	3.0	24.89
Walnut Creek @ SP Railroad Bridge	Railroad	503	1.4	24.73

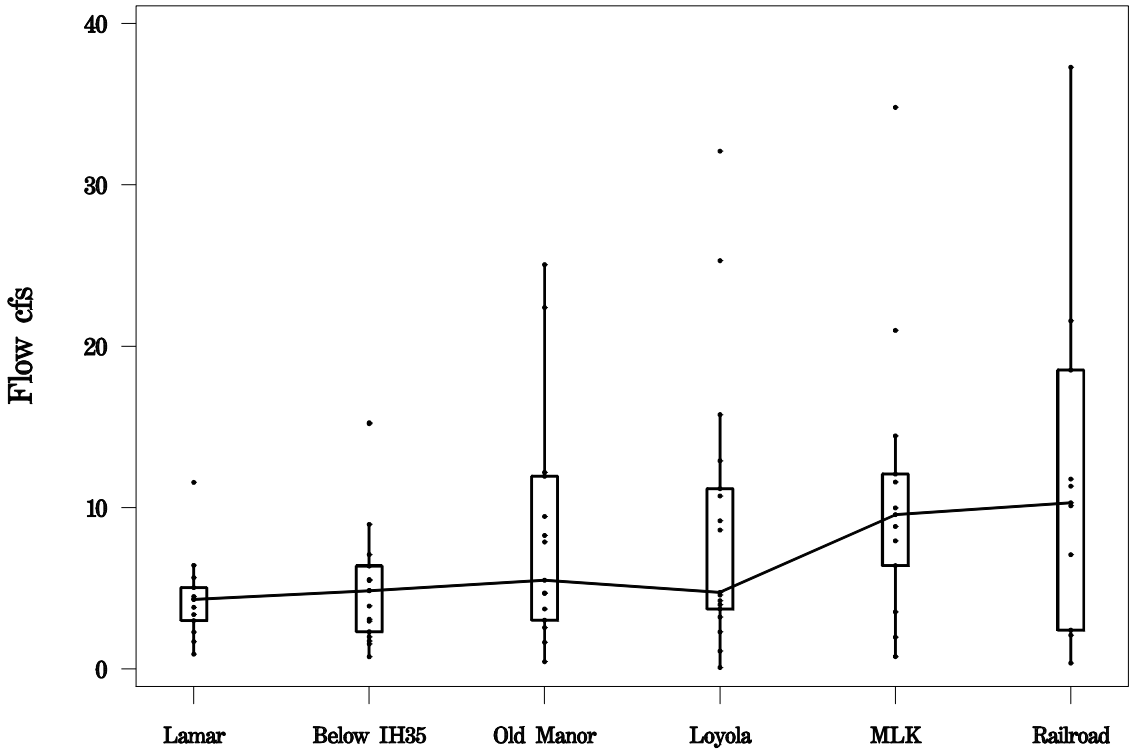
Duncan's method was used to tell which sites were different. Data from the railroad bridge site during the period when it was affected by sewage treatment plant effluent was not included in the analysis. Significant differences are listed in the table below, followed by box and whisker plots of all the parameters. The parameters included the analysis are conductivity, fecal coliform bacteria, flow, ammonia, nitrate, pH, orthophosphate, temperature, total Kjeldahl nitrogen, total phosphorus, total suspended solids, and turbidity.

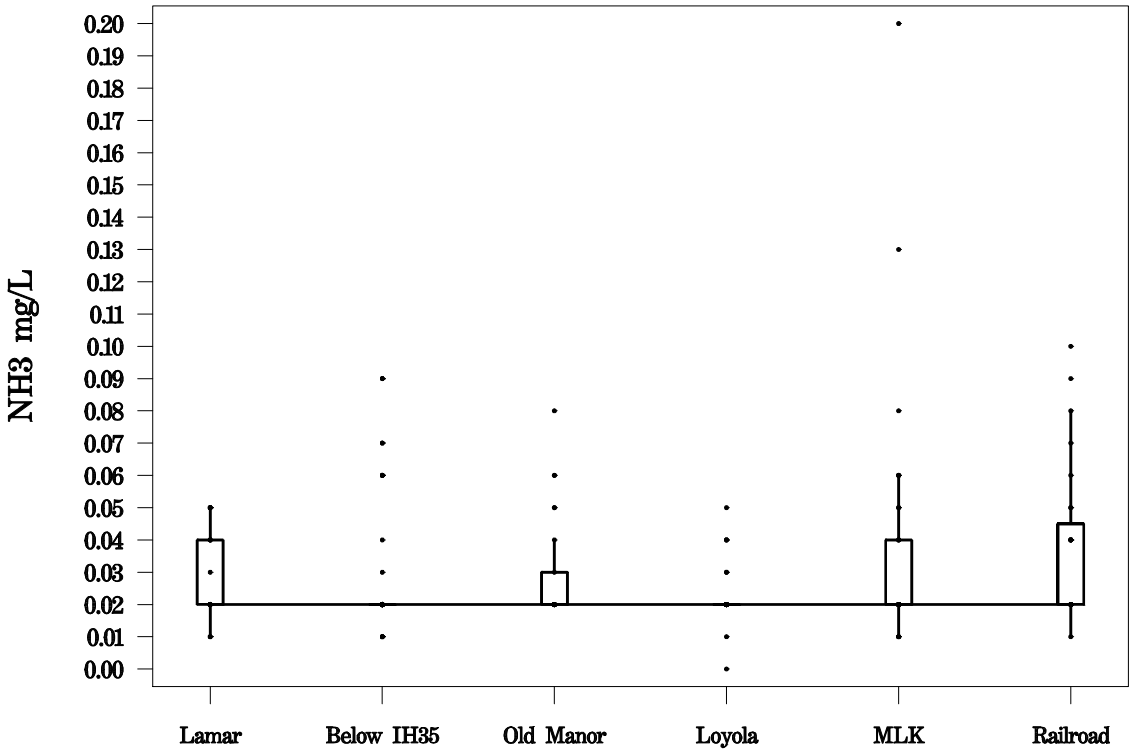
Significant Site Differences during Baseflow

Parameter	Pr>F	Comments on which sites are different
Conductivity	=0.0060	Higher at Railroad
Fecal Coliform	<0.0001	Higher at MLK
Orthophosphate	=0.0036	Lamar – MLK less than MLK – Railroad (overlap at MLK)
Total Phosphorus	<0.0001	Highest at Railroad, Lamar-Loyola greater than Below IH35-MLK (overlap from Below IH35 – Loyola)
Total Suspended Solids	<0.0001	Loyola and Railroad greater than Lamar-Old Manor and MLK
Turbidity	<0.0001	Lamar – Old Manor less than Loyola - Railroad

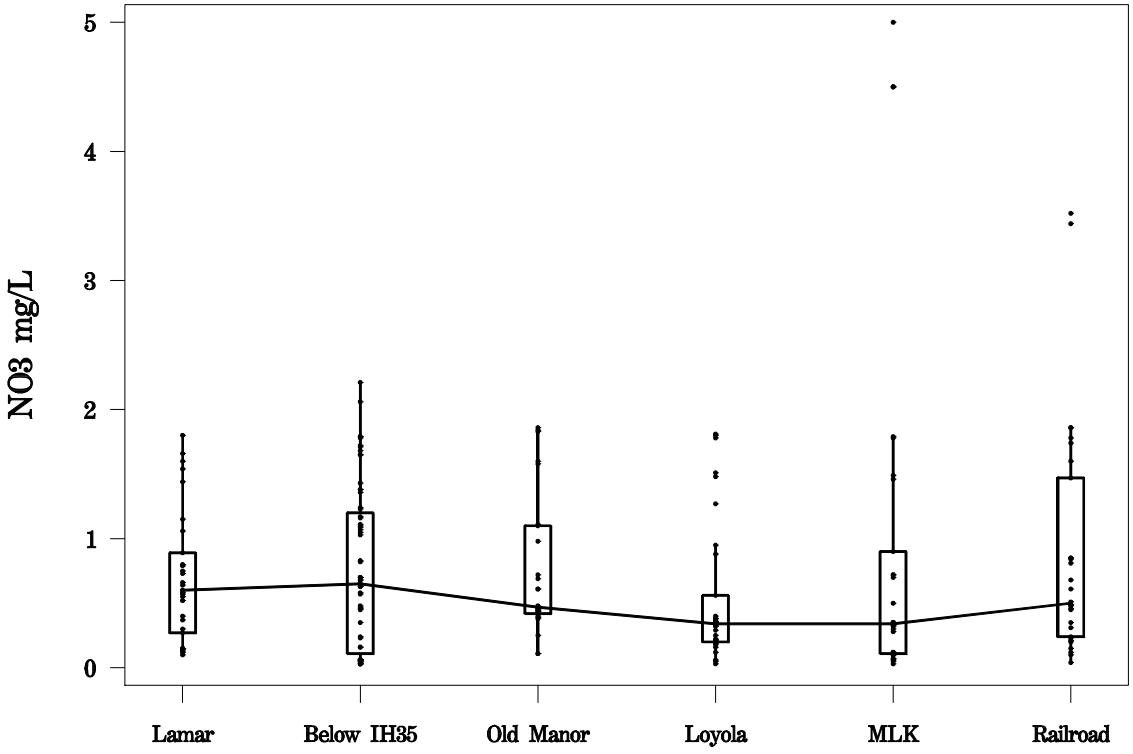

Conductivity uS/cm
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA BBBBB
Significant Site Differences

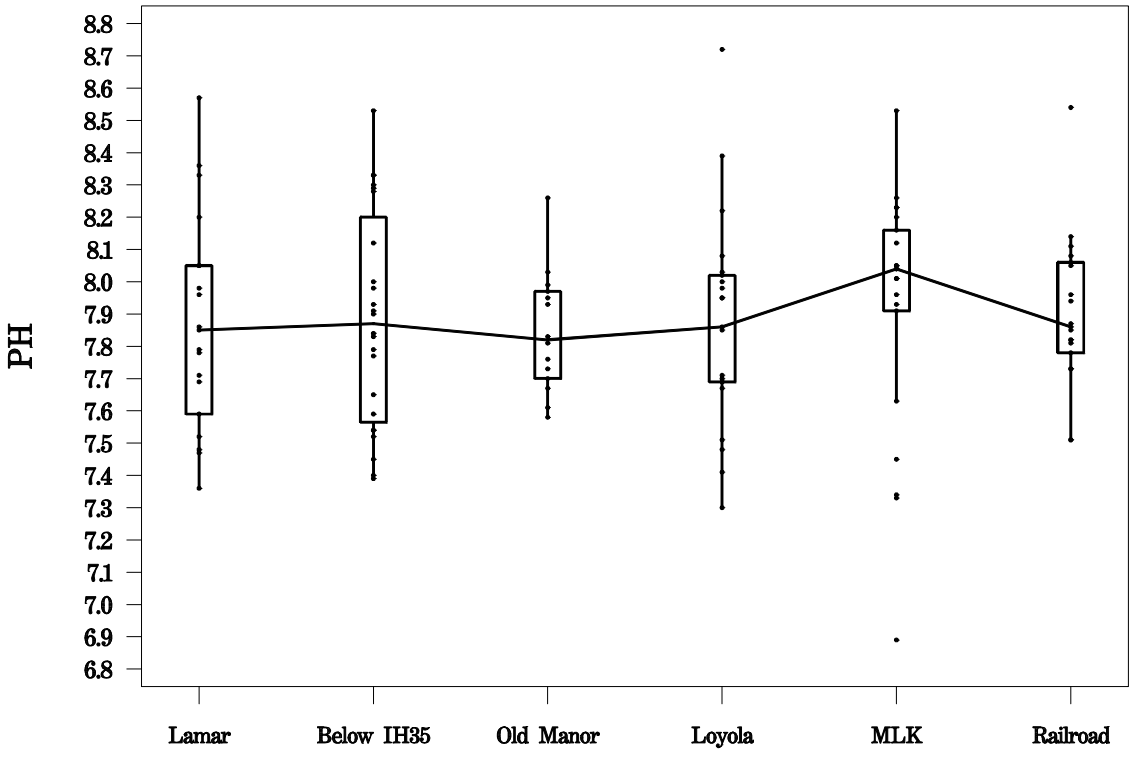

Fecal Coliform col/100mL
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA BBBBB AAAAA
Significant Site Differences



