2013 Stream Assessment-Centerville Creek

Final Report

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Partners

The Centerville Creek project is collaboration between the UW-Manitowoc Biology Department, Lakeshore Natural Resource Partnership, and Friends of Hika Bay. This partnership formed in 2010 to develop a science-based water quality monitoring and assessment program involving watersheds in southern Manitowoc County. This program progressed throughout the summers 2011, and 2012 and has continued into the summer of 2013 in order to collect further data after the completion of the restoration project.

Background

The work of 2010, and 2011 focused on gathering baseline data for Centerville Creek before restoration began happening within the mill pond area in 2012. The research project continued into the summer of 2013 after restoration was complete in order to collect further data on the watersheds contribution to pollutants entering Lake Michigan. Centerville Creek was the site of a historic mill pond, and although the mill pond dam was removed in 1996, years of sediment buildup have affected the creeks water quality poorly. This in turn, poorly affects the aquatic life sustainable within it. In addition, the creek empties into Lake Michigan near Hika Bay, which routinely has high levels of *E. coli* (*Escherichia coli)* and *Cladophora* contamination. The goal of 2010 and 2011, which has now carried over for a fourth year to 2013, was to collect baseline data on physical, chemical, and biological parameters in Centerville Creek which will be used in making decisions regarding the creek restoration and management. . Restoration on Centerville Creek began in summer 2012; this included removing large amounts of sediment from the creek, as well as the invasive species surrounding the creeks banks.

As an institution with undergraduate education as a primary objective, UW-Manitowoc promotes and develops undergraduate research as a key component in their biology program. Biology professors Rick Hein and Rebecca Abler worked with LNRP and Friends of Hika Bay to create a student internship in which I, the student intern, had primary responsibility for data collection and analysis under faculty supervision. As in both of the summers 2011, and 2012, I was given the opportunity to continue summer research in the summer of 2013 to collect water quality data of Centerville Creek from May, 2013 to August, 2013.

In 2010 data was collected from a total of five collection sites established along Centerville Creek (figure 1). As of summer 2011, two extra sampling locations were added to the upper north branch of Centerville Creek (figure 2) allowing for four sampling sites (CE07, CE08, CE09, and CE04) to be upstream of the former mill pond. The three sampling locations used in 2010, located in the area of the sediment build in the former mill pond were used this year as well. The first of the mill pond sample locations (CE03) was at the confluence of the two branches. The fifth sampling location (CE02) was midway between the confluence and the location of the former dam, placing it approximately in the middle of the former mill pond area. The final sampling site (CE01) was at the location of the former dam which had been removed in 1996. As research continued into 2012, three more sites were added to the sampling sites of Centerville creek. Two sites were added along the south branch of the creek, (CE05, and CE06) ensuring a larger data set for possible south branch contribution, while one site (CE10) was added upstream along the north branch in efforts to better determine the significant contributor of pollutants along the north branch of Centerville Creek. Each site, as in previous summers, was sampled weekly for the following physical, chemical, and biological parameters: water temperature, pH, stream velocity, turbidity, ammonia nitrogen, phosphate, conductivity, dissolved oxygen, and *E. coli.* Sampling methodologies followed water quality assessment standards, and are available in Appendix A.

Major Findings

Averages for all parameters across all sampling locations are provided in Table 1. (Appendix B) The data analyzed from the three consecutive summers of research indicated that all parameters showed variation across all sampling locations. As seen in previous sampling seasons, phosphate, ammonia, and *E. coli* levels consistently exceeded normal levels for surface waters. The dissolved oxygen levels, which would typically be expected to be low in these types of circumstances, were well within the normal accepted range. Stream velocity was generally low throughout the north branch of the creek, but would occasionally increase due to major rain events, this is consistent with the previous sampling season's data. However, a difference in that data on stream velocity in the summer of 2013 from the data of both previous summers suggests that stream velocity slowed at the confluence of the two branches of the stream and would regain velocity within the former mill pond area. Stream velocity would then pike within the area of the former dam (see Appendix B, graphs). This year's data on turbidity is consistent with the data of the previous summers. The turbidity was generally higher across the north sampling locations, starting at North Washington (CE10) (figure 2). Turbidity would then typically decrease at the confluence of the North and South branches, being lowest along the South branch sampling locations. An increase would then be seen again throughout the former mill pond area. This year's data continues to show a trend seen within the two previous year's data on the matter of phosphates decreasing within the former mill pond area, while dissolved oxygen levels increased (Appendix B). Average *E. coli* levels this year were above the surface water threshold set by the BEACH Act (1,000 MPN/100ml) at all sampling points. The North Branch continues to appear to be a significant contributor to high *E. coli*, phosphate, and turbidity in Centerville Creek (Appendix B). *E. coli* contamination does not appear directly correlated to nutrient levels.