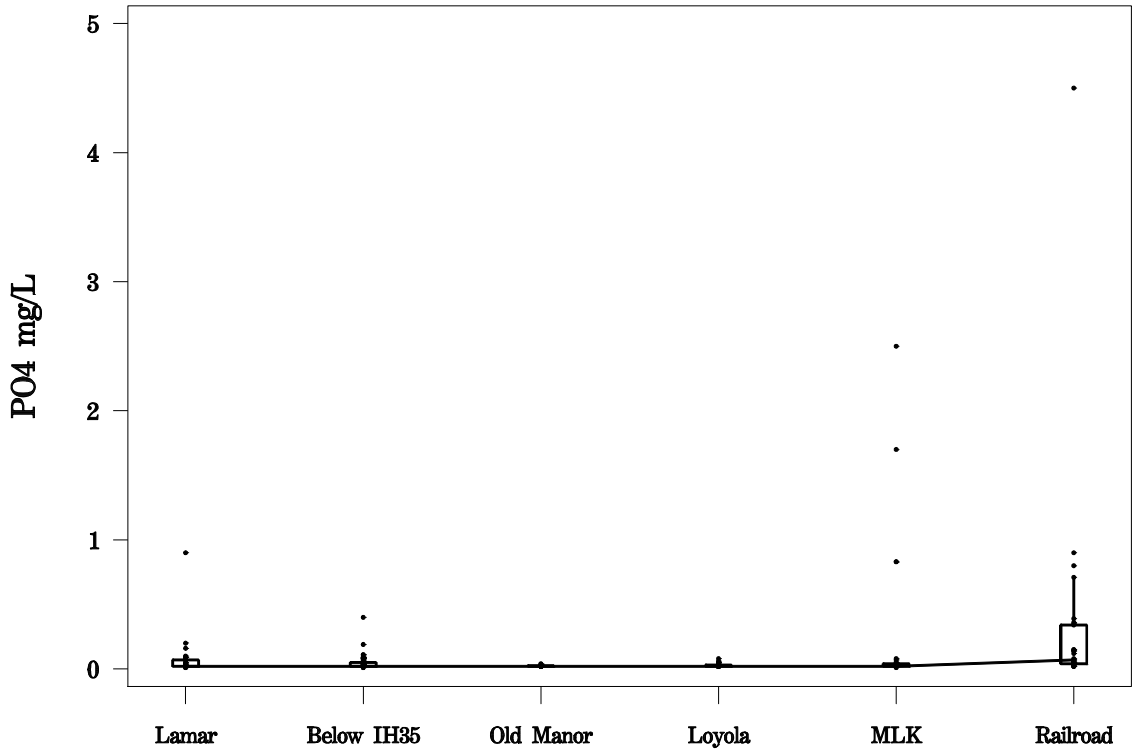


Data from 1996-2001. USGS data not included.





Data from 1996-2001. USGS data not included.



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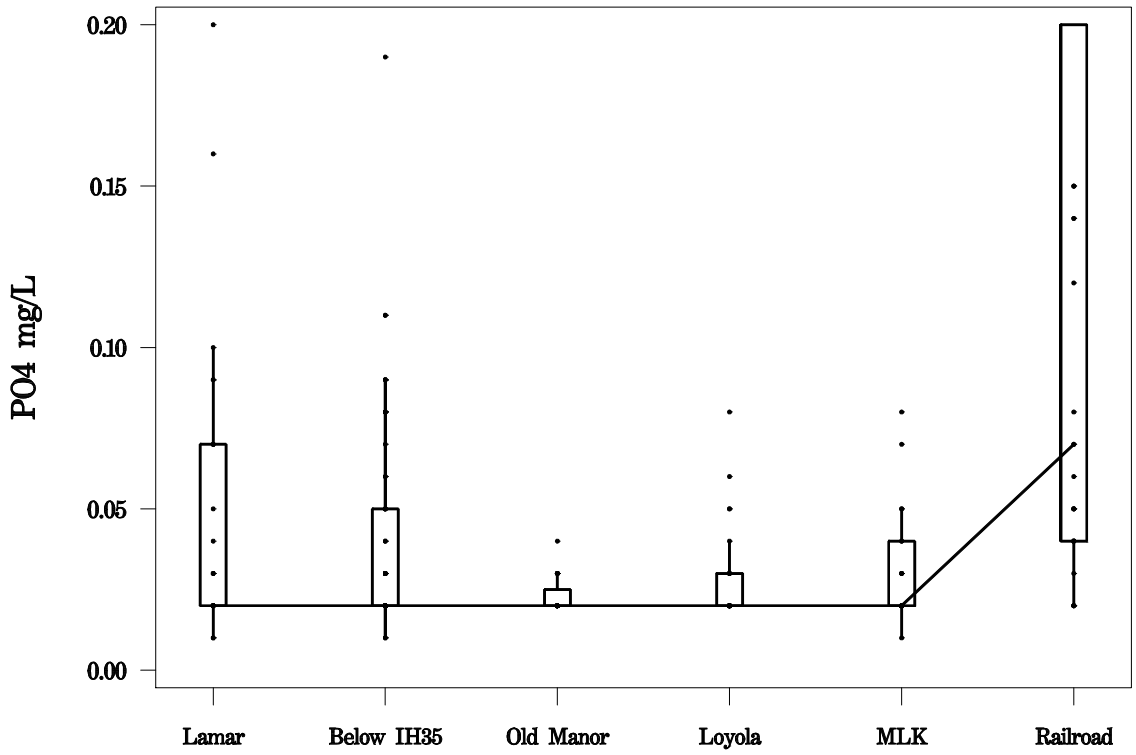
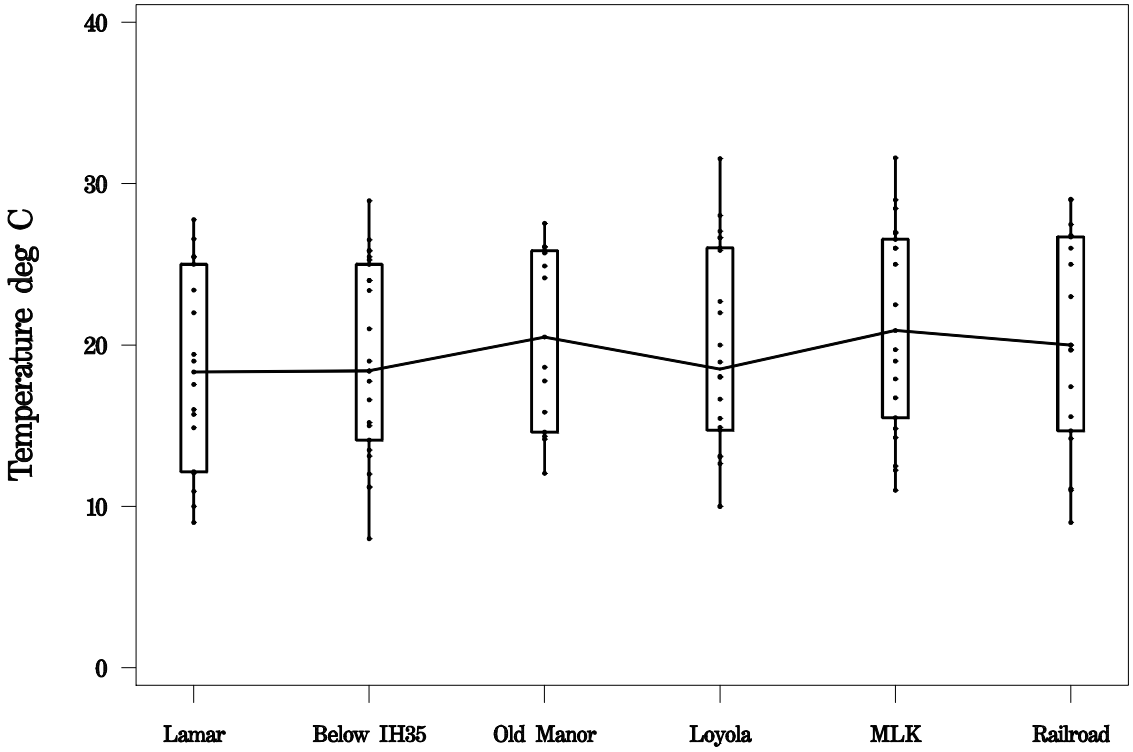
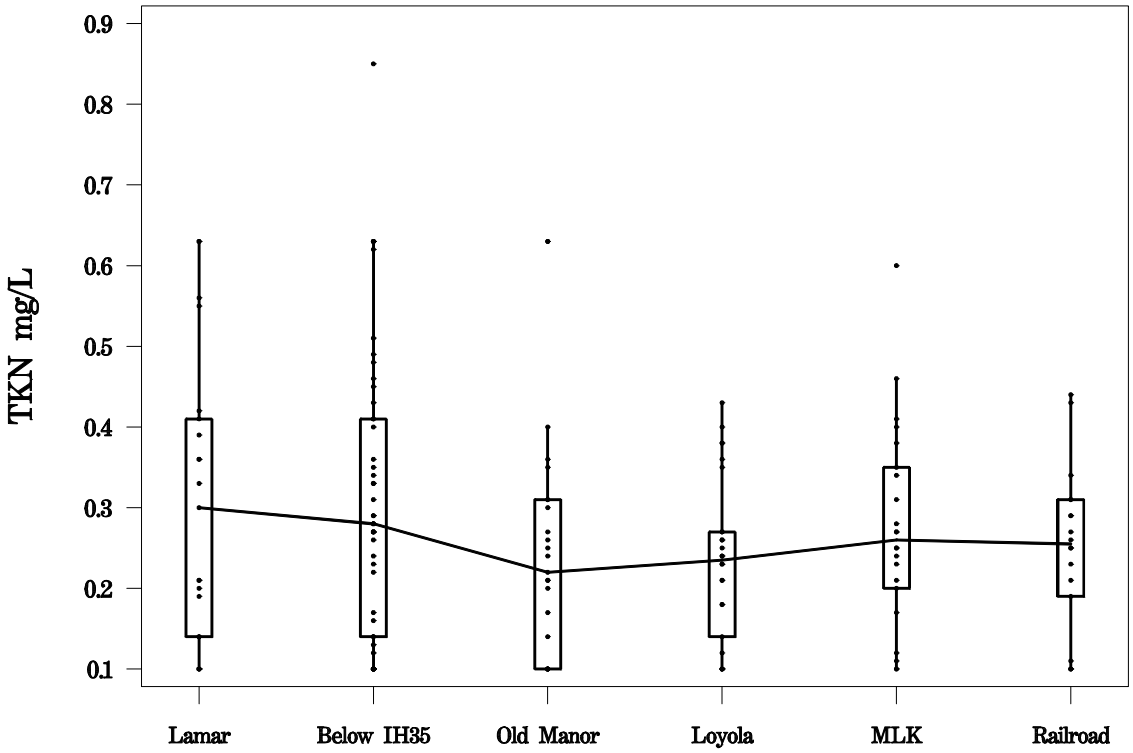
Significant Site Differences

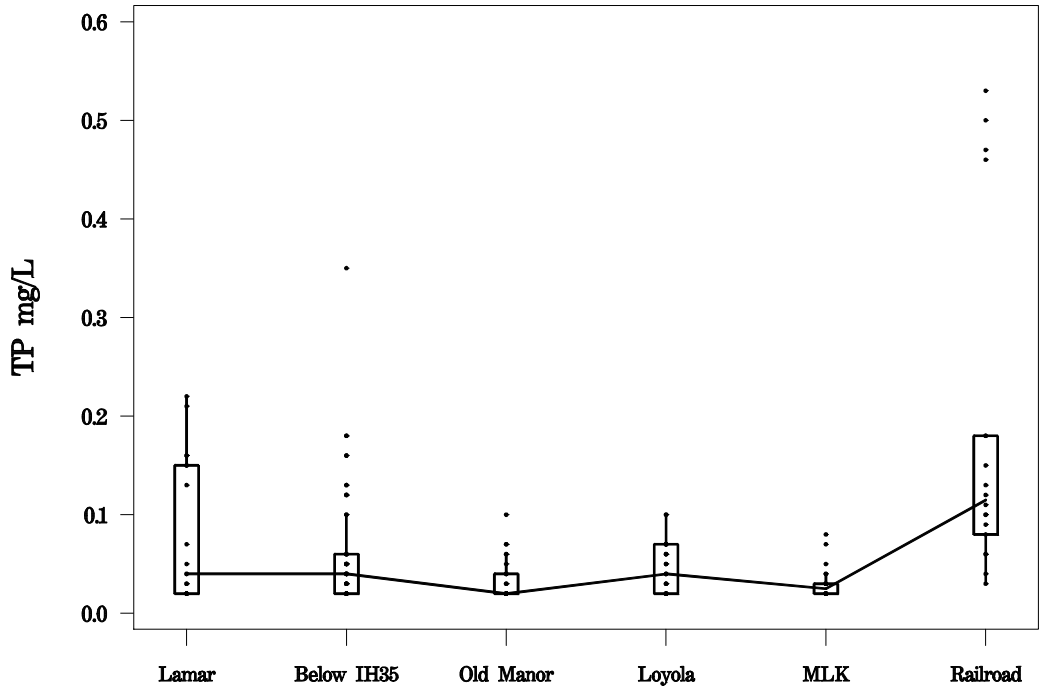


Data from 1996-2001. USGS data not included.





Data from 1996-2001. USGS data not included.



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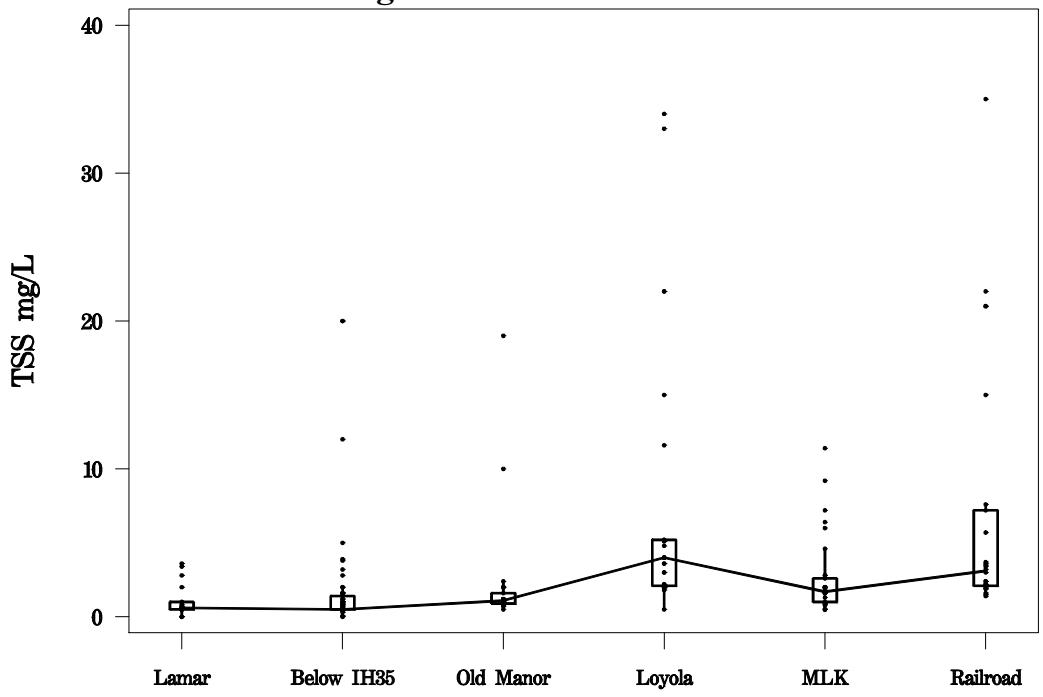
Significant Site Differences



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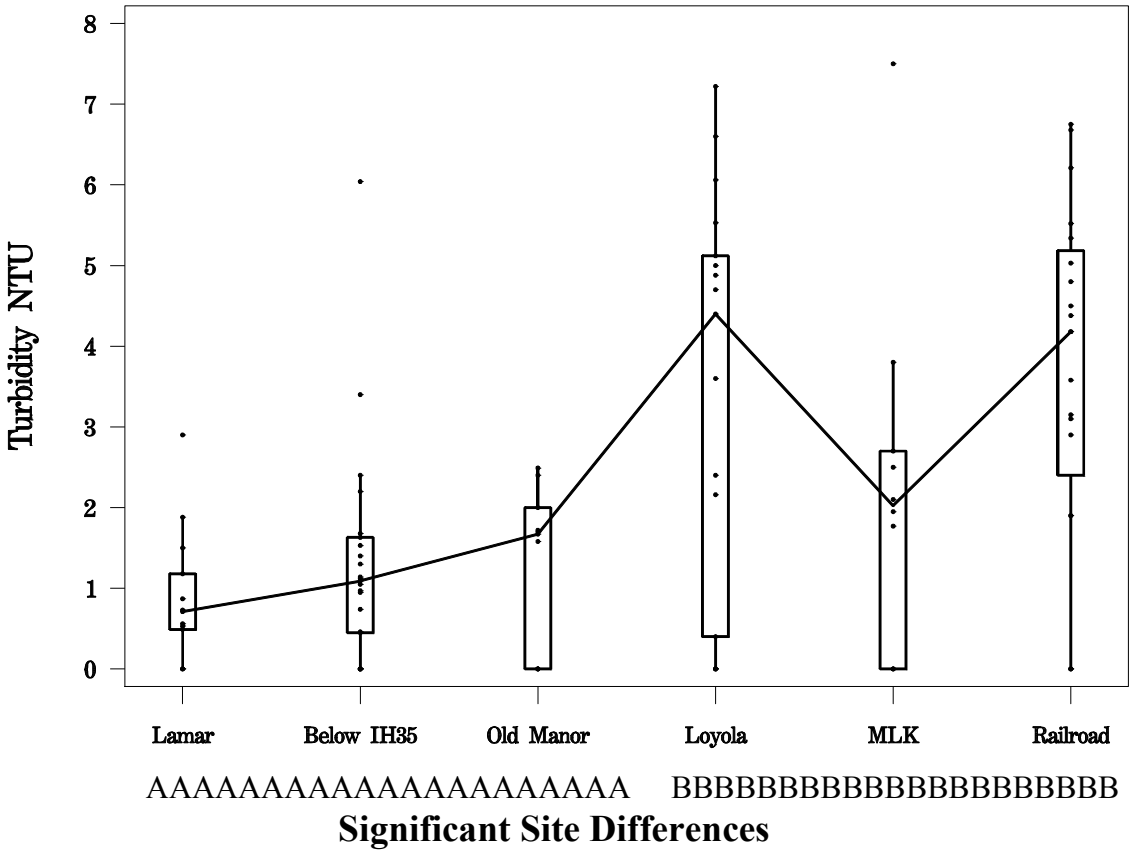
Significant Site Differences



Significant Site Differences

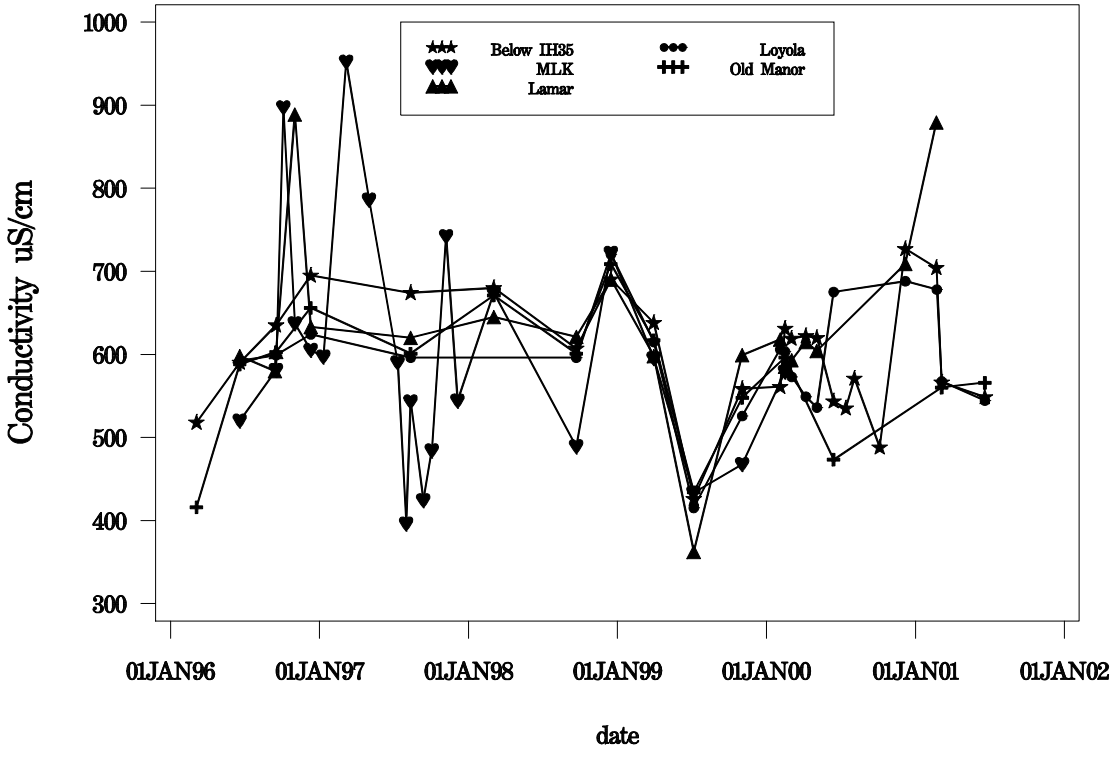
Data from 1996-2001. USGS data not included.

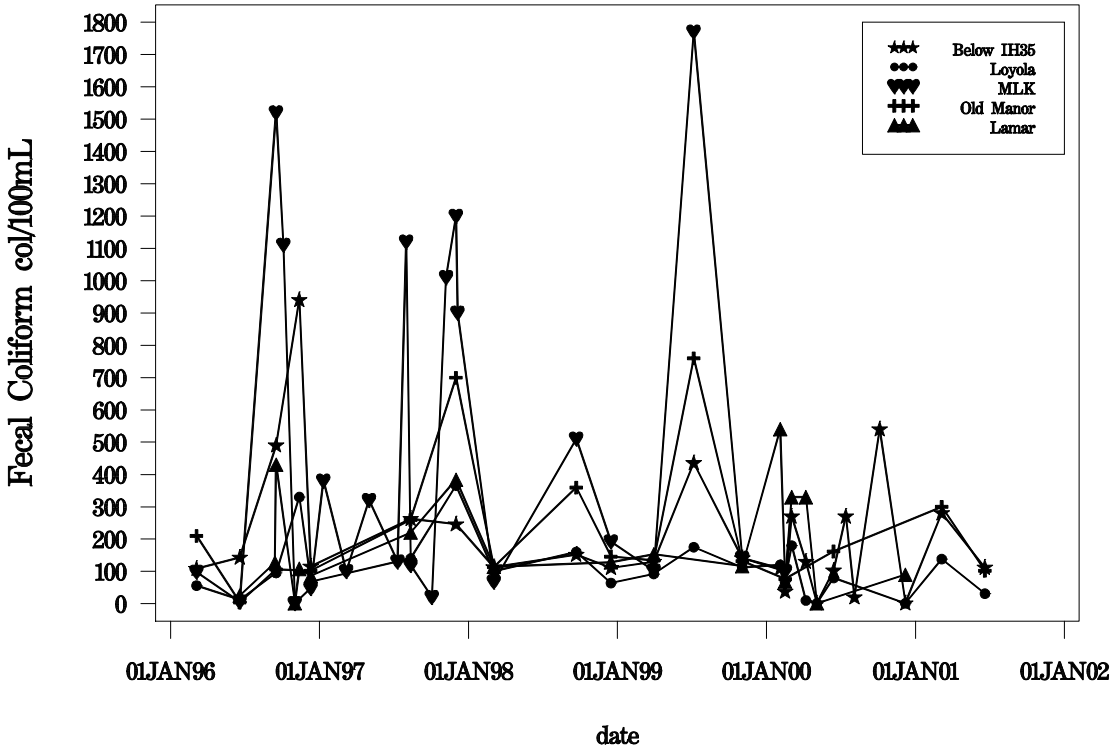
III. Trend Analysis 1996-2001

COA baseflow data from five of the six site from 1996-2001 was plotted. Data from the Railroad Bridge site was not included in these plots or analyses. Regression analysis was used to determine if a significant change over time had occurred. Significant trends are identified in the table below, followed by the time series plots.