Discussion and Broader Impacts

North Branch Contribution to Pollution

The North Branch of Centerville Creek consistently showed high levels of phosphate, conductivity, turbidity, and *E. coli* compared to the South Branch. (Appendix B). A difference that should be acknowledged between the data of 2011 and both summers of 2012, and 2013 would be the Mid-Point sample site within the mill pond area. At this sample point, in 2011, phosphates would typically spike and then drop off again after passing through the Mid-Point. For two consecutive summers this spike was not seen within the mill pond area, this can be attributed to the little rain received over the last two summer sample seasons. The consistently high levels regularly exceeded environmental and health standards for surface waters. At the confluence, it seemed as if the mixing of these water masses diluted certain contaminants such as phosphates, and *E. coli*; however, these levels were not brought into normal range at any point along the sampling transect. Therefore, it appears that significant contamination sources exist along the North Branch, upstream of our South Branch sampling sites. Since Centerville Creek empties into Lake Michigan, this may be a significant source of beach contamination near Hika Bay. Because we see high turbidity, conductivity, and phosphate, we hypothesize that surface runoff into the creek is a likely source of these contaminants. However, since *E. coli* levels are not specifically correlated to nutrient pollutant levels, we cannot determine whether they come from the same source.

In the sampling season of 2013, a single, isolated spike in both ammonia nitrogen, as well as *E. coli* data was noticed that raised some further concern in regards to the north branch Washington St. sample site. On August 27th, 2013, samples were routinely collected from all sampling locations and the results that came back from most of the sites were typical of those seen in the dry conditions of late august. However, one site in particular CE10 (north branch Washington) returned results exceedingly higher than those of any other site that day in both ammonia nitrogen and *E. coli*. The results from these samples on August 27th, 2013 were higher than that of even the average of the summer for this site in relation to ammonia nitrogen and *E coli*. (Appendix C.) To better understand what would cause a spike so severe, further investigation into north branch contribution is needed.

Mill Pond Reclamation Management Implications

One of the main concerns regarding Centerville Creek was that years of sediment buildup impeded creek flow and contributed to nutrient pollution in the creek. However, now that this sediment has been removed during the restoration, the creek will still need time to recover from the years of pollutant intake it has endured. The data collected throughout the three consecutive summers of sampling, spanning from 2011-2013, indicates that upstream sources, particularly along the North branch, are significant pollution contributors. However, the mill pond sediment cannot be ruled out as a compromising factor in Centerville Creek, considering the high phosphate levels seen within the mill pond area. With the removal of this sediment in the millpond area during the summer of 2012, continued sampling seasons of collecting data, including data taken after rain events, must take place in order to develop a more accurate understanding of the creek's ecology and how the restoration has benefitted the creek's overall water quality.

Differing from the summer of 2012, in the 2013, stream velocity data indicates that velocity decrease at confluence (CE03) of the two branches, while picking up velocity throughout the mill pond, and spikes highest by the time the stream reaches the former dam (CE01). Nutrient pollution levels were higher than maximum acceptable levels prior to entering the mill pond. However, turbidity increased slightly between confluence (CE03) and the dam barrier (CE01) sampling points. Dissolved oxygen levels in the stream were good throughout the creek sampling area, and in fact increased significantly within the mill pond.

The improvement of water quality in terms of reduction of phosphates and increased dissolved oxygen suggest that primary production may be occurring in the mill pond. This may be enhanced by the initial decreased velocity in the mid-point (CE02) area. Additionally, there are several pools within the mill pond that may provide a site for primary production to occur. Increased turbidity within the mill pond area could have several causes. Turbidity could be a direct result of sediment runoff into the creek from the mill pond banks. However, increased organismal growth as a result of primary production could also increase turbidity. The increased ammonia nitrogen levels within the mill pond were unexpected; ammonia in streams is generally associated with runoff from agricultural or urban contamination sources.

Since ammonia is volatile, it would be expected to decrease as the stream moves farther from the source. Furthermore, ammonia is readily taken up by producers, and therefore would be expected to decrease with primary production. The increased ammonia levels in Centerville Creek could suggest a source within the mill pond, or could be the result of conversion of other nitrogen species, such as nitrates which entered the creek at an earlier point.

Suggestions for future work

1. In 2011 we responded to the high levels of *E. coli* along North branch by proposing the addition of sample sites for Summer, 2012 further upstream along the North branch of Centerville Creek to determine a) whether Centerville Creek is a likely source of contamination along Hika Bay, b) how significant a contributor to high E. coli contamination is North Branch, and c) the origin of contamination concerning *E. coli* along the North Branch. Sources of this contamination could include, a faulty septic system somewhere along the North Branch, or possibly poorly controlled manure use by farm owners within the area. In the Summer, 2012, we located a problem site along the North Branch of Centerville Creek, this site was the furthest away from the lake, but consistently showed results over the sampling standard of >2419.6 (MPN). In 2013, we were unable to add further sites along the north branch of Centerville Creek. Therefore, our suggestion is to again add sites further upstream beyond this sampling site to try to pin point a specific contributor to the *E. coli* contamination.

2. Due to sediment runoff from the mill pond banks, we propose taking soil samples of the surrounding banks to analyze for nutrient deposits. This will allow us to determine if sediment runoff into the creek is a contributor to nutrient contamination within the mill pond area.

3. The data that has been collected represents the fourth set of data collected from Centerville Creek since 2010. Although all sample seasons have provided valuable data, longer term data sets collected over the course of restoration and beyond are crucial to understanding the actual ecological processes and impacts of restoration measures. Continued support will allow for stronger data sets , increased collaboration across the county, and decision making based on best practices.