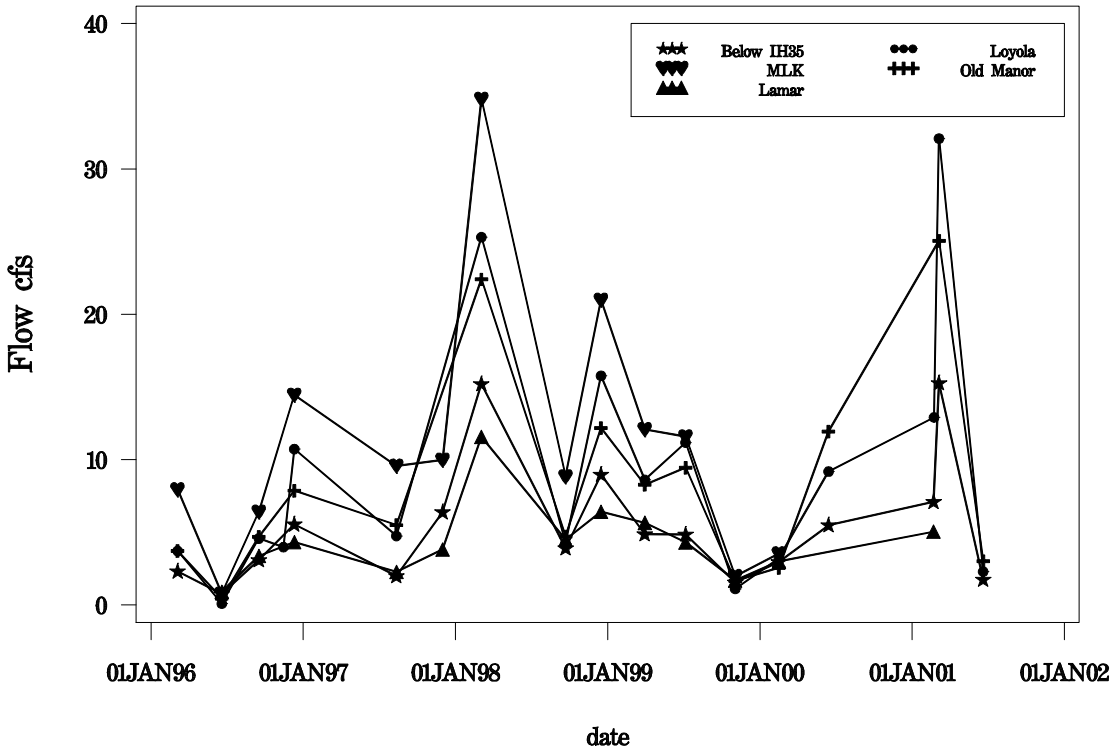
Significant Trends during Baseflow

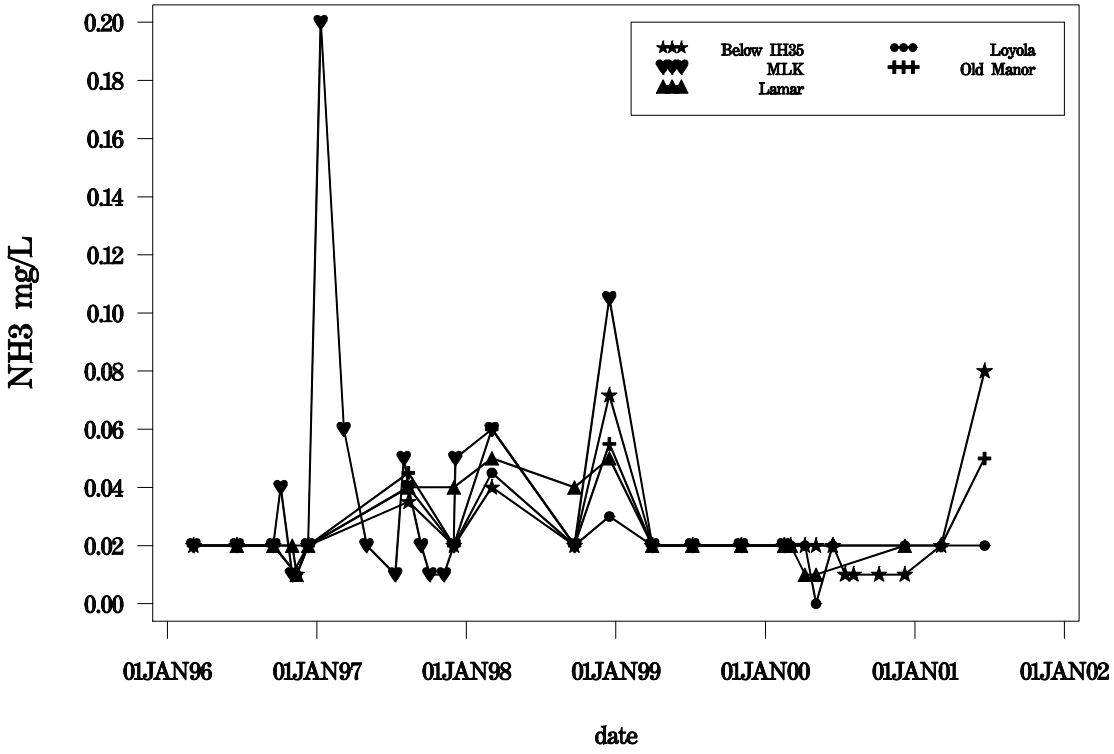
Parameter	Comments on which sites are different
Orthophosphate	Decreasing trend at Lamar, IH35 and MLK
Total Kjeldahl Nitrogen	Decreasing trend at IH35, Loyola, and MLK
Total Phosphorus	Decreasing trend at Lamar and IH35, increasing at Old Manor and Loyola
Total Suspended Solids	Increasing trend at IH35 and Old Manor

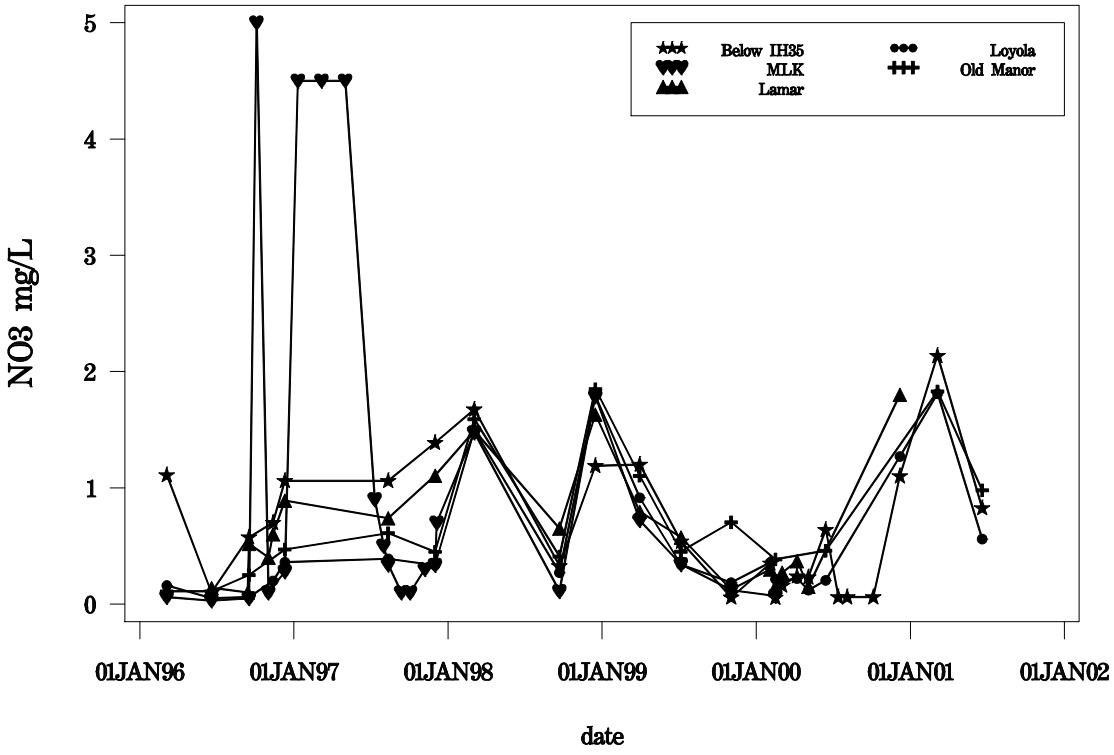


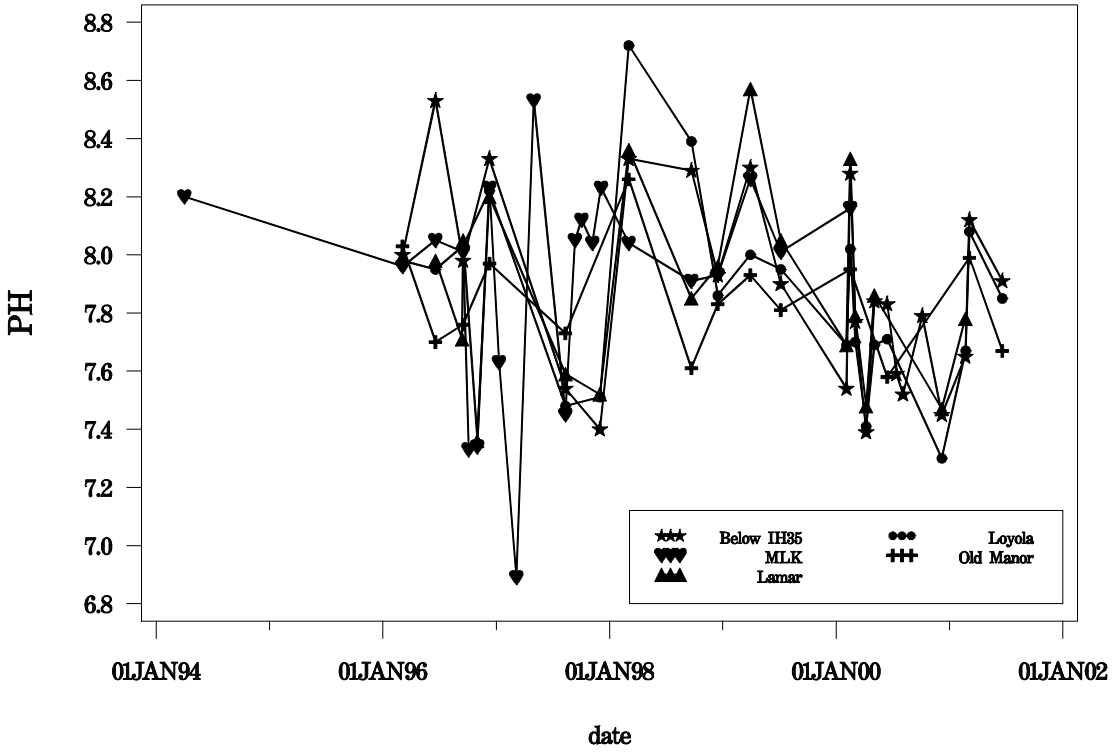


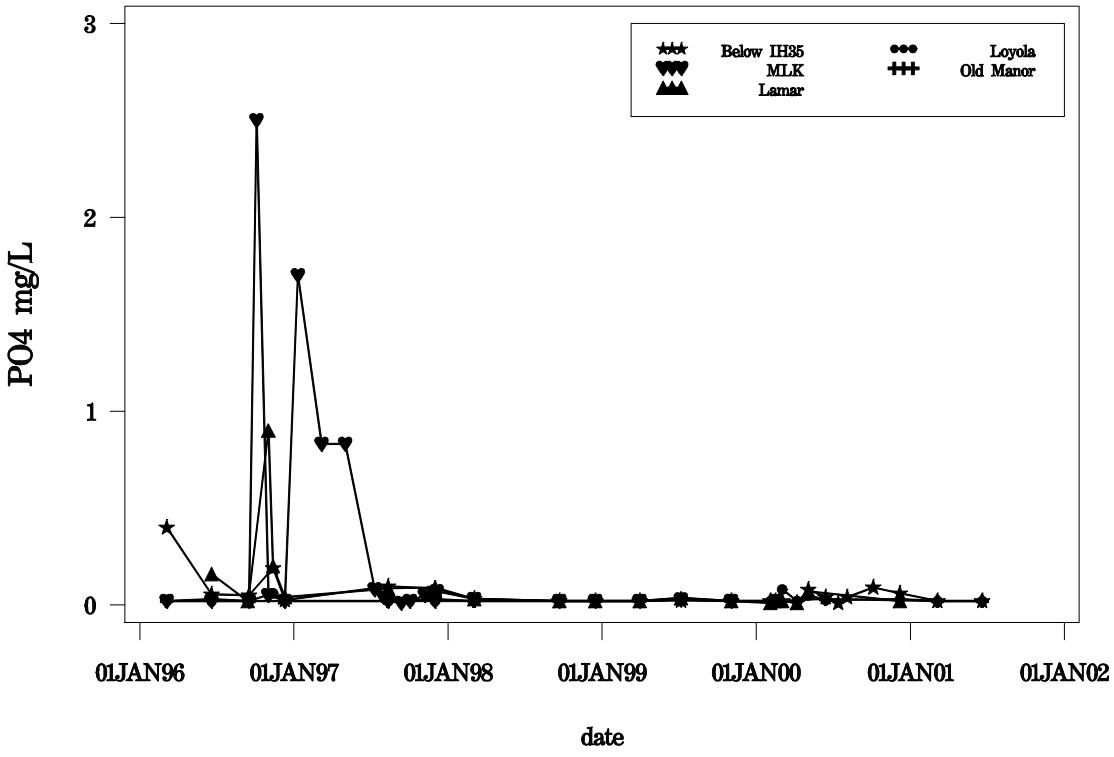
USGS data not used. Data at the Railroad Bridge not used.



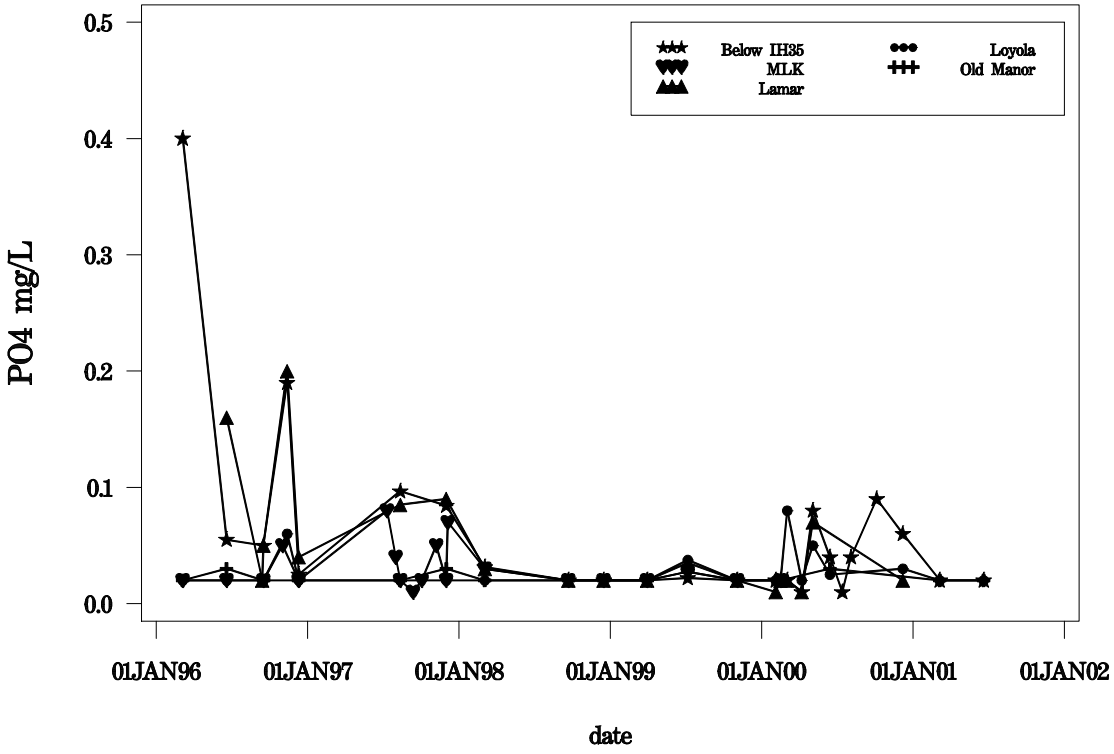

NH3 mg/L
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Below IH35
MLK
Lamar
Loyola
Old Manor
01JAN96
01JAN97
01JAN98
01JAN99
01JAN00
01JAN01
01JAN02
date

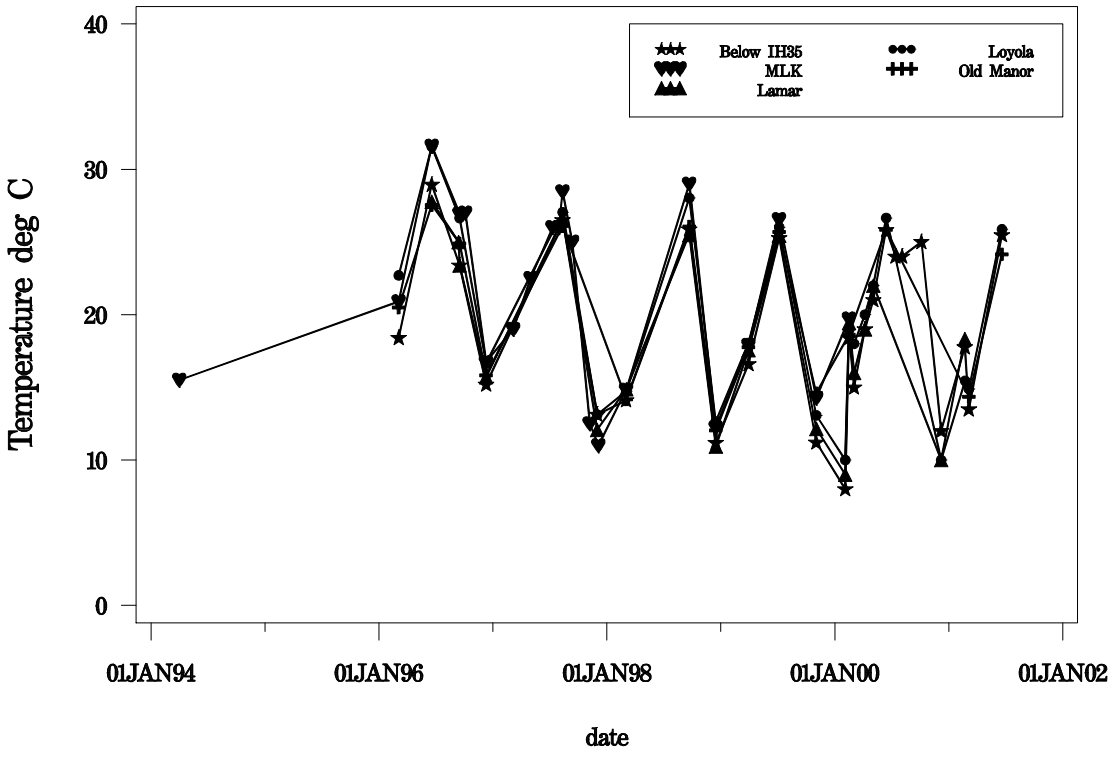

NO3 mg/L
5
4
3
2
1
0
Below IH35
MLK
Lamar
Loyola
Old Manor
01JAN96
01JAN97
01JAN98
01JAN99
01JAN00
01JAN01
01JAN02
date