4. UW-Manitowoc currently collaborates with UW-Oshkosh to monitor and survey bacterial contamination of beaches in Manitowoc County, including Hika Bay Beach. Because Centerville Creek may be a source of contamination for this beach, we suggest coordinating the Centerville Creek assessment and restoration project with the beach research in order to maximize efficiency of data collected and provide a more comprehensive picture of this watershed.

Figure 1: Satellite image depicting, the sites sampled in summer 2011.

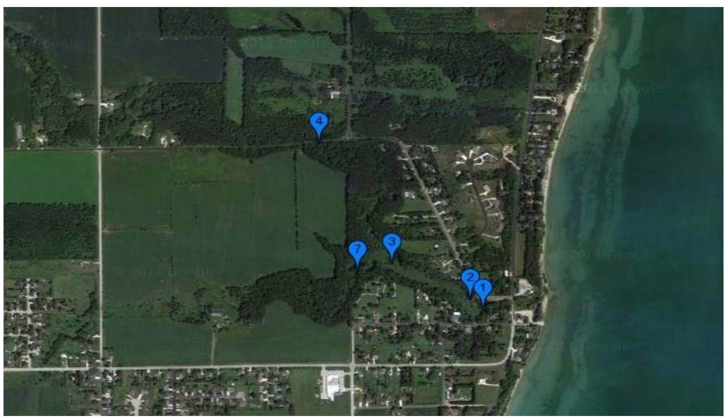


Figure 2: Satellite image depicting, the sites sampled in summer 2012.

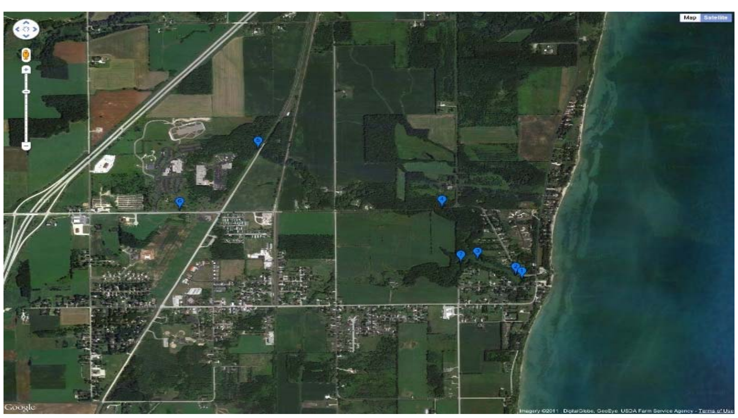


Figure 3: **Satellite image depicting, the sites sampled in summer 2013.**

Appendix A: Sampling Methodologies

Water Quality Parameter	Method
Temperature	Thermometer
pH	Meter
Stream Velocity	Stop Watch/ Tennis ball
Turbidity	Meter
Ammonia nitrogen	Hach test kit
Phosphate	Colorimetric method using Spectrophotometer (ammonium molybdate/stannous chloride method)
Conductivity	Meter
Dissolved oxygen	Winkler titration
E. coli	Colilert method