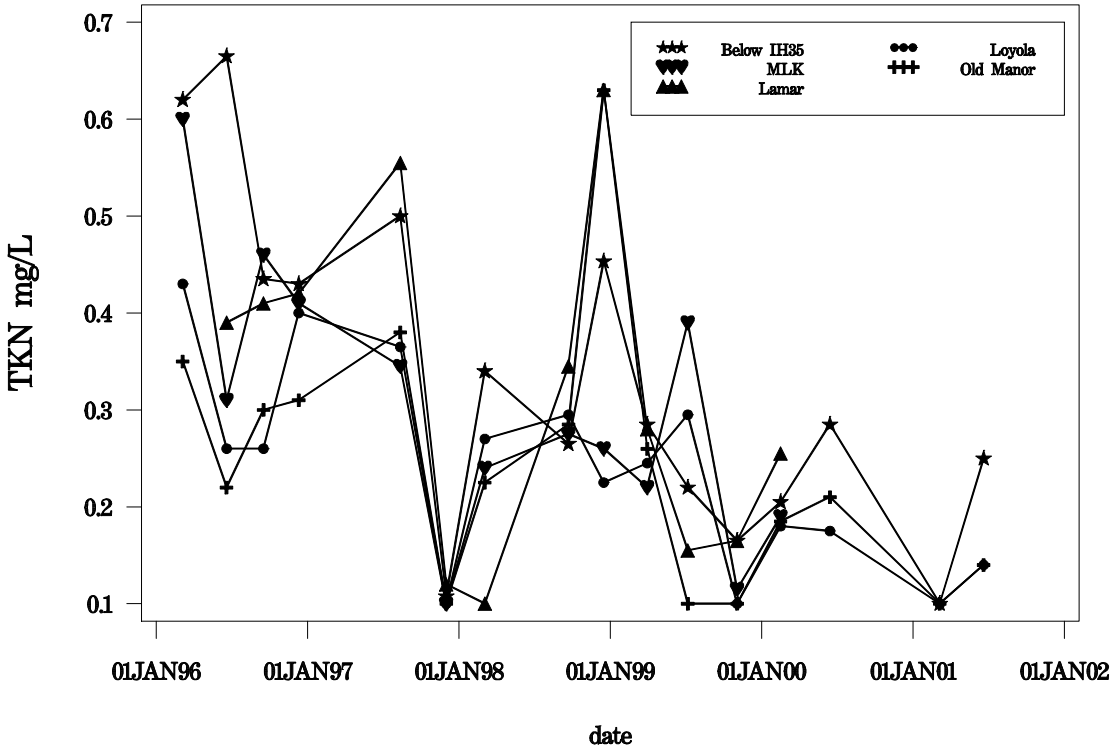




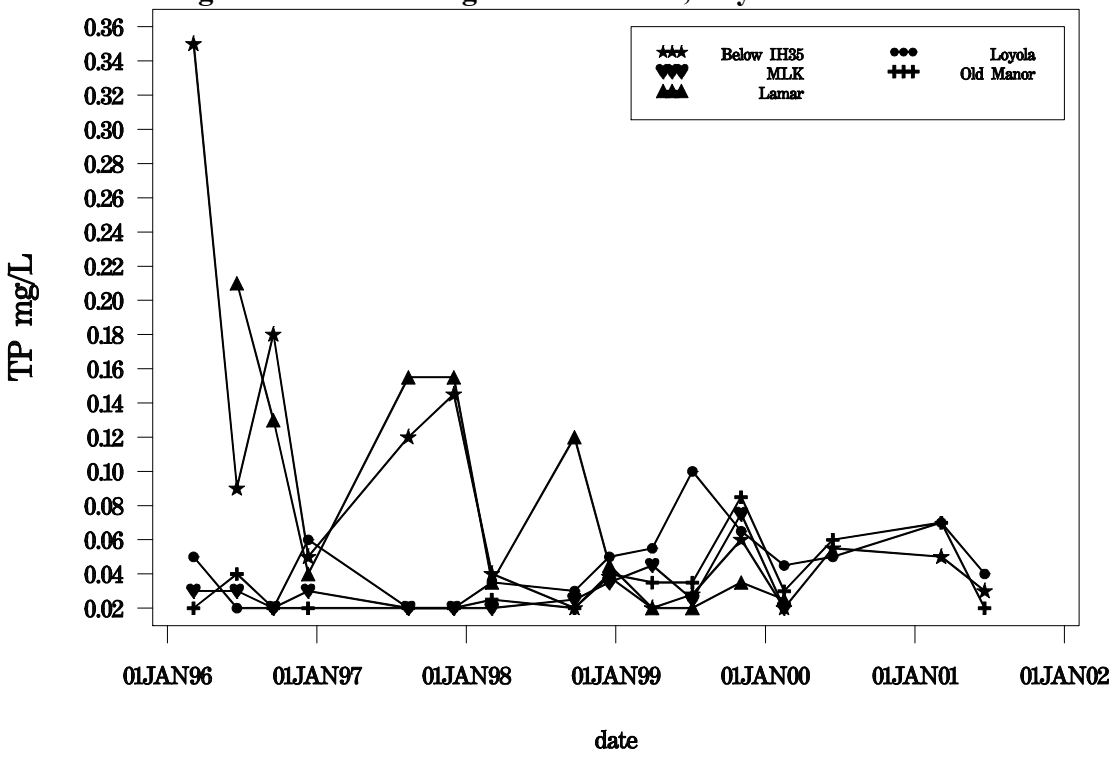
Significant Decreasing Trend at Lamar, IH35 and MLK


PO4 mg/L
0.5
0.4
0.3
0.2
0.1
0.0
Below IH35
MLK
Lamar
Loyola
Old Manor
01JAN96
01JAN97
01JAN98
01JAN99
01JAN00
01JAN01
01JAN02
date

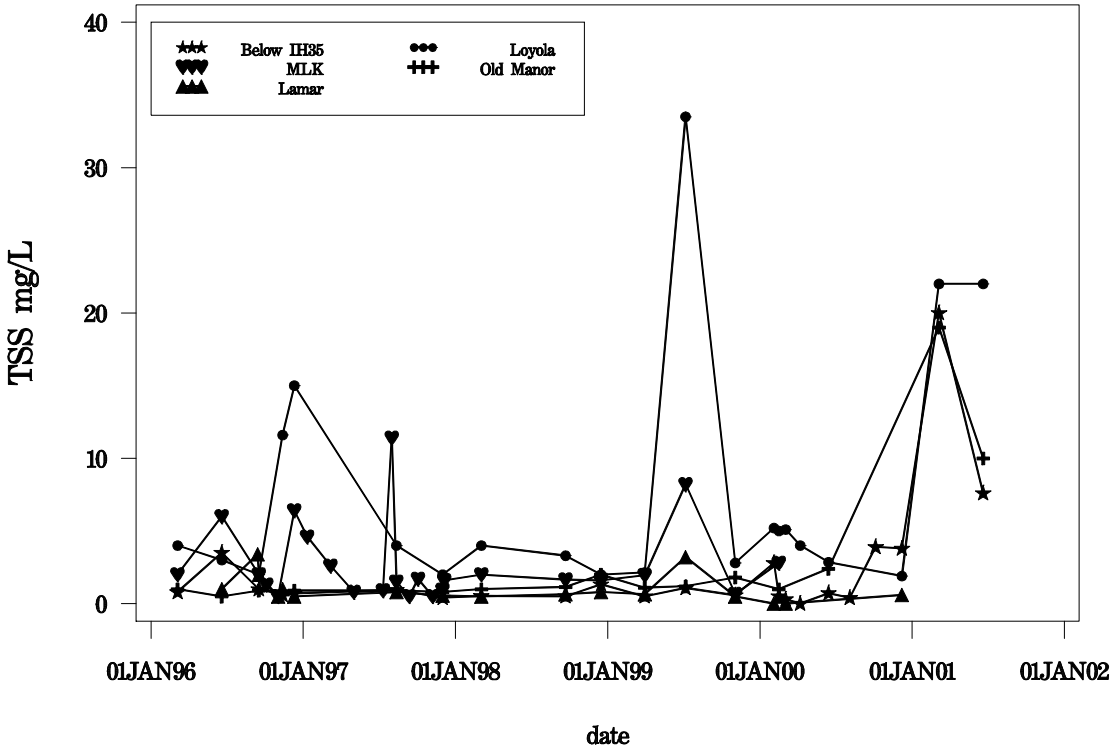

Temperature deg C
40
30
20
10
0
Below IH35
MLK
Lamar
Loyola
Old Manor
01JAN94
01JAN96
01JAN98
01JAN00
01JAN02
date



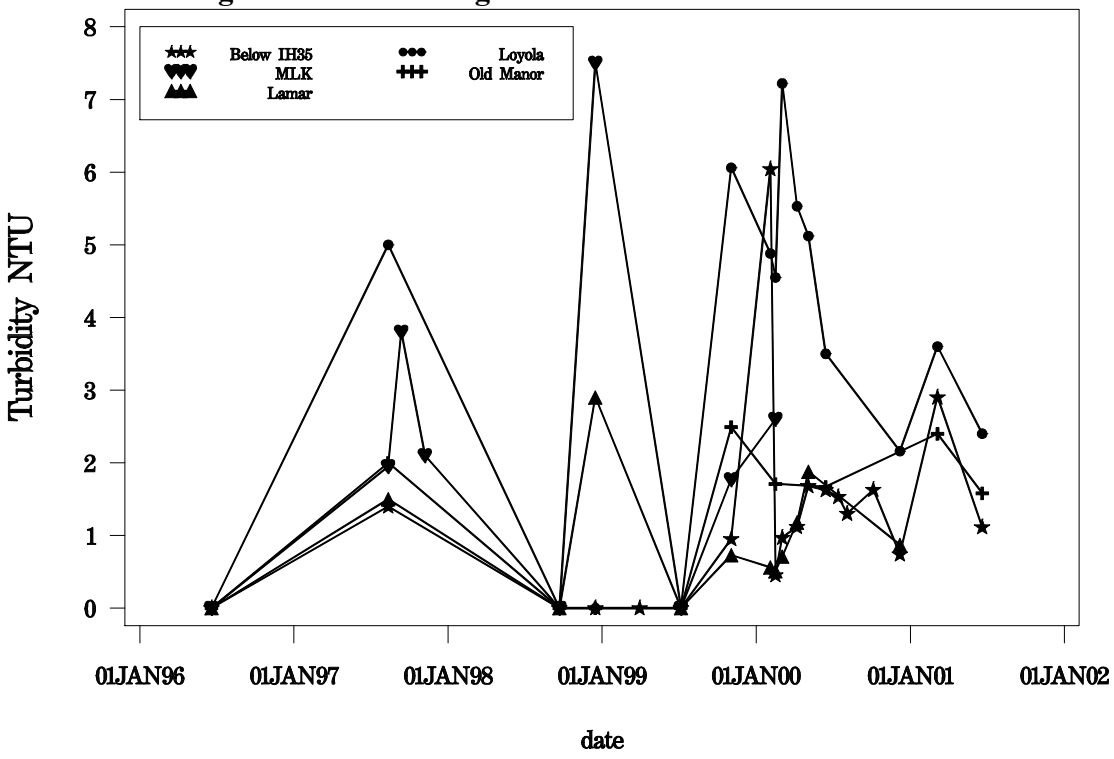
Significant Decreasing Trend at IH35, Loyola and MLK



Significant Decreasing Trend at Lamar, IH35, Increasing at Old Manor and Loyola



Significant Increasing Trend at IH35 and Old Manor

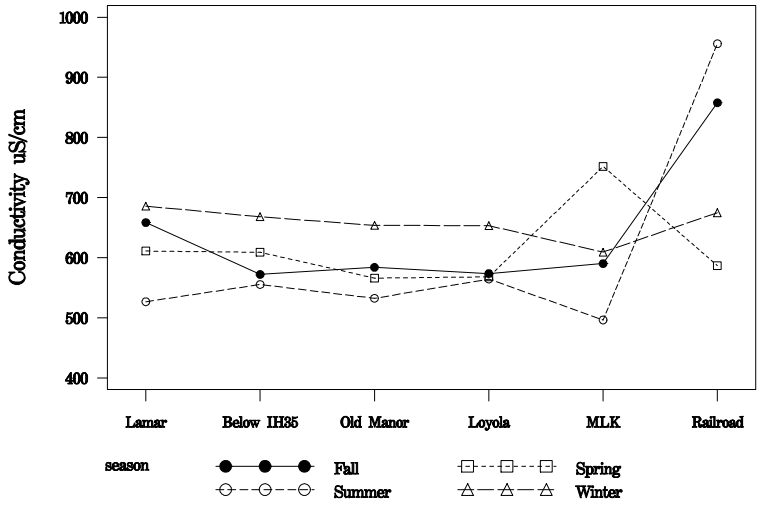


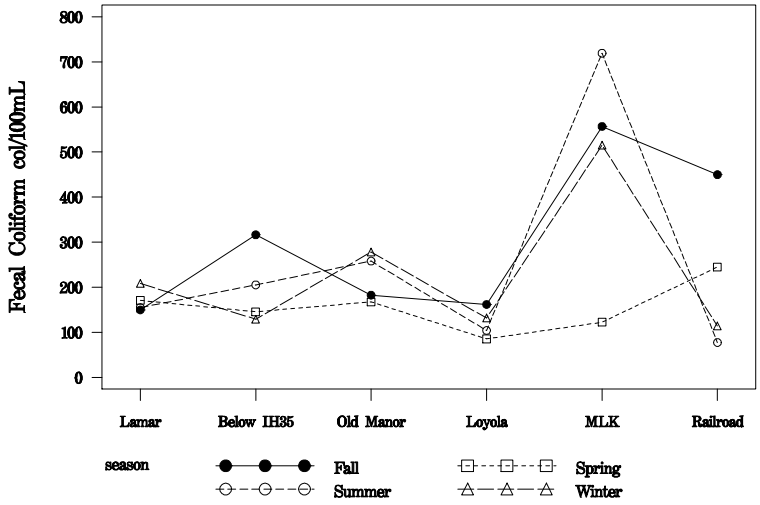
IV. Seasonal Differences

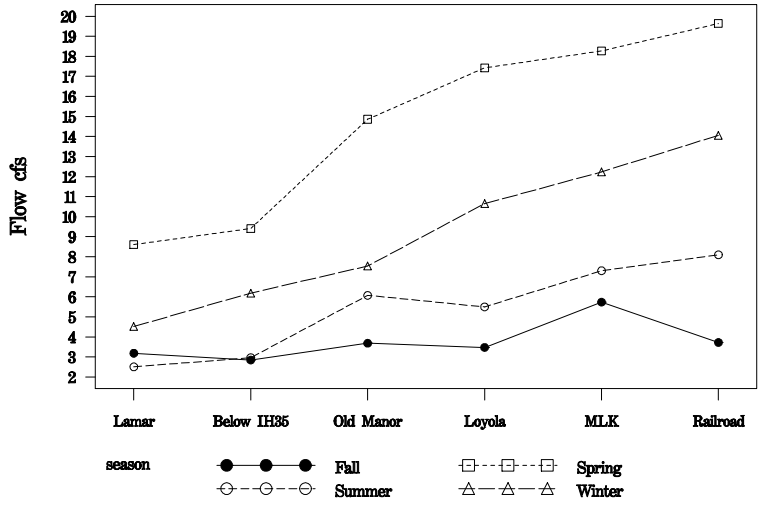
The data was divided in two four seasonal groups: Winter (December-February), Spring (March-May), Summer (June-August), and Fall (September-November). The six sites with the most data were investigated using analysis of variance to find significant seasonal differences during baseflow conditions. Duncan's method was used to tell which seasons were different.

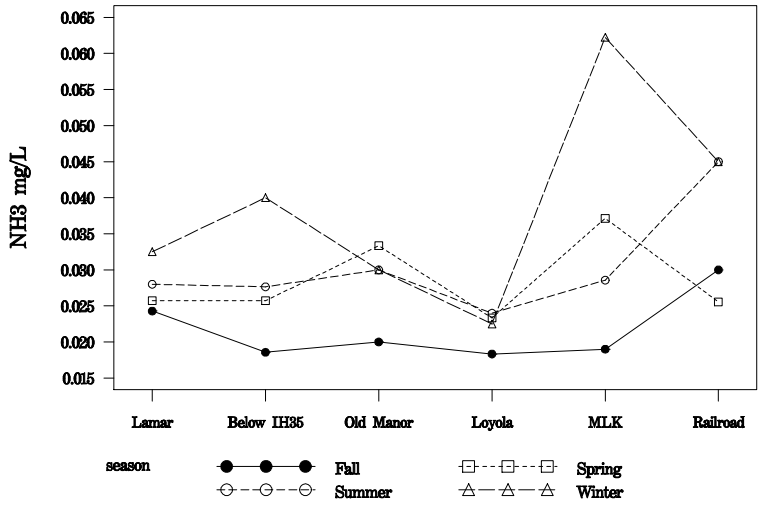
Significant Seasonal Differences during Baseflow

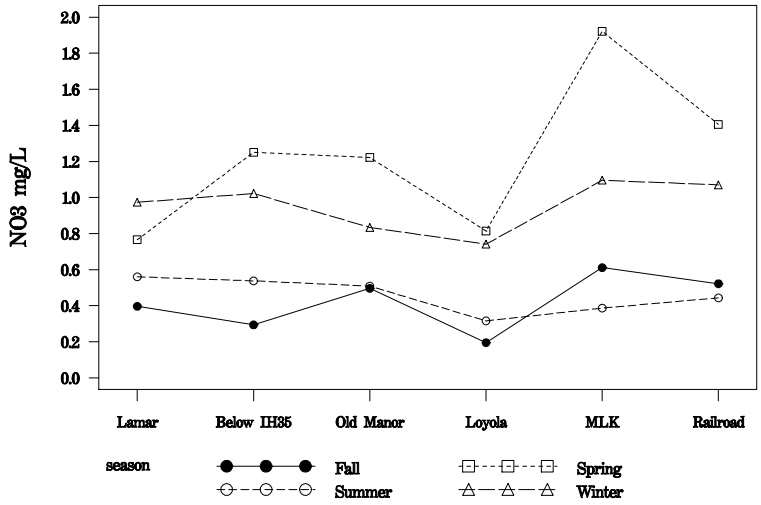
Parameter	Pr>F	Comments on which sites are different
Flow	<0.0001	Spring > Winter & Summer > Summer & Fall
Ammonia	=0.0234	Winter&Summer&Spring>Summer&Spring&Fall
Nitrate	<0.0001	Spring&Winter > Summer&Fall
Temperature	<0.0001	Summer>Fall>Spring>Winter

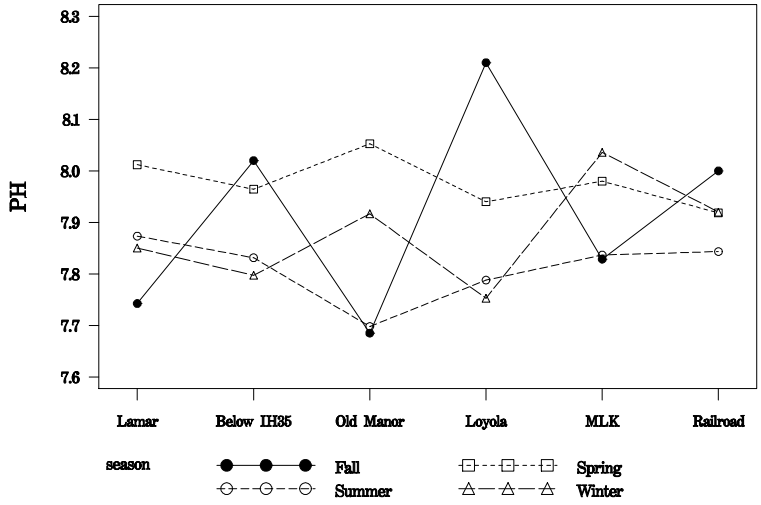


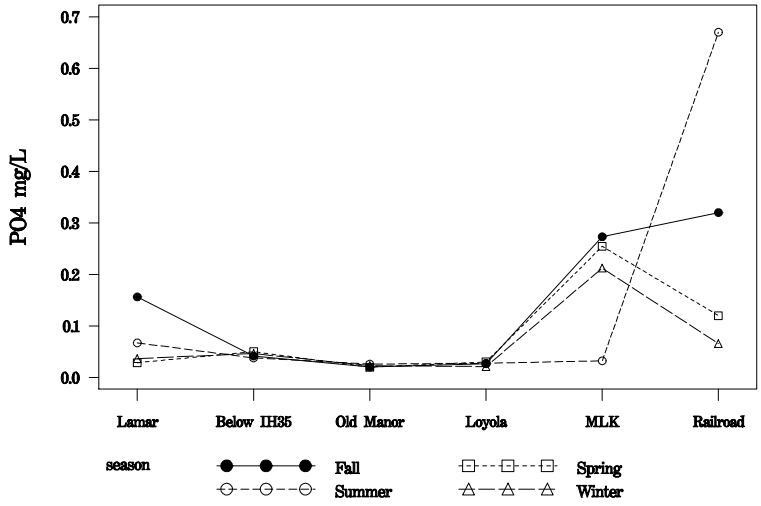


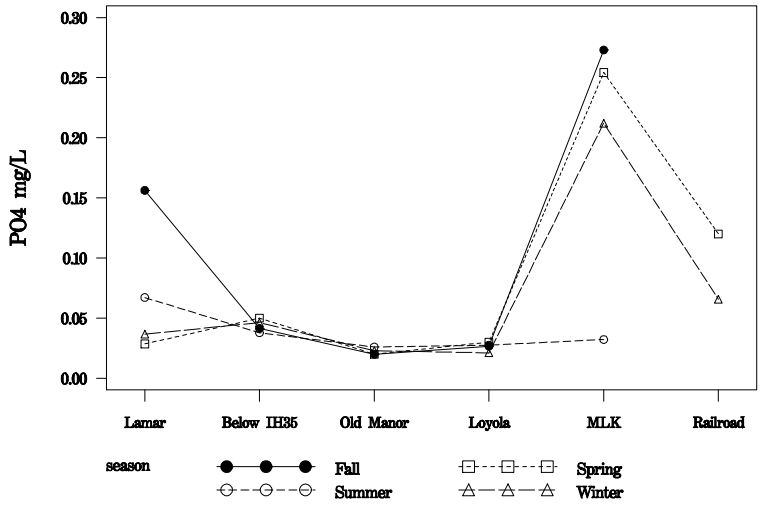

Flow cfs
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter

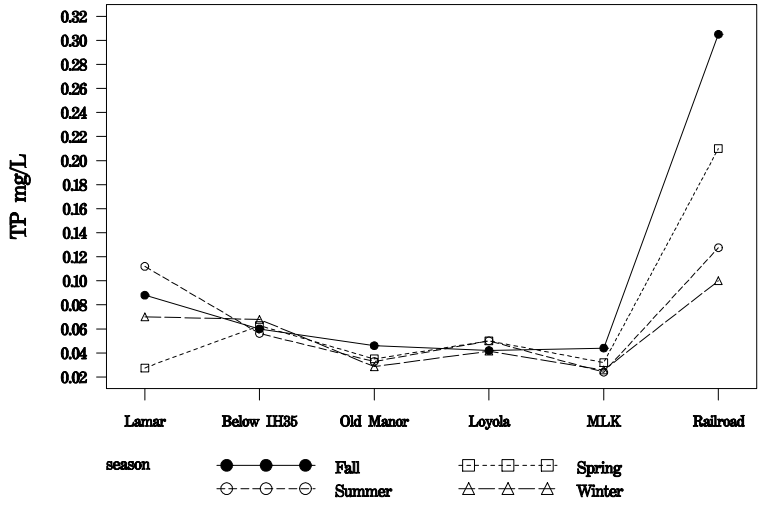

NH3 mg/L
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter

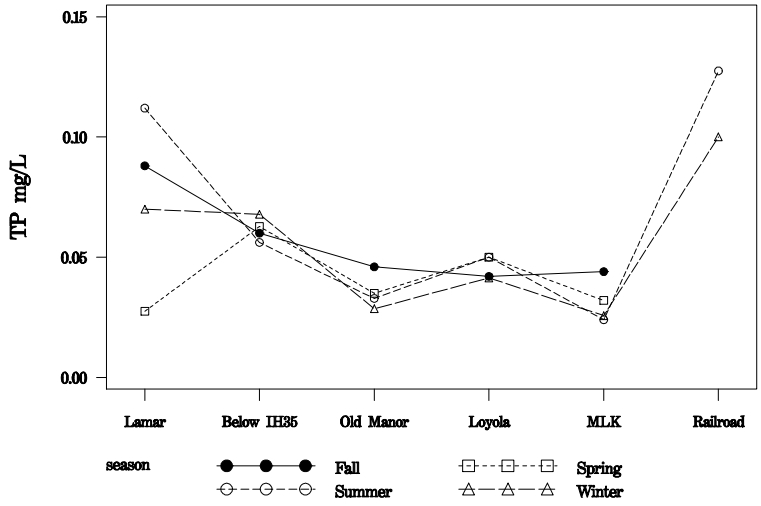

NO3 mg/L
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter

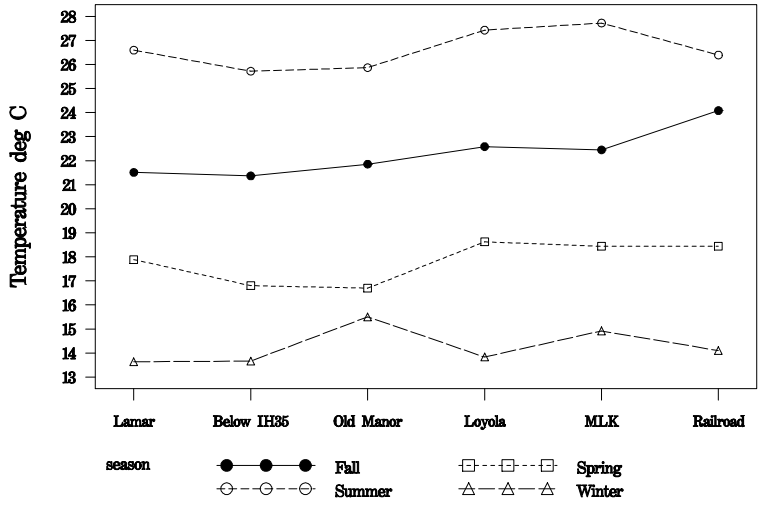

PH
8.3
8.2
8.1
8.0
7.9
7.8
7.7
7.6
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter