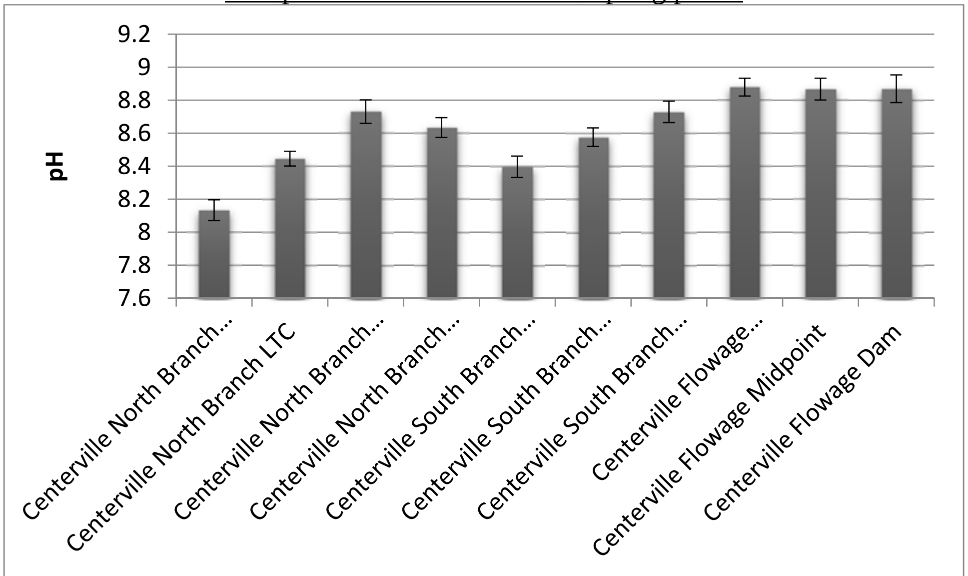
Appendix B: Summer 2011 and 2012 Data

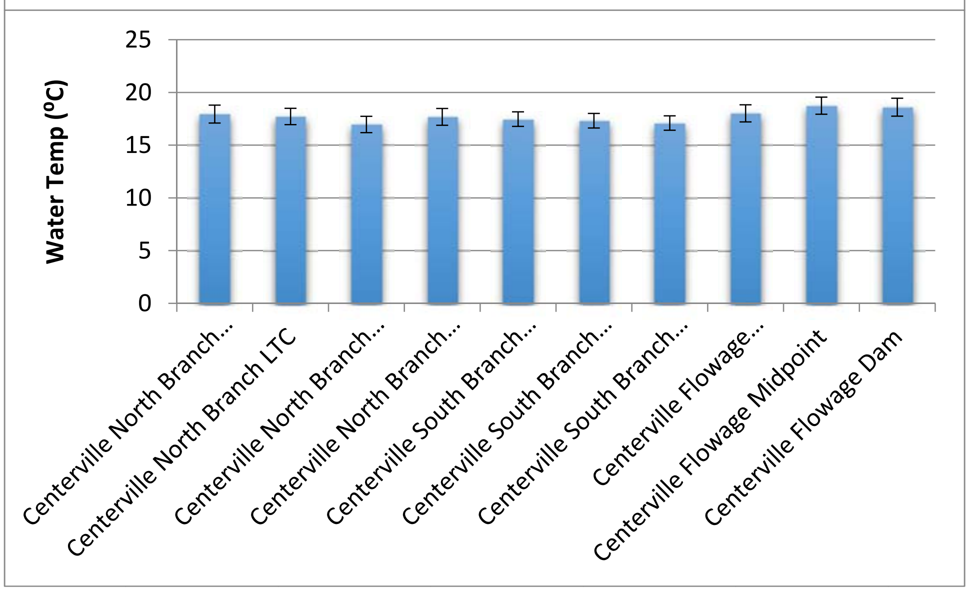
Table 1: Average values for data collected across all sampling points, Centerville Creek

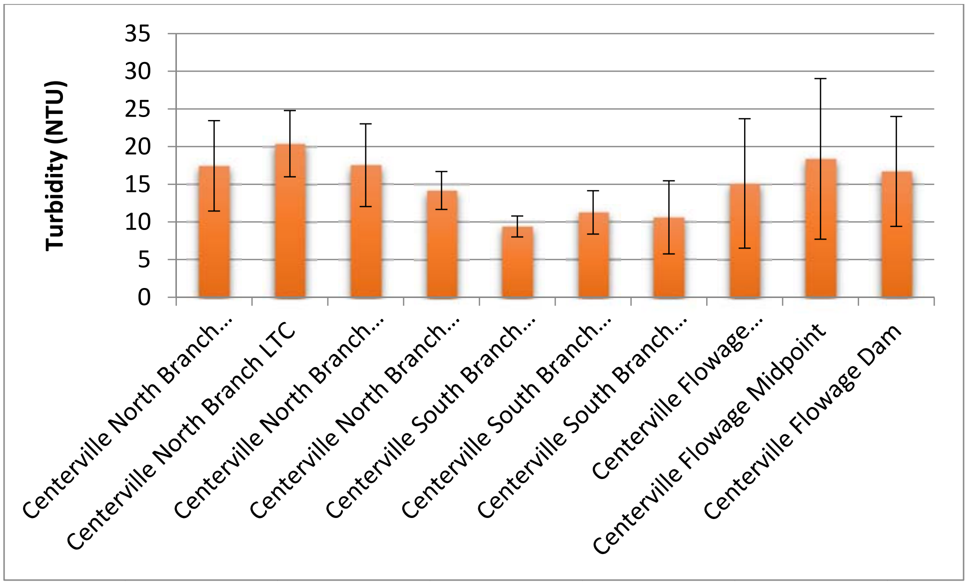
Averages for All Creek Sample Points,	Summer 2011	Summer 2012	Summer 2013	Increase/Decrease Between 2011 and 2012	Increase/Decrease Between 2012 and 2013
Water temperature (°C)	23.1	18.84	17.75154	4.26	1.09
pH	8.5	8.46	8.625923	0.04	0.17
Turbidity (NTU)	29.6	15.44	15.09808	14.16	0.34
Stream flow (M/sec)	30.5*	0.20	0.339231	*	0.14
Conductivity (µS)	836.1	867.42	843.4923	31.32	23.93
Dissolved oxygen (mg/L)	8.43	7.82	8.364077	0.61	0.54
Total Dissolved Phosphate (mg/L)	0.14	0.04	0.064817	0.10	0.025
Total Phosphate (mg/L)	*	0.08	0.15381	*	0.07
Ammonia nitrogen (NH3) (mg/L)	0.06	0.03	0.040075	0.03	0.01
Ammonia nitrogen (NH4) (mg/L)	0.65	0.34	0.371483	0.31	0.03
E. coli (MPN/100 ml)	595.7	1476.606	925.0962	880.906	551.5098

Appendix B, continued:

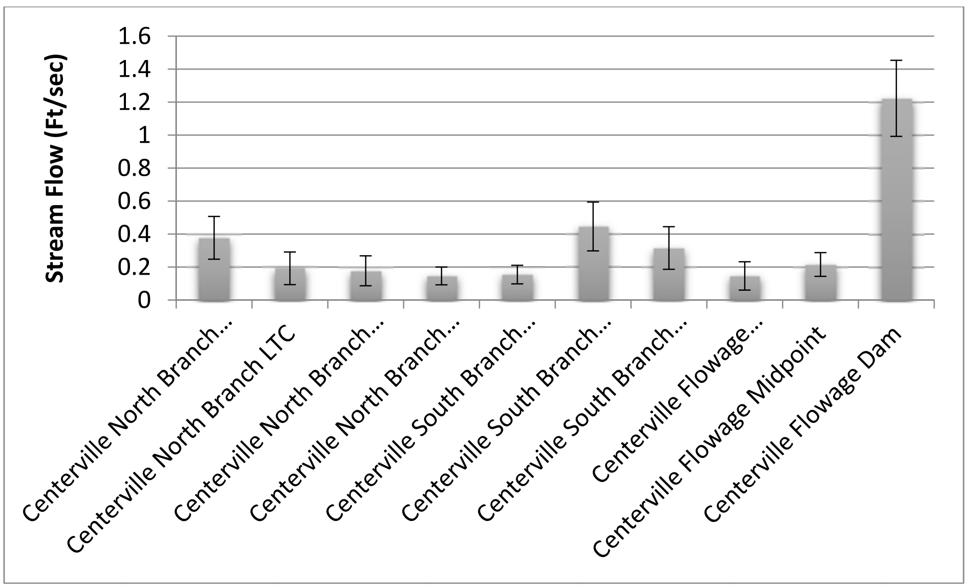
Comparison of data at each Sampling point:



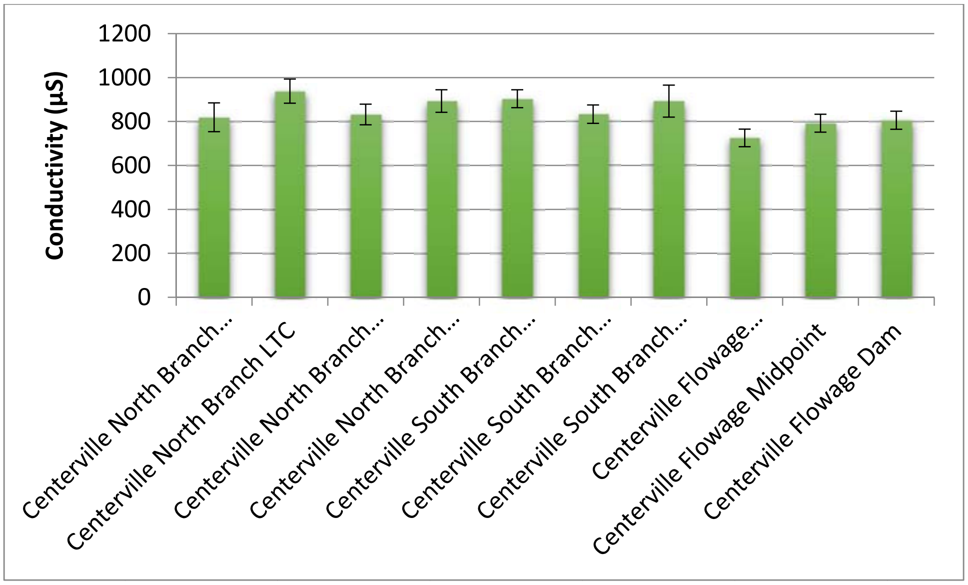


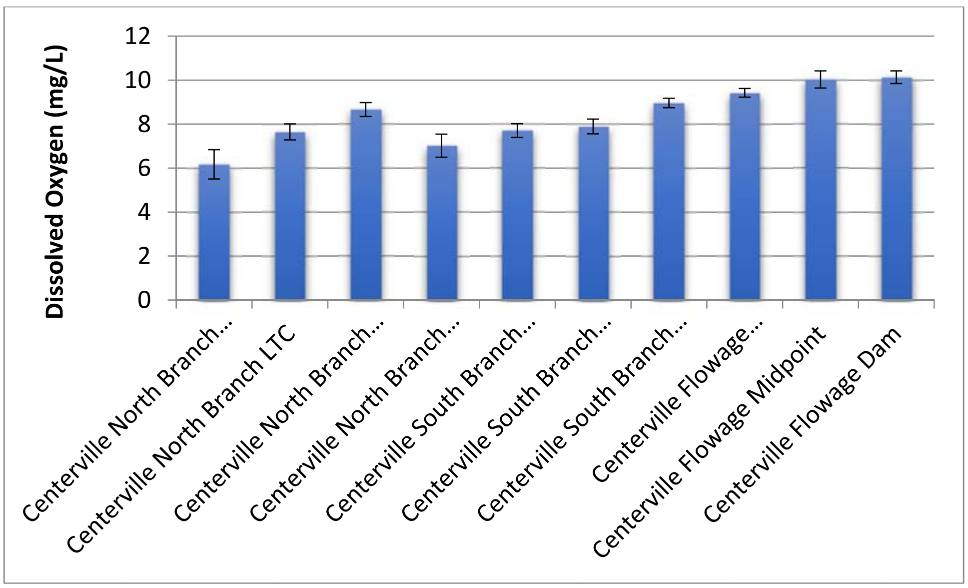


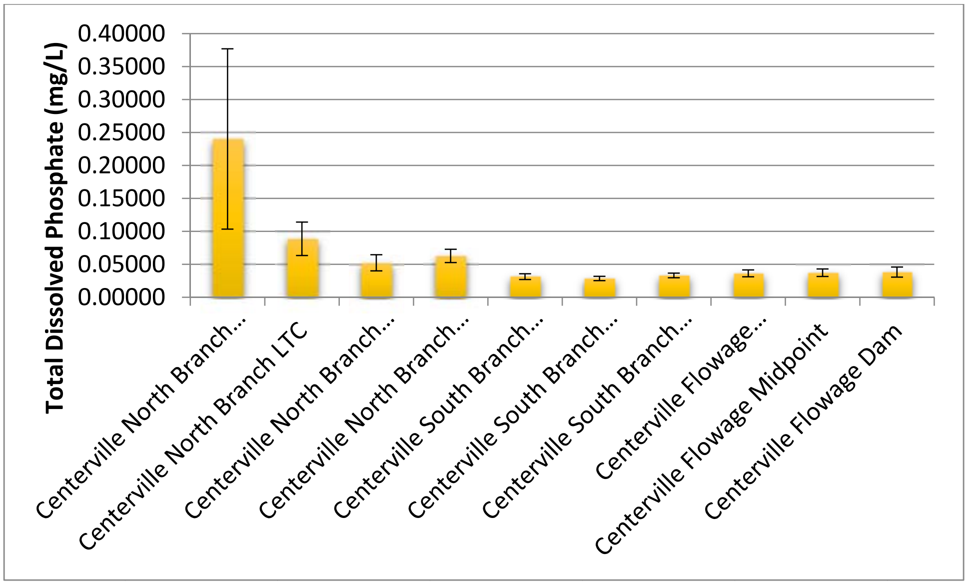
Turbidity (NTU)
35
30
25
20
15
10
5
0
Centerville North Branch...
Centerville North Branch LTC
Centerville North Branch...
Centerville North Branch...
Centerville South Branch...
Centerville South Branch...
Centerville South Branch...
Centerville Flowage...
Centerville Flowage Midpoint
Centerville Flowage Dam



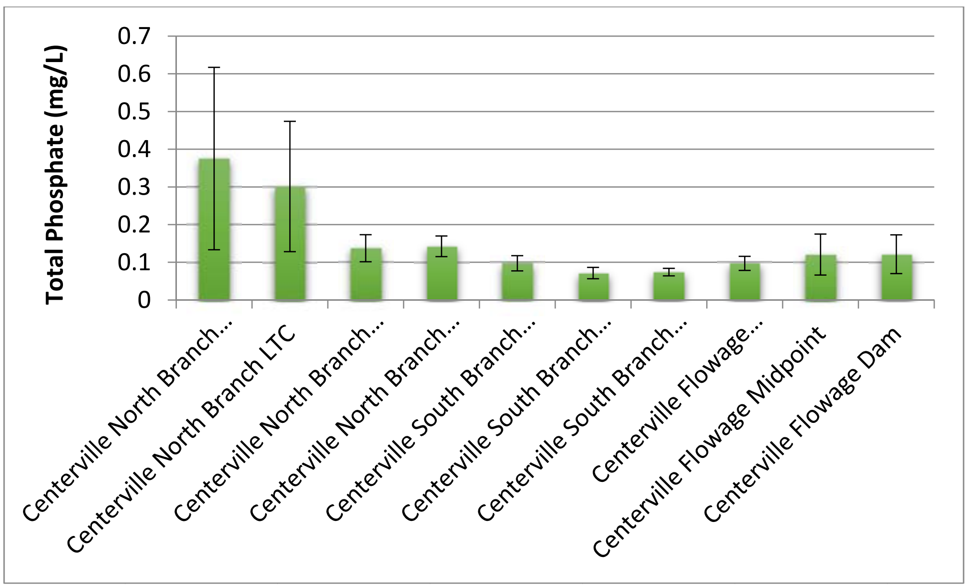
Stream Flow (Ft/sec)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Centerville North Branch...
Centerville North Branch LTC
Centerville North Branch...
Centerville North Branch...
Centerville South Branch...
Centerville South Branch...
Centerville South Branch...
Centerville Flowage...
Centerville Flowage Midpoint
Centerville Flowage Dam


Conductivity (µS)
1200
1000
800
600
400
200
0
Centerville North Branch...
Centerville North Branch LTC
Centerville North Branch...
Centerville North Branch...
Centerville South Branch...
Centerville South Branch...
Centerville South Branch...
Centerville Flowage...
Centerville Flowage Midpoint
Centerville Flowage Dam