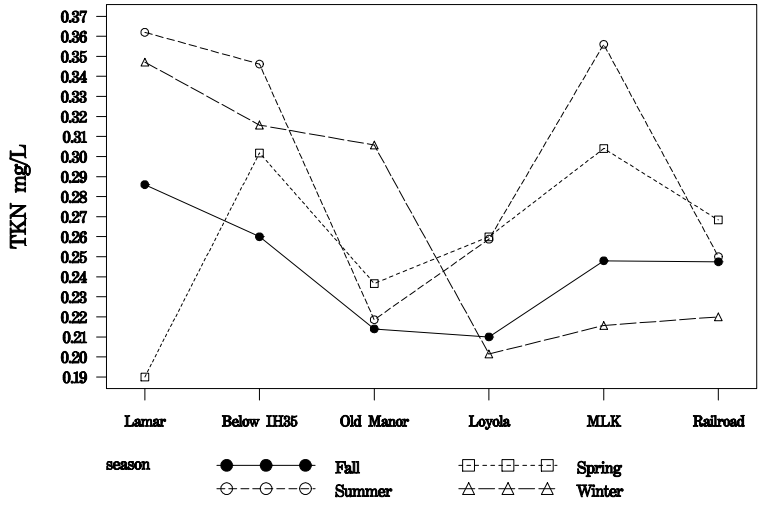

PO4 mg/L
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter

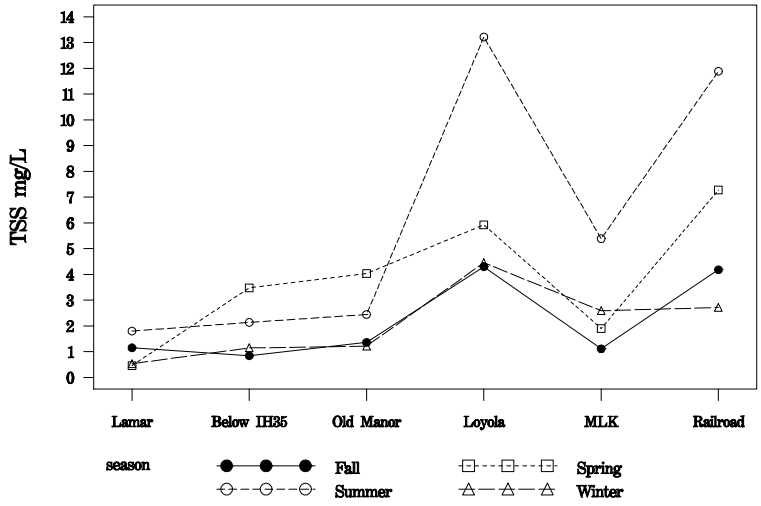

PO4 mg/L
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter

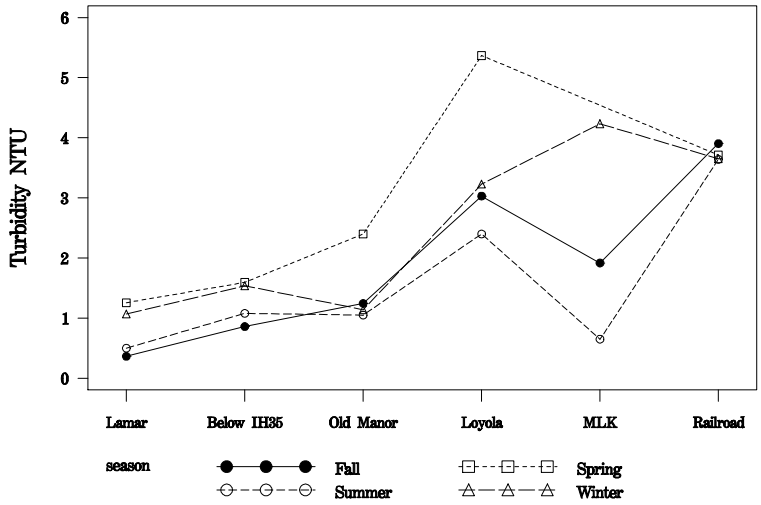

TP mg/L
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter


TP mg/L
0.15
0.10
0.05
0.00
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter


Temperature deg C
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter

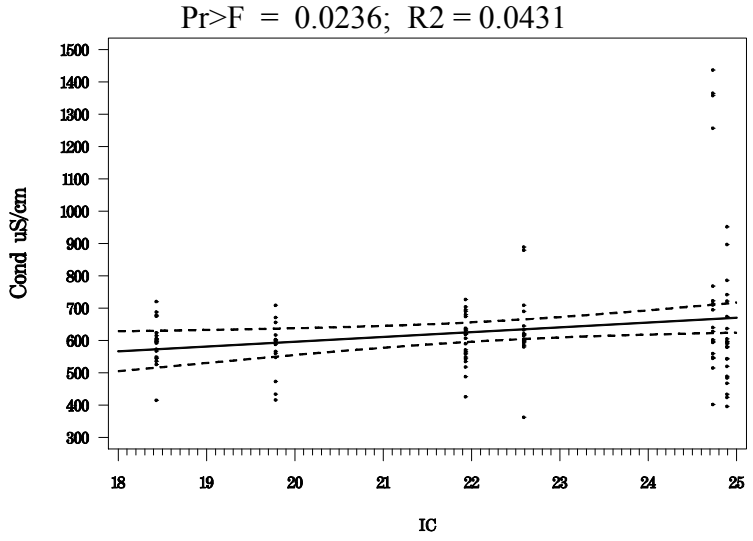

TKN mg/L
0.37
0.36
0.35
0.34
0.33
0.32
0.31
0.30
0.29
0.28
0.27
0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.19
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter

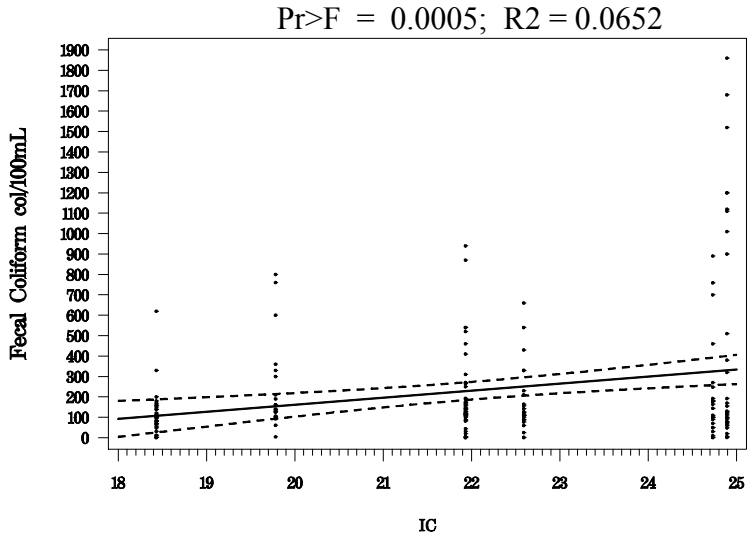

TSS mg/L
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter


Turbidity NTU
6
5
4
3
2
1
0
Lamar
Below IH35
Old Manor
Loyola
MLK
Railroad
season
Fall
Spring
Summer
Winter

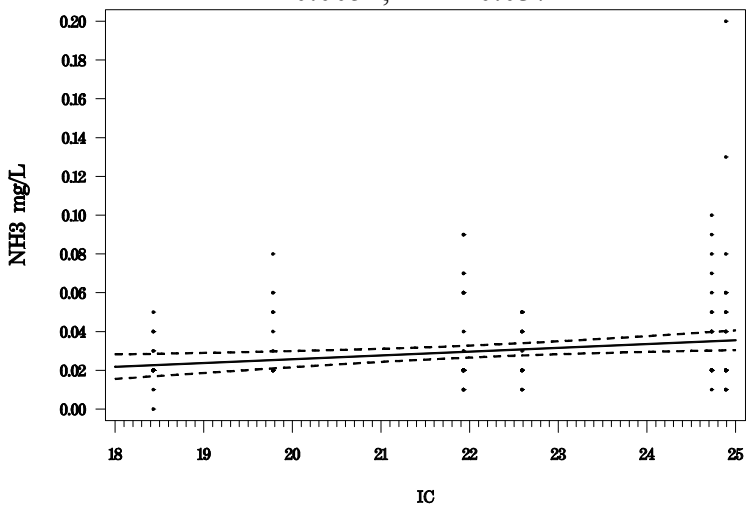
V. Relationships with Impervious Cover

Regression analysis was used to determine if there was a significant relationship between water quality parameters and impervious cover. For six parameters, conductivity, fecal coliform bacteria, ammonia, nitrate, orthophosphate, and total phosphorus, the regression slope was significantly different from zero. However the r-squares were all less than 0.07. Obviously many other factors affect constituent levels. Plots showing the regression line and confidence limits on the means are shown below.

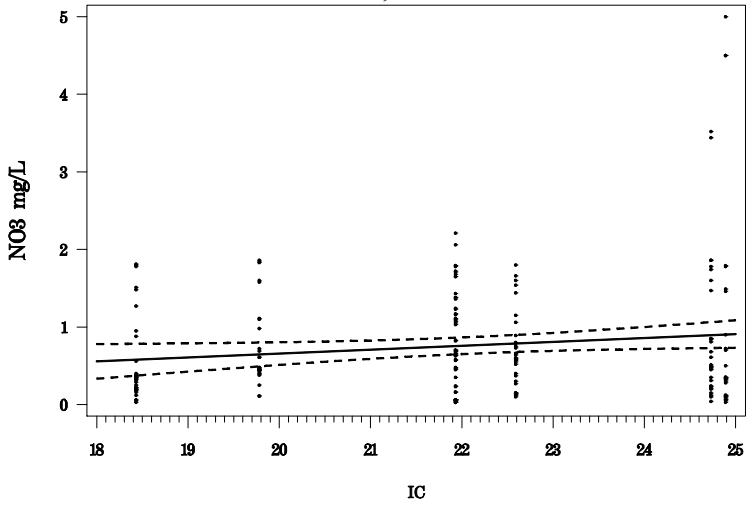




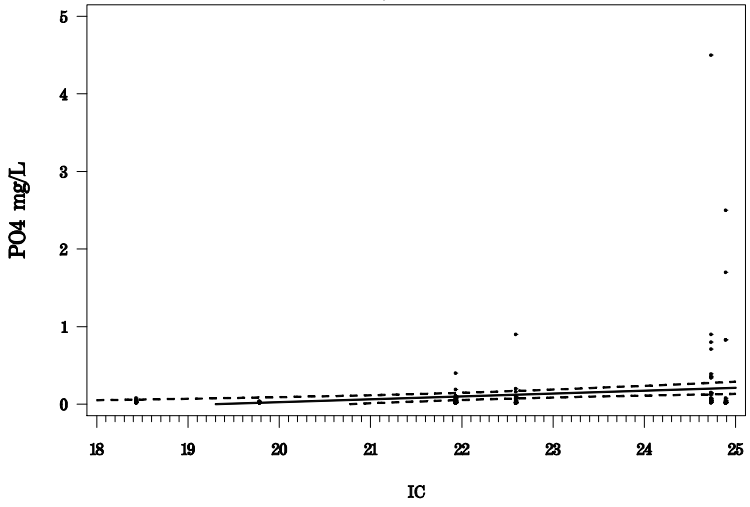
Pr>F = 0.0054; R2 = 0.0372



Pr>F = 0.0405; R2 = 0.0190



Pr>F = 0.0008; R2 = 0.0476



Pr>F = 0.0013; R2 – 0.0629