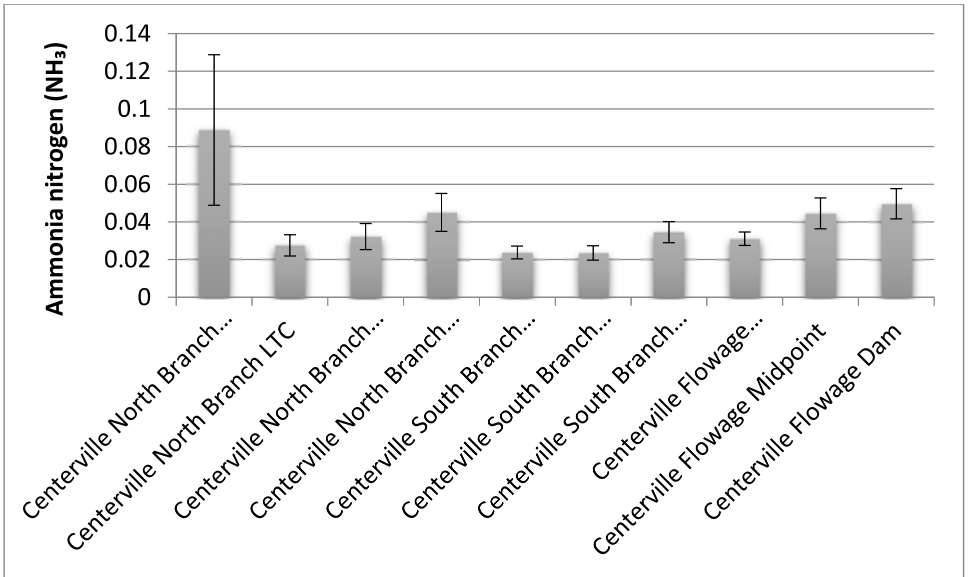

Dissolved Oxygen (mg/L)
12
10
8
6
4
2
0
Centerville North Branch...
Centerville North Branch LTC
Centerville North Branch...
Centerville North Branch...
Centerville South Branch...
Centerville South Branch...
Centerville South Branch...
Centerville Flowage...
Centerville Flowage Midpoint
Centerville Flowage Dam

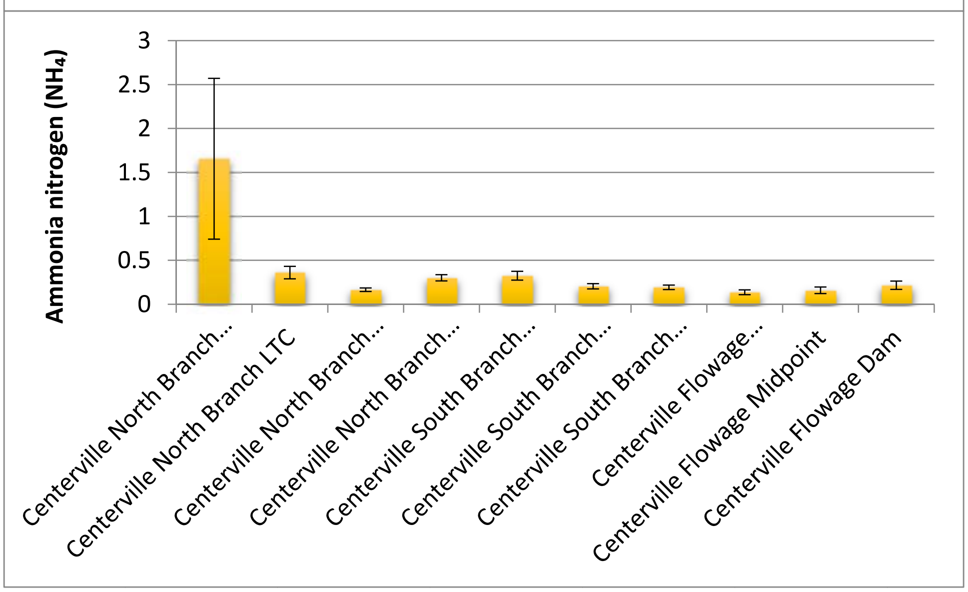


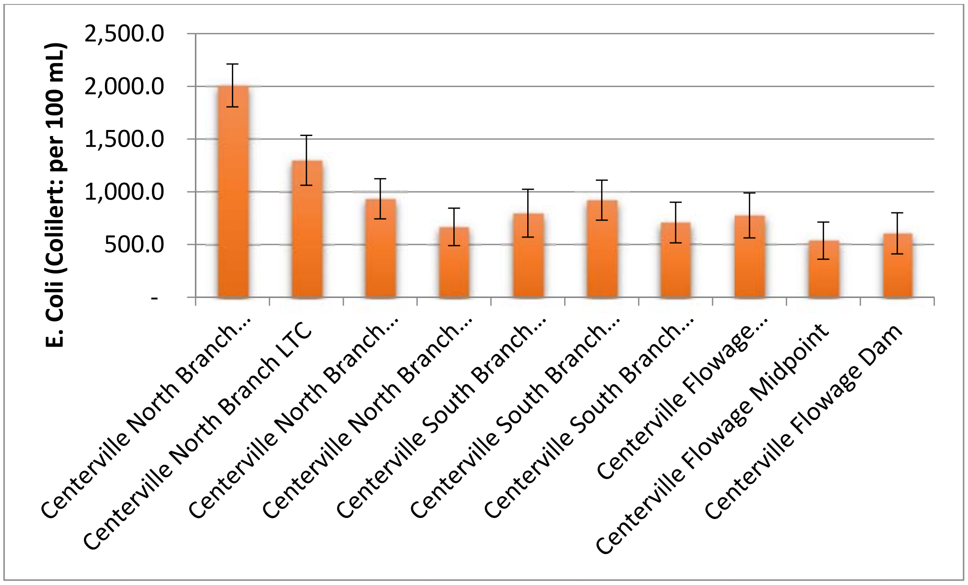
Total Dissolved Phosphate (mg/L)
0.40000
0.35000
0.30000
0.25000
0.20000
0.15000
0.10000
0.05000
0.00000
Centerville North Branch...
Centerville North Branch LTC
Centerville North Branch...
Centerville North Branch...
Centerville South Branch...
Centerville South Branch...
Centerville South Branch...
Centerville Flowage...
Centerville Flowage Midpoint
Centerville Flowage Dam



Total Phosphate (mg/L)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Centerville North Branch...
Centerville North Branch LTC
Centerville North Branch...
Centerville North Branch...
Centerville South Branch...
Centerville South Branch...
Centerville South Branch...
Centerville Flowage...
Centerville Flowage Midpoint
Centerville Flowage Dam

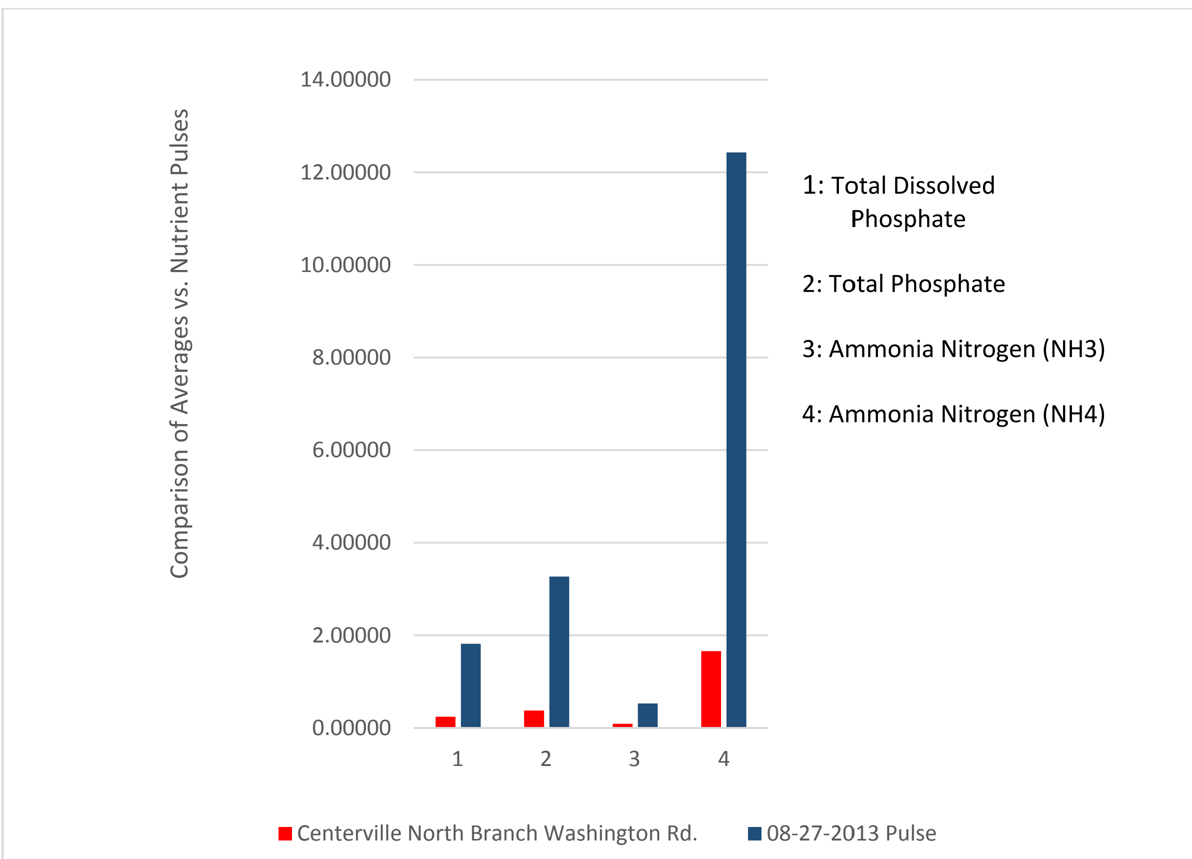

Ammonia nitrogen (NH₃)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Centerville North Branch...
Centerville North Branch LTC
Centerville North Branch...
Centerville North Branch...
Centerville South Branch...
Centerville South Branch...
Centerville South Branch...
Centerville Flowage...
Centerville Flowage Midpoint
Centerville Flowage Dam


Ammonia nitrogen (NH₄)
3
2.5
2
1.5
1
0.5
0
Centerville North Branch...
Centerville North Branch LTC
Centerville North Branch...
Centerville North Branch...
Centerville South Branch...
Centerville South Branch...
Centerville South Branch...
Centerville Flowage...
Centerville Flowage Midpoint
Centerville Flowage Dam



Appendix C:

Comparison of summer 2013 Average vs. August 27th, 2013 nutrient data spike for CE10 sample site:



Appendix C, continued:

Comparison of summer 2013 Average vs. August 27th, 2013 Biological data spike for CE10 sample site: