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NUTRIENT VARIATIONS OF SIX SURFACE WATER BODIES IN MCHENRY COUNTY, IL

A senior thesis written by

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In partial fulfillment of the graduation requirements

For the major in geology

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Abstract

This research analyzes water quality from several rural and suburban ponds in McHenry County, Illinois, with a goal of developing a better understanding of pollution sources and temporal variations in concentrations of nitrate, potassium, phosphorus, chloride, and sodium. Over the past 25 years, the population of McHenry County has grown rapidly, with residential developments expanding into former farmlands. Yet, the county remains heavily agricultural, with roughly 60% of the surface area used for agricultural purposes. With growing concern over pollution of surface water bodies, this research analyzes concentrations of NO_3^-, P^+, K^+, Cl^-, and Na^+ in the surface water sampled from six sites: two in subdivisions, two in farmland, and two in close proximity to major highways. Data were collected once a week from the beginning of June through the end of July, and twice during the first week of November 2016. Data were collected using two methods: the first method involved a color change test with Hach test kits to test for NO_3^- and Cl^- using 5 mL samples that were collected from the edge and surface of each water body. The second method tested for dissolved Na^+, K^+, and P^+. Water samples were collected from the edge and surface of each water body and then pipetted onto filter papers. Filter papers were subsequently dried and analyzed using XRF spectroscopy. The highest concentrations of NO_3^- and Cl^- were 13.2 ppm and 0.4 ppm, respectively, with EPA limits of 10 ppm and 250 ppm, respectively. These highest levels probably correspond to the application of fertilizers in the spring and road salt applied during the winter that are washed into the water bodies. The highest concentrations of Na^+, P^+, and K^+ were 215 ppm, 181 ppm, and 345 ppm of K^+, respectively, compared with EPA limits of 20 ppm for Na^+, 0.05 ppm for P^+, and no limit for K^+. These highest levels probably result from applications of fertilizers and roads salts as well as wastewater from nearby homes with water softeners. With NO_3^-, Na^+, and P^+ being over the EPA

limit for most of the testing period there is cause for concern for downstream pollution as well as pollution of aquifers that recharge locally. Natural occurring P+ ranges from 0.005 ppm to 0.05 ppm, so the high levels of P^+ are of particular concern for ecosystems downstream, as eutrophication processes will increase.

Introduction

Throughout the past decade, geologists have looked at the anthropogenic effects on water quality in different regions of the country. In this study, an analysis was conducted on the anthropogenic effects on the water quality in McHenry County, Illinois, by testing for nitrate, potassium, phosphorus, sodium and chloride at six sites.

The common sources of nitrate, potassium, and phosphorus in surface and groundwater come from soil organic matter, septic and animal waste, and fertilizers. The main source of these nutrients in McHenry County is going to be from the fertilizers from the farm fields. Nitrate is completely water soluble, and the majority of runoff will occur during storm events. Large amounts of sewage disposal and the use of fertilizers since the 1960s have contributed to the amount of nitrate in the surface and groundwater (Hwang, 2015). High levels in drinking water can be can highly dangerous to human health and have been linked to the blue-baby syndrome and stomach cancer. Therefore, it is important to understand the concentration of nitrates in the groundwater and to identify its sources (Hwang, 2015). The EPA has set limits for NO_3^- and P^+ at 10.0ppm and 0.05 ppm, respectively. However, there is no limit for K^+ in drinking water.

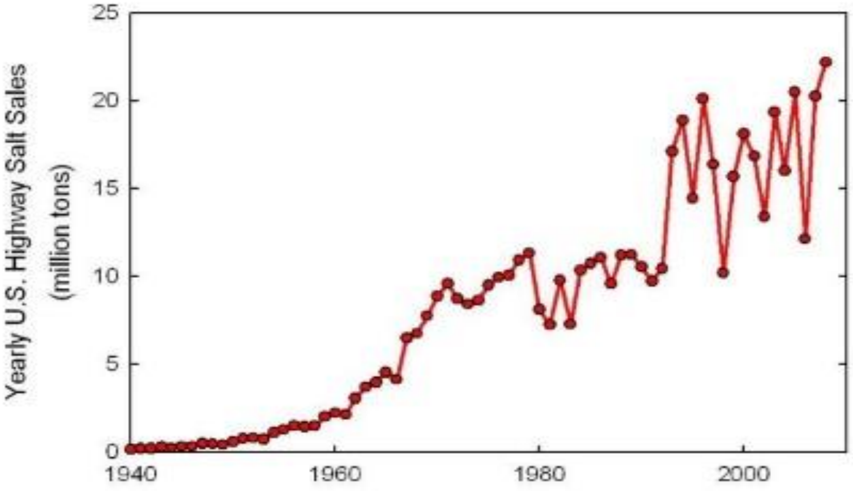

Figure 1. Yearly Highway Salt Sales in U.S. (Kelly, 2012)

Groundwater contamination from sodium and chloride is most associated with urbanization because they are used as a deicer during the winter months. Other sources include leachate from landfills, water conditioning salt, septic waste, and animal waste (Hwang, 2015). Significant amounts of road salt, halite, accounts for three-fourths of the total use in the United States and increased dramatically during the 1960s. During an average winter, over 270,000 tons of road salt is applied to roads in six counties in the Chicago area, including McHenry County (Kelly 2008). It has a positive impact on the safety of driving during the winter but has a larger negative impact on the environment. Chloride salts are highly soluble and end up being transported to water bodies and into the groundwater where most of the drinking water comes from in the Chicagoland region. The EPA has a drinking water standard of 250 ppm for Cl^- and 20 ppm for Na^+. Figure 1 shows the amount of road salt applied since 1940. Just in the last few years, the amount of road salt applied is substantial. There are alternative deicing agents than the use of halite, but these are more expensive, and so it is not economical for a widespread use. Even if the use of halite as a deicing agent were to stop immediately, it would take decades before the chloride concentration returned to pre-1960s levels in shallow groundwater (Woller, 1976). In a study done by Kelly in 2008, the chloride concentrations in wells were linked to distances away from heavily traveled roads. In

McHenry County, average concentrations of chloride were lower in wells a mile or more away from roads. This is something to be expected because it takes longer for the chlorides to reach those wells, versus wells that are closer to highly traveled roads.

Site Description

McHenry County is located in northeastern Illinois; it is west of Lake County and east of Boone County, and north of Kane County. Over the past 25 years, the population of McHenry County has grown rapidly, with residential developments expanding into former farmlands. Yet, the county remains heavily agricultural, with roughly 60% of the surface area used for agricultural purposes. According to the U.S. Census Bureau of 2000, McHenry County experienced the fastest growth rate in Illinois between 1991 and 2000. It also had the seventh fastest growth rate of all Illinois counties from 2001 to 2010. The samples collected are broken down into three categories: subdivisions, farms, and major highways. The six locations of these sites, along with the land use of the county is shown in figure 3.

Geology of McHenry County

During the Quaternary Period, McHenry County was covered by the Illinoian and Wisconsinan glacial episodes. The glacial drift deposits range from 50 feet in the southwestern part of the county and up to 450 feet in the northwest part of the county. Beneath the deposits, the upper bedrock formations range in age from Precambrian to Silurian. It consists mostly of dolomite, shale, and sandstone. Figure 2 portrays the different bedrock formations in the county.

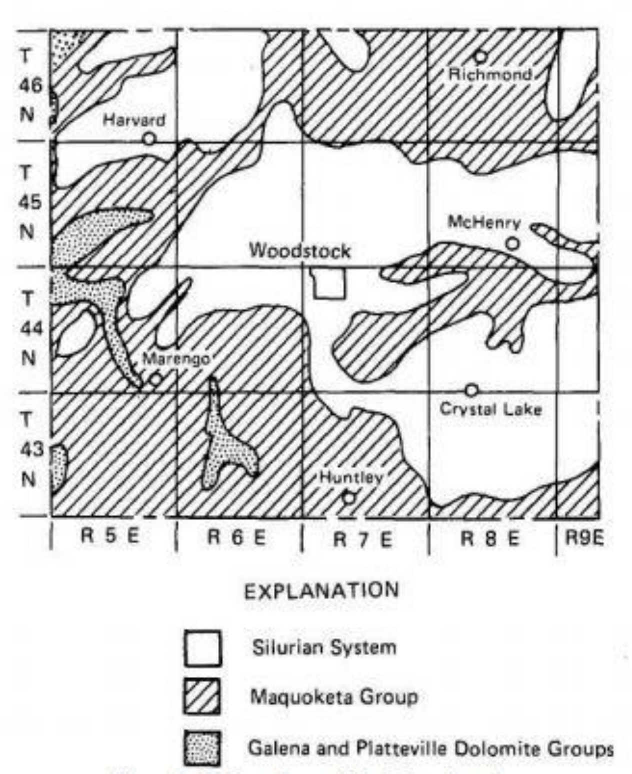

Figure 2. Bedrock Geology (Woller, 1976)

The Silurian dolomite is part of the geohydrologic system present throughout northeastern Illinois, known as the shallow dolomite aquifer ranging from depths from 50 to 300 feet. Next is the Maquoketa Group, which is Ordovician in age and consists primarily of shale lying at depths of 50 to 250 feet. Below the Maquoketa Group is a thick sequence of hydrologically connected rocks known as the Cambrian-Ordovician aquifer in McHenry County. It consists of the Galena-Platteville Dolomite, Glenwood-St. Peter Sandstone, Eminence-Potosi Dolomite, Franconia Formation and Ironton-Galesville Sandstone (Woller, 1976). Most of McHenry County's water supply is groundwater coming from shallow sand and gravel aquifers. This makes them a highly useful source of water because they are highly permeable with a rapid recharge rate, but are vulnerable to surface-borne contamination (Hwang, 2015).

Site Locations

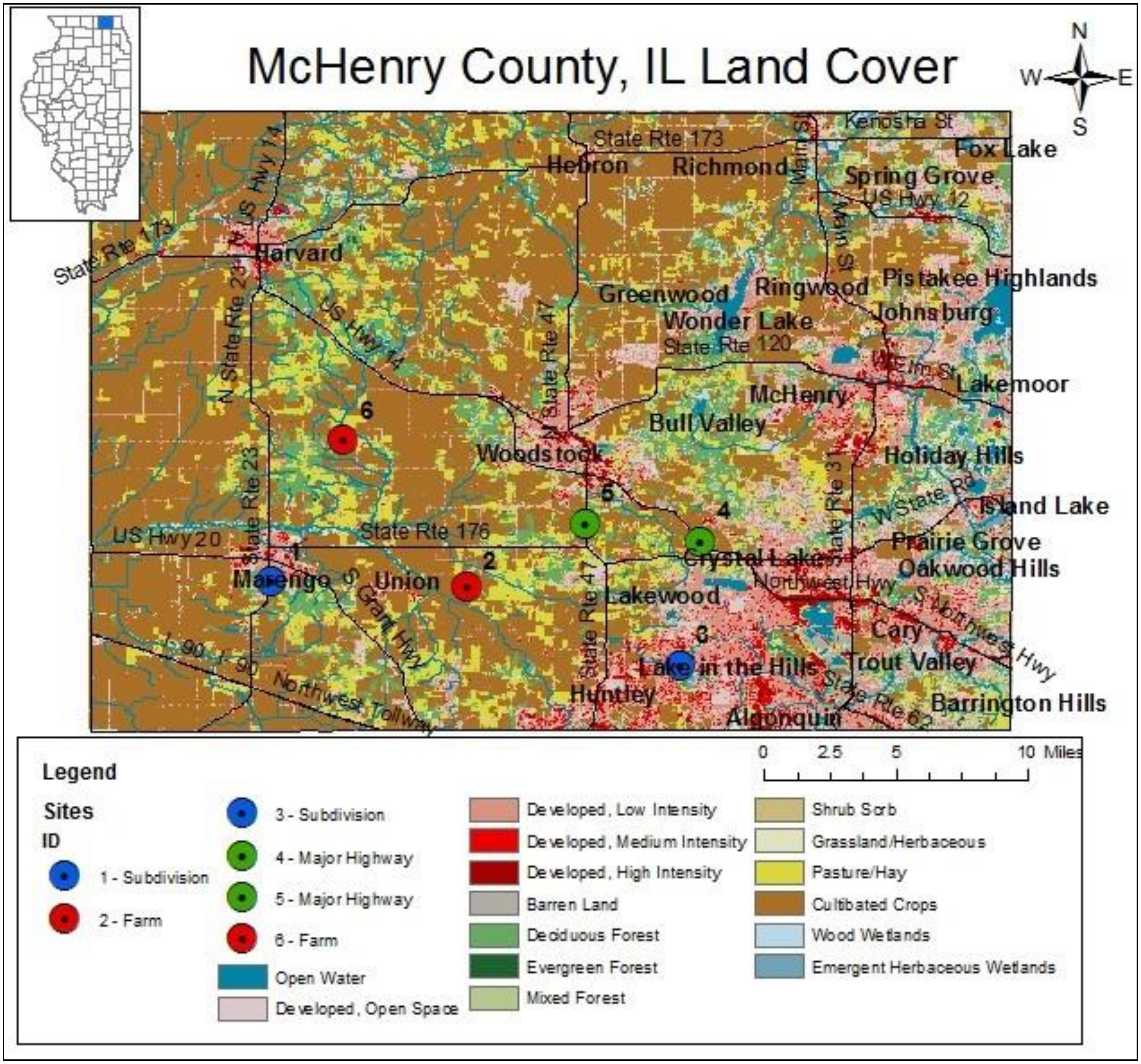

Figure 3. McHenry County land use and site locations.

Methods

In the summer of 2016, water samples from six locations throughout the county. Site 1 is located in Marengo IL, in Doral Ridge subdivision, site 2 is located on McCue Road in Union IL, site 3 is located in Lake in the Hills IL, in Heron Bay subdivision, site 4 is located at McHenry County College on Route 14 in Crystal Lake IL, site 5 is located on Route 47 in Woodstock IL, and the final site, site 6 is located on Hiawatha Lane in Marengo, IL. These six sites were broken down into three categories. The first category is subdivisions, which is site 1 and site 3. The second category is at or near farms, which are site 2 and site 6. The final category is major highways, which will be site 4 and site 5.

Data were collected once a week from the beginning of June through the end of July, and twice during the first week of November 2016. Data were collected using two methods: the first method involved a color change test with Hach test kits to test for NO_3^- and Cl^- using 5 mL samples that were collected from the edge and surface of each water body. The second method tested for dissolved Na^+, K^+, and P^+. Water samples were collected from the edge and surface of each water body and then pipetted onto filter papers. These filter papers were subsequently dried and analyzed using XRF spectroscopy. A total of 68 samples were collected and analyzed from June 1, 2016, through July 28, 2016, and between November 3, 2016, and November 10, 2016. Samples that we tested using the XRF were ran three times and an average was calculated and portrayed in the graphs below.

Results and Discussions

Potassium

Potassium Concentration (ppm)						
Date	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
6/1/2016	7.666667	188.6667	4.333333	7.666667	4.666667	4.666667
6/10/2016	2	151	3.666667	10.33333	9	4.333333
6/16/2016	1.666667	323	6	14.66667	1.333333	4.333333
6/25/2016	1.333333	326.3333	5	1.333333	0.666667	1.666667
6/30/2016	0.333333	321.6667	7	14	1	0.333333
7/8/2016	0.666667	350	5	9	3	3.333333
7/14/2016	0.666667	299.6667	4.333333	1	0.666667	8.333333
7/22/2016	3	336.3333	1	0.666667	8.333333	2.333333
7/28/2016	0	183	1	3	3	5
11/3/16	5.666667	152.3333	2.666667	2.333333	1.666667	2.666667
11/10/16	6.666667	241.6667	4.333333	3.333333	5	0.666667

Table 1. Concentration of Potassium at all six

Potassium was tested by collecting water in a 30ml bottle and pipetting 100µl onto a piece of filter paper and running a Micro Carry Analysis in the X-Ray Fluorescent Spectrometer (XRF) to find the concentration in the water at each site. After analyzing all the samples from June 1 to July 28 sites 1,3,4,5 and 6 were all around the same concentration. Site 2, on the other hand, had very high concentration levels during the entire timeframe. Table 1 shows the concentration levels between all six sites. A reason for site 2 to have a greater concentration than the rest of the sites is that site 2 is directly on a farm, so any fertilizer and animal waste runoff will go directly into the pond, which will contribute to the high level of Potassium at site 2. There weren't too many major spikes at sites 1,3,4,5 and 6, but at site 2 there are two big changes. The first had an increase between week two and week three and the second change was a huge decrease between week eight and week 9.

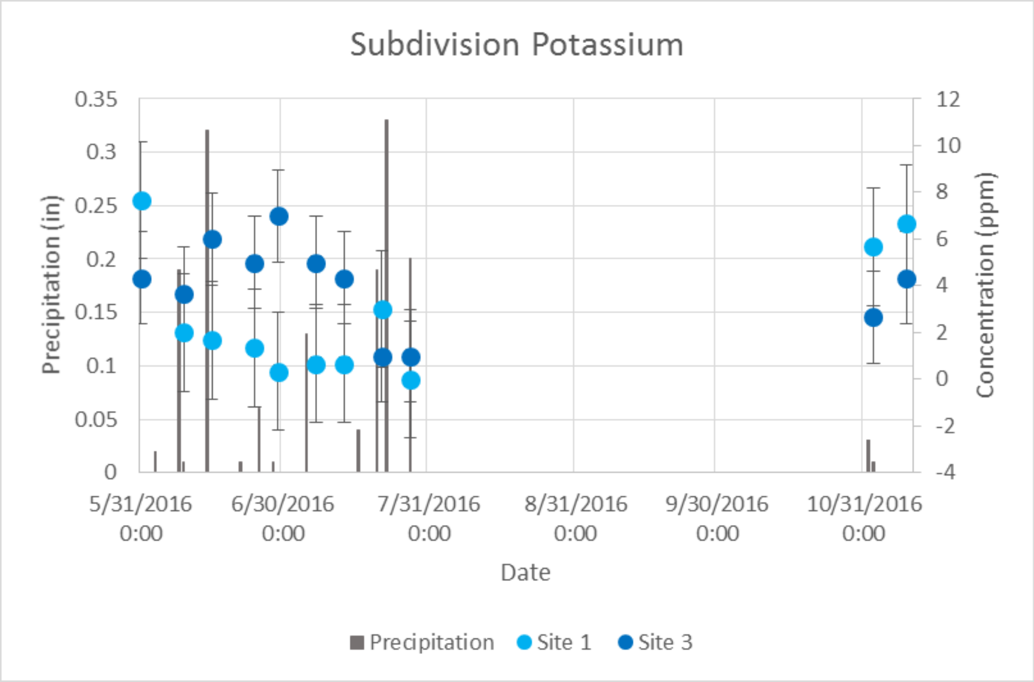

Figure 4. Graph of Potassium Concentrations at site 1 and site 3.

Concentration levels at the subdivision sites were analyzed and shown in figure 4.The concentration levels are on the secondary y-axis measured in parts per million. On the primary y-axis is precipitation rate that was taken every fifteen minutes from a USGS station in Woodstock, IL. The concentration levels at both sites are the same for week 1 and week 2, but after that, site 1 decreases and site 3 increases. As the weeks went on, site 1 decrease and stayed constant at 0ppm until week 8 the level increased but then went back down to zero the last week of July. As for site 3, it increased until week 5, which is when it dropped a little and stayed constant at 4ppm for the next two weeks where it dropped to 0ppm but then increased to 2ppm the final test day of July. These numbers don't come as a surprise because they are naturally occurring levels of Potassium, and any spike in the subdivision sites could have come from homeowners fertilizing their yard and then having a rain shower within a few days after fertilizing, washing any runoff into the pond. After the last test date in July, the next time that data was collected was in the beginning of

November on November 3 and November 10. Here, concentration levels were measured to see if there were any major changes between the concentration levels in the summer and the concentration levels towards the end of fall. For the potassium concentration at the subdivision sites, the results were similar results to the concentration levels in June and July.

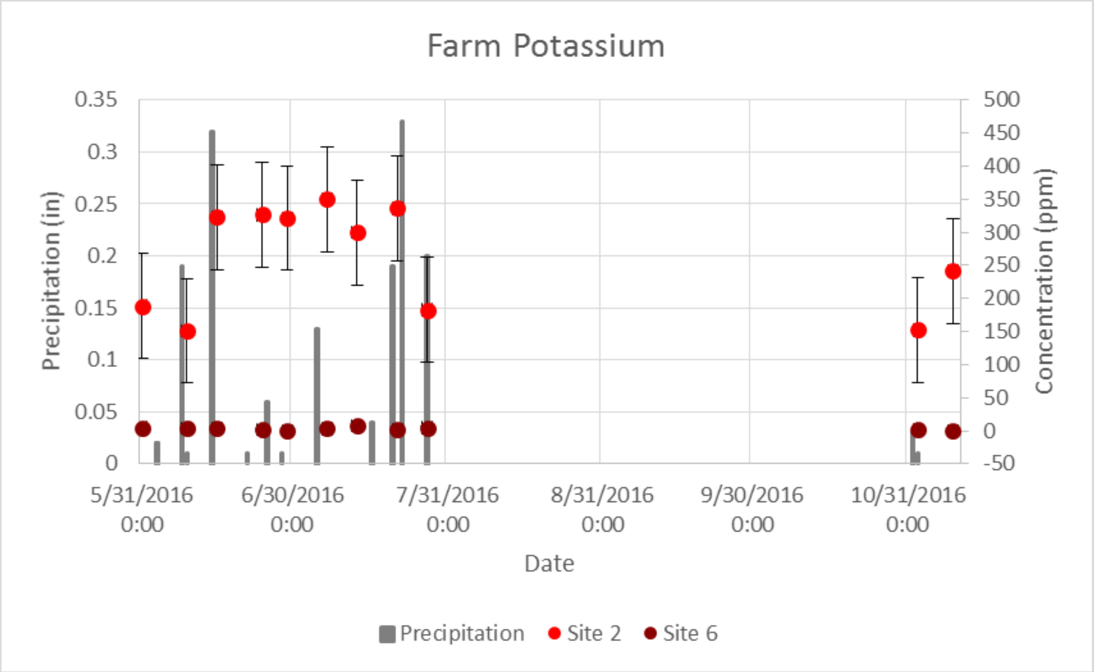

Figure 5. Graph of Potassium concentrations at site 2 and site 6.

At site 2, the concentration level reaches a high of 350 ppm, while site 6 has a high of 7ppm. The reason for these two sites, which have similar characteristics, but such a major difference in concentration levels is that site 2 is directly on farm property where water runoff from the cornfields surrounding it and the animal's pastures will go straight into the pond. At site 6, the pond is further away from the cornfield and there is a buffer zone about 50 feet wide between the field and the pond. The trees soak up any water runoff first before reaching the pond, thus decrease nutrient concentrations at site 6. The concentration levels in site 6 stay constant throughout the 9 weeks of testing. Site 2 starts off relatively low but then increases between week 2 and week 3. When precipitation rate is added to the graph there is a correlation between the amount of rainfall between week 2 and week 3 testing period and the increased concentration level. During the middle of testing, the concentration stayed constant from week 3 to week 8 and then decreased at the final week of testing in July, even with a fair amount of rainfall that occurred between the last two testing days. Concentrations decreased at the end of testing, even with a fair amount of rain, because at the end of the July there is not as much runoff from the fields because as the crops continue to grow they protect the soil more than in the spring, thus reducing the amount of surface runoff. The concentration levels at site 2 showed a decrease in the November testings' versus the concentration results from June and July, while the concentration levels stayed constant at site 6. This would be expected as farmers are harvesting their crops, but after harvest season farmers may spread fertilizers to prepare their fields for next year's crops. This may cause the concentration levels to increase, but because data was only collected twice in November then there isn't sufficient amount of data to draw that conclusion.

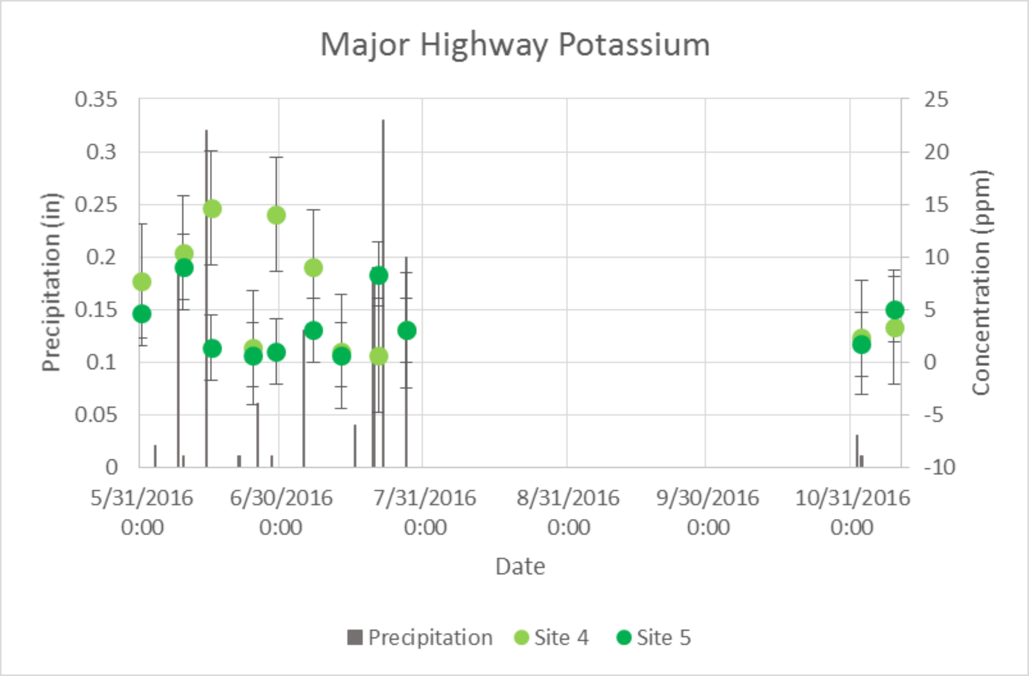

Figure 6. Graph of Potassium concentration at site 4 and site 5.

Concentrations at the major highways sites 4 and 5 are shown in figure 6. The concentration levels at these sites are a little all over the place, with no direct trends. It seems though that site 4 had a higher concentration than site 5 throughout the testing period, but based on the geography of the sites it would have been excepted that site 5 would have a higher K^+ concentration than site 4. Site 4 is located on Route 14, a four-lane highway, between Woodstock and Crystal Lake. There are farm fields along the highway, but site 5 located on route 47, a two-lane highway, which is in the middle of Woodstock, Marengo, and Crystal Lake, has more farm fields and a high potential for runoff from farm fields to end up in the pond. The results of potassium concentration levels in the major highway sites during the beginning of November were in the same range of concentration levels during the June and July testing period.

Sodium

Sodium Concentration (ppm)						
Date	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
6/1/2016	229.6667	76	72.66667	104.3333	40	65.66667
6/10/2016	132.6667	82.33333	69	119.3333	48	92.66667
6/16/2016	202.6667	162.3333	120.3333	163	31	100.6667
6/25/2016	218.6667	151.3333	133.6667	87.33333	24.33333	53.66667
6/30/2016	191.3333	150.3333	120.3333	216	30.33333	60
7/8/2016	170.3333	148.3333	234	243.6667	43.66667	99.66667
7/14/2016	153.3333	133.3333	92.66667	96	36.66667	78.66667
7/22/2016	159.3333	125.6667	82	77	56.33333	81.33333
7/28/2016	159.3333	86.33333	89	77	47.33333	112.3333
11/3/2016	131	73.33333	88.66667	13.66667	19.33333	54
11/10/2016	189.6667	86.33333	77.66667	34.66667	32	67.33333

Table 2. Concentration of Sodium at all six sites.

Sodium was tested by collecting water in a 30ml bottle and pipetting 100µl on a piece of filter paper and running a Micro Carry Analysis in the X-Ray Fluorescent Spectrometer (XRF) to find the concentration in the water at each site. After analyzing all the samples, a general trend for all the sites was an increase in the first few week, then relatively constant in the middle weeks, and then a decrease at the end of the testing period. Table 2 shows these centration levels during the testing period.

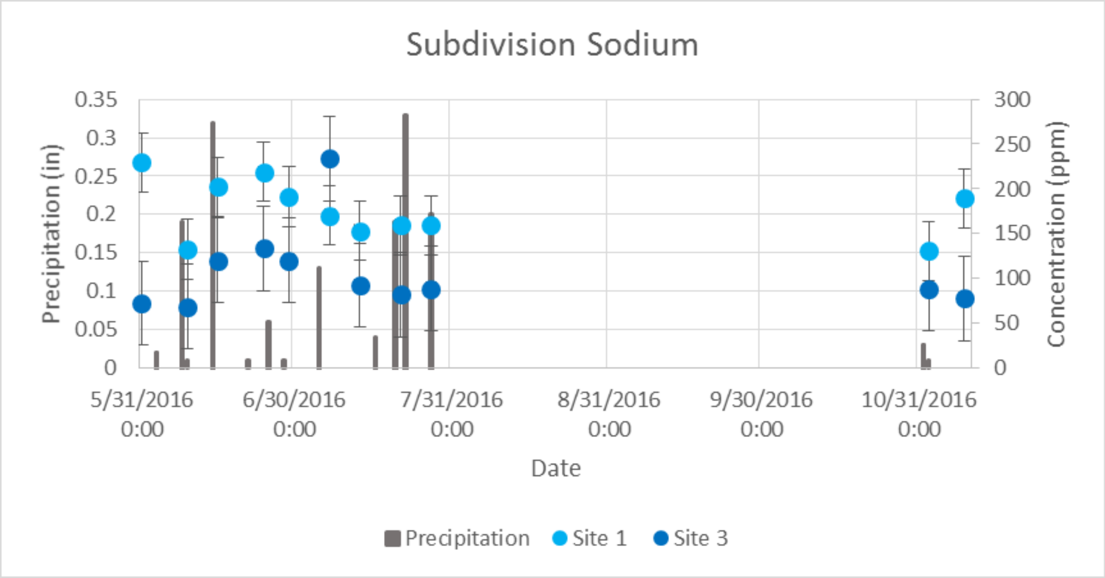

Figure 7. Graph of Sodium concentrations at site 1 and site 3.

In the subdivision sites, site 1 had a higher concentration of sodium, than site 3 throughout the testing, which is shown in figure 7. Again, note that the concentration levels are on the secondary y-axis and the precipitation rate is on the primary y-axis. Looking at these sites geographically, site 3 located in Lake in the Hills, has a greater population and the entrance of the subdivision is located on a well-traveled road and pond is about 70 feet from the edge of the road, so site 3 would have originally thought to have a higher Na^+ concentration than site 1. After further analyses of the geography of each site, the results makes sense because site 1 has a high gradient from the road, while at site 3 there is a very small gradient between the road and the pond. At site 1, the water is able to reach the pond faster than at site 3, so the concentration level builds up quicker when there is a heavy rainfall, thus the concentration becomes higher. Since testing was occurring in the Midwest and weather can never be predicted; if there was a heavy snowfall then the sodium concentration levels would increase in November due to the application of road salts. There was no snowfall prior to testing, thus no road salts were applied, so the concentration levels at the subdivision sites were relatively the same in November as they were in June and July.

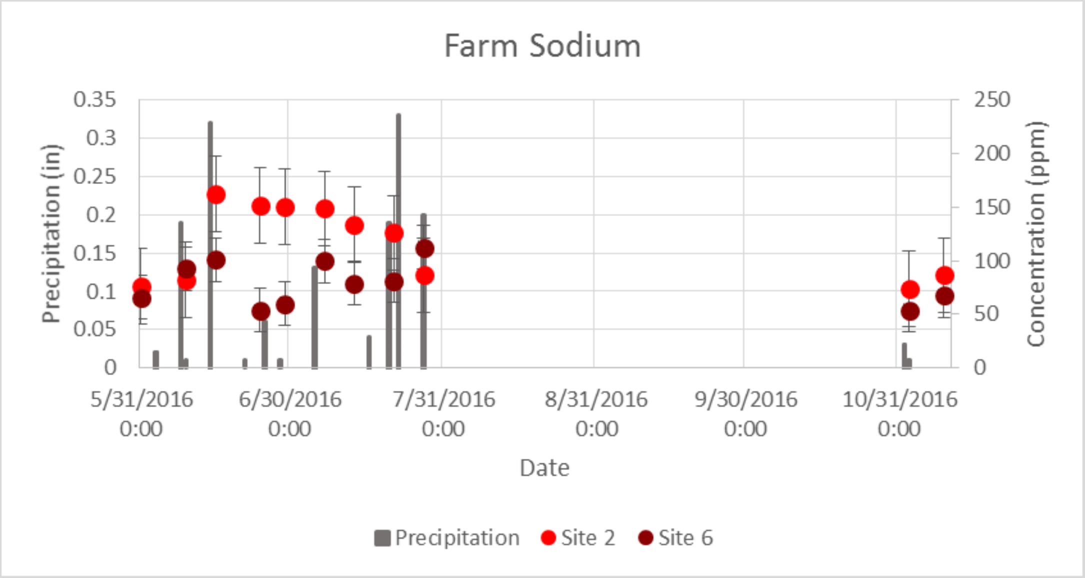

Figure 8. Concentration of Sodium at site 2 and site 6.

The concentration of Sodium at the farm sites were a lot closer together than the Potassium concentration, but site 2 still had a greater concentration than site 6, which can be seen in figure 8. Both sites were close in concentration levels for the first two weeks of testing, but then between week two and week three testing site 2 had a huge increase in Sodium. It continued to increase at a steady rate until week six. Both sites started and ended with similar concentration levels, but during the middle of the testing period site 2 was higher than site 6. Precipitation is not the only variable that is changing the concentration levels, and sometimes it does not have an effect; as we see in the final two weeks of testing. Here, there was lots of precipitation, but the concentration levels decreased at site 2 and increased at site 6. As the crops continue to grow the amount of runoff decrease because the crops can hold the soil in place and soak up more water. Just like previous results in November, the concentration levels of sodium at the farm sites were in the same range as the concentration levels in June and July.

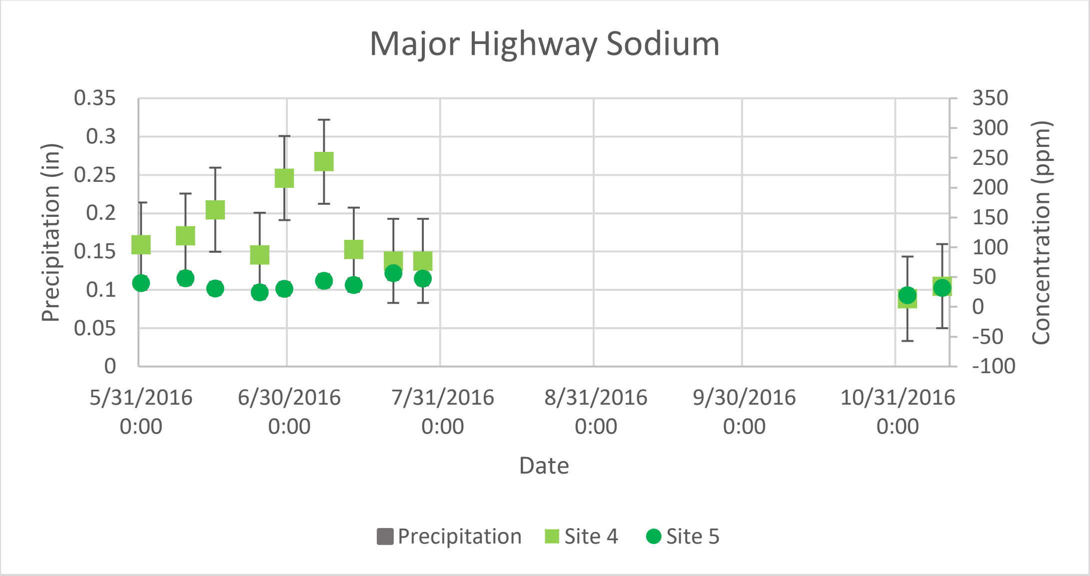

Figure 9. Concentration of Sodium at site 4 and site 5.

The concentration levels between the major highway sites at site 4 and site 5 are a little harder to understand. At site 5, the concentration levels are constant throughout the testing, but looking at figure 9 there is a huge increase and decrease of the concentration of Sodium at site 4. It starts as a general increase, but then drops in week 4 and has a huge increase from 68ppm to 200ppm at week 5. The concentration increases even more at week 6 but then drops substantially at week 7 from 261ppm to 94ppm. Looking at the rain between each week there was not a lot of rain to cause the huge spike between week 4 and week 5. The next big rain storm between each week was the final two weeks, which overall accumulated the most precipitation during the testing period. This is striking because there is no huge increase during weeks 8 and 9, instead, the concentration levels stayed relatively constant. Since there was no snowfall prior to the November testings and no need for roads to be applied, the concentration levels at the major highways sites had a small decrease since the last testing in July.

Phosphorus

Phosphorus Concentration (ppm)						
Date	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
6/1/2016	0.666667	36.66667	0.333333	0	0	2
6/10/2016	0	31.33333	0	7.666667	3.333333	0.666667
6/16/2016	0.333333	81.66667	0.333333	1.666667	0	0.666667
6/25/2016	0	85.66667	0	0	0	0
6/30/2016	1	95.33333	0.333333	5.333333	0.666667	0
7/8/2016	0.666667	84.33333	0.333333	1	0	0
7/14/2016	0	74.66667	0	0.333333	0	5.666667
7/22/2016	0.333333	88.33333	0	0	0.333333	0.666667
7/28/2016	29.66667	62	0	2	3	1
11/3/2016	0	37	0	0	0	0
11/10/2016	0	35	0	0.333333	0	0

Table 3. Concentration of Phosphorus at all six sites.

After analyzing the data collected, shown in table 3, site 2 is the only site with a high amount of Phosphorus, as the rest of the sites showed natural concentration levels. Two of the main sources of Phosphorus contamination come from the use of fertilizers and from animal waste. Site 2 is the only site that has animals and farm fields. Site 6 has cornfields near the pond but there is a buffer zone between the edge of the cornfield and the edge of the pond that limits the amount of runoff into the pond. The increase of P^+ is caused by the amount of rainfall and erosion occurring around the pond. P^+ is not soluble in water but attaches itself well to the soil, and when soil washes into the pond from heavy rainfall then the concentrations will increase in the water.

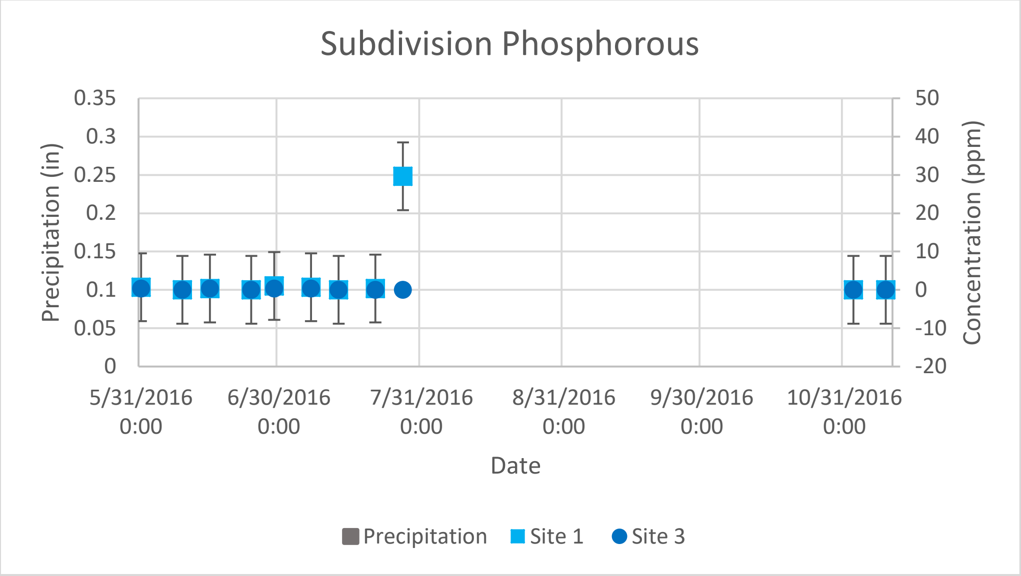

Figure 10. Concentration of Phosphorus at site 1 and site 3.

The Phosphorus levels at the subdivision sites make sense with concentration levels less than 5 ppm for almost every testing. There is one week that stands out against the rest of the weeks, with week 9, the final week of July, had a huge increase from 0 ppm to 30 ppm. A reason for this could be a combination of residents fertilizing their lawns and the amount of rain accumulated between each other. In addition, since the pond has a high downgradient from the houses and road, with any heavy rainfall the runoff will go straight into the pond. A reoccurring pattern observed during the November testings show concentration levels similar to June and July testings.

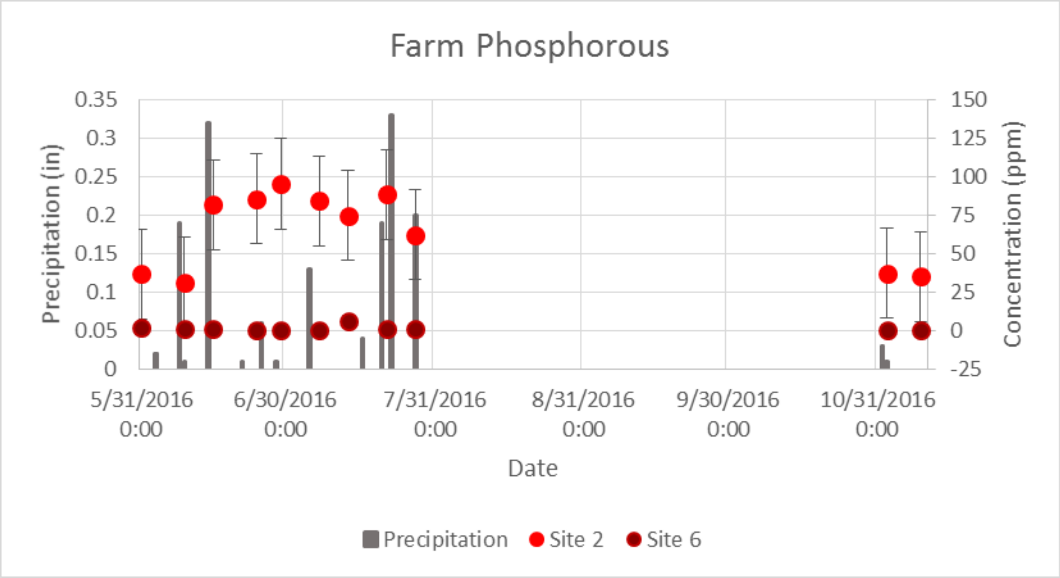

Figure 11. Concentration of Phosphorus at site 2 and site 6.

The comparisons of P^+ between the two farm sites are similar to the concentration of P^+ at the farm sites, where site 2 is much higher throughout the testing period. The conclusion for the Potassium concentrations can also be the same of the Phosphorus concentrations being higher at site 2 than site 6. The main reason for this is the buffer zone between the edge of the cornfield and the edge of the pond at site 6, thus limiting the amount of runoff into the pond. One thing that does stick out is the decrease in concentration between the final two testings at site 2. There was a good amount of rain between the two testing's, but still had a decrease in concentration. That is because it was at the end of July and the crops in the field have grown a lot since the first testing, keeping the soil intact and prevent large amounts of runoff.

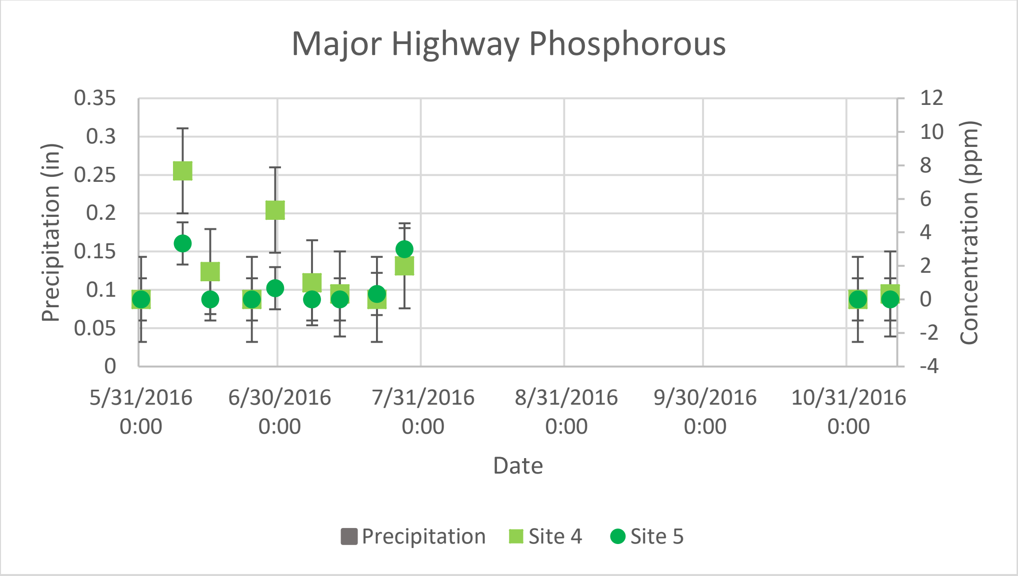

Figure 12. Concentration of Phosphorus at site 4 and site 5.

Just like the concentration levels of Potassium at the major highway sites, the concentration levels of Phosphorus at these sites seem to be switched based off predicted conclusions. Since site 4, which is in a more urbanized area with fewer farm fields than site 5, has a higher level of concentration for both Potassium and Phosphorus, then any runoff from the nearby fields can enter into the water easier and faster at site 4 than site 5. Both sites follow similar trends with increases and decreases occurring during the same week of testing. The same can be said about the concentration levels of phosphorus during November as the concentration levels of potassium in November. Both major highway sites had a concentration level of 0ppm during the two times they were tested, which comes as no surprise.

Nitrate

Date	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
6/1/2016	0	13.2	0	4.4	4.4	4.4
6/10/2016	0	13.2	0	0	4.4	0
6/16/2016	0	4.4	0	4.4	4.4	0
6/25/2016	0	4.4	4.4	0	0	0
6/30/2016	0	4.4	4.4	0	0	0
7/8/2016	0	4.4	0	0	4.4	0
7/14/2016	0	4.4	0	0	4.4	0
7/22/2016	0	4.4	0	0	4.4	0
7/28/2016	0	4.4	0	0	4.4	0
11/3/2016	0	4.4	0	0	0	0
11/10/2016	0	4.4	0	0	0	0

Table 4. Concentration of Nitrate at all six sites.

Nitrate concentrations were recorded at each site by using the Nitrate Test Kit, Model NI-11 from Hach. This kit measured the concentration level by a color-changed method. A test tube was filled with 5ml of the site's water and then a reagent powered was dissolved into the water. The color of the water was then matched with the color on the color wheel to determine the concentration. Table 4 show the nitrate concentration levels from June 1 to July 28 at all six sites. The nitrate levels at the subdivision sites shown in figure 13 were mostly constant at 0 ppm except at site 3 during the middle of the testing period where concentrations were 4.4 ppm. Constant concentration levels at each site can be linked to the method of using a color change reagent test.

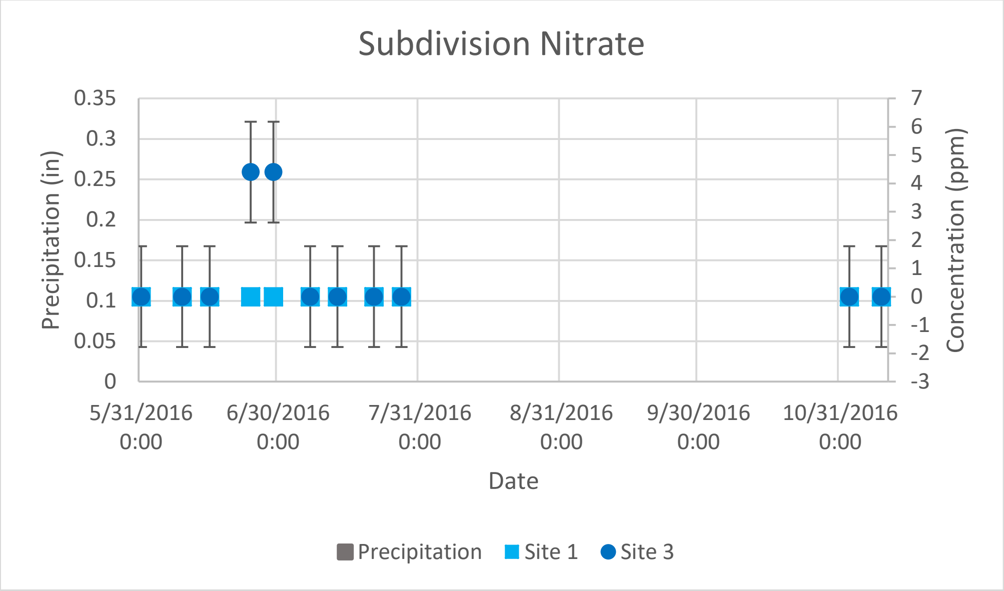

Figure 13. Concentration of Nitrate at site 1 and site 3.

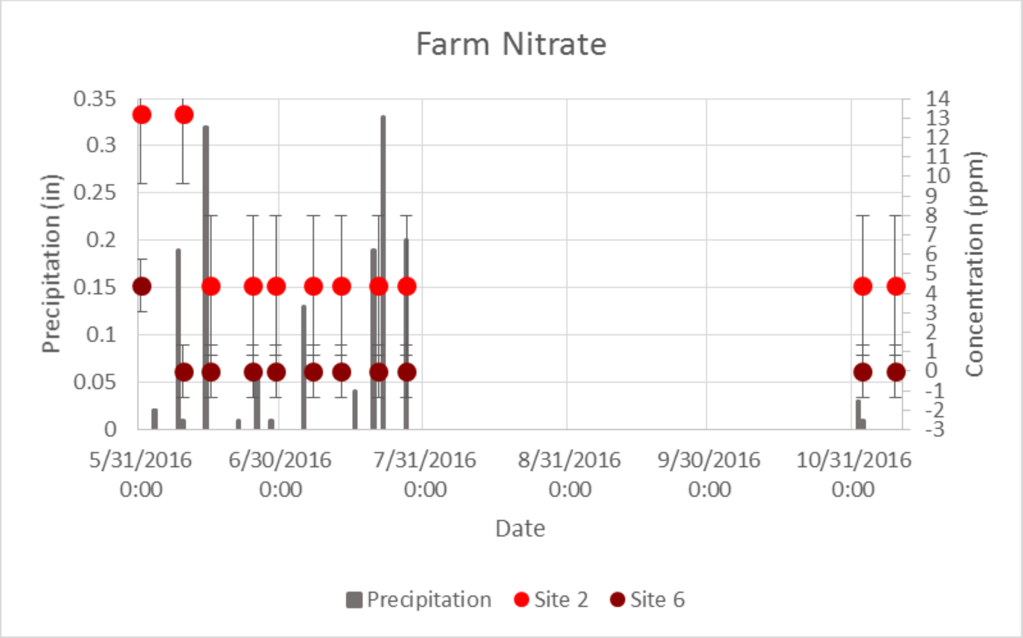

Figure 14. Concentration of Nitrate at site 2 and site 6.

The concentration levels were also constant throughout the testing period at the farm sites, shown in figure 14. Site 2 was higher than site 6 during the testing, which continues to follow the trend of the other nutrients. Most of the nitrate comes by nitrogen-based fertilizers and is usually applied in the springtime. Since testing began June 1, the fertilizer would have been applied towards the end of April or early May, so when the first sample was collect nitrogen was already in the system making the concentrations high at site 2. Unlike P^+, NO_3^- is water highly soluble in water. When high amounts of precipitation enter the water body with high NO_3^-, then the precipitation will dilute the water body. This occurs during the third week at site 2 when the concentration dropped from 13.2 ppm to 4.4 ppm after a heavy rainfall. From this point on the concentration at site 2 stayed constant at 4.4 ppm.

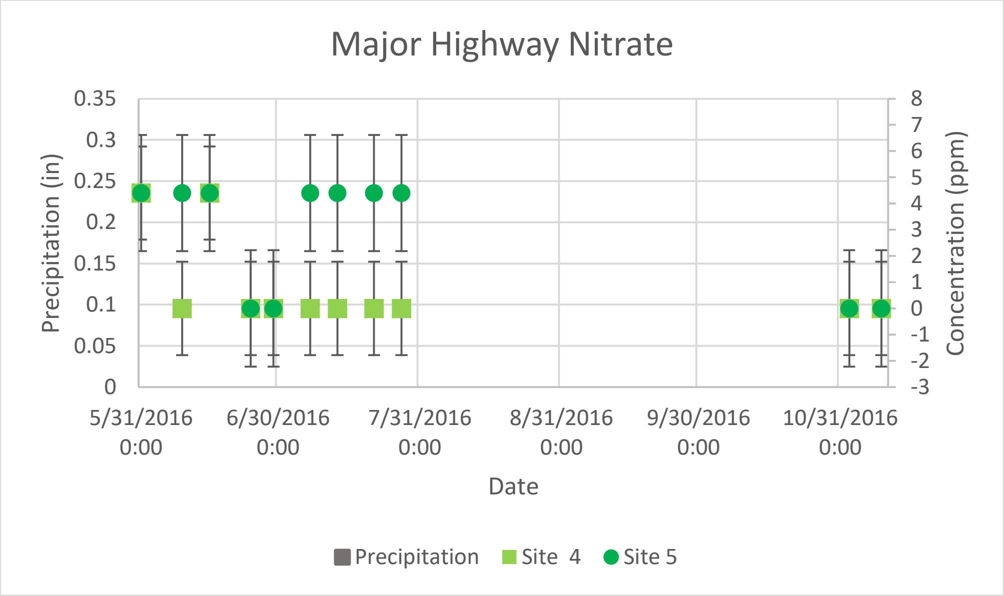

Figure 15. Concentration of Nitrate at site 4 and site 5.

Just like the previous testings at the major highway sites, it becomes hard to find trends in the data, but it is also eye catching as to why this is happening. Throughout the testing period, site 5 has been higher than site 4, which is the opposite of what would have been predicted before testing began. For the nitrate concentrations, both sites have the same concentration of 4.4ppm at the first testing, but then the next week site 4 decreased and site 5 remained constant the following two testings. Between week 3 and week 4 both sites dropped to 0ppm, site 4 remained at that concentration for the remainder of the testing period, while site 5 increased the following week back up to 4.4ppm, where is stayed constant for the rest of the testing period.

As for the concentration at all the six sites for the November testing, they were all constant to their previous testings in June and July. Nitrate levels at the subdivision and major highway sites had a concentration of 0 ppm, while the farm sites at site 2 had a concentration of 4.4 ppm and site 6 had a concentration of 0 ppm.

Chloride

Chloride Concentration (ppm)						
Date	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
6/1/2016	0.1	0	0	0.1	0	0
6/10/2016	0.1	0	0.1	0.1	0	0
6/16/2016	0.1	0	0	0.1	0	0
6/25/2016	0.1	0	0.1	0	0	0
6/30/2016	0.1	0	0.1	0	0.1	0
7/8/2016	0	0	0	0.1	0.1	0
7/14/2016	0	0	0	0.1	0.1	0
7/22/2016	0	0	0	0.1	0.1	0
7/28/2016	0	0	0	0.1	0.1	0
11/3/2016	0.1	0	0	0	0	0
11/10/2016	0.1	0	0	0	0.4	0

Table 5. Concentration of Chloride at all six sites.

Chloride concentrations were measured the same way as nitrate was measured by using a color change test kit: Total Chlorine Color Disc Test Kit, Model CN-66T. Most of the concentration levels during the testing period of June through July were all low. The highest concentration was 0.4 ppm; these levels were either in the subdivision sites or at the major highway sites. The farm sites, on the other hand, had a constant concentration level for the entire testing period. Table 5 shows the concentration levels at all six sites. Constant concentration levels at each site can be linked to the method of using a color change reagent test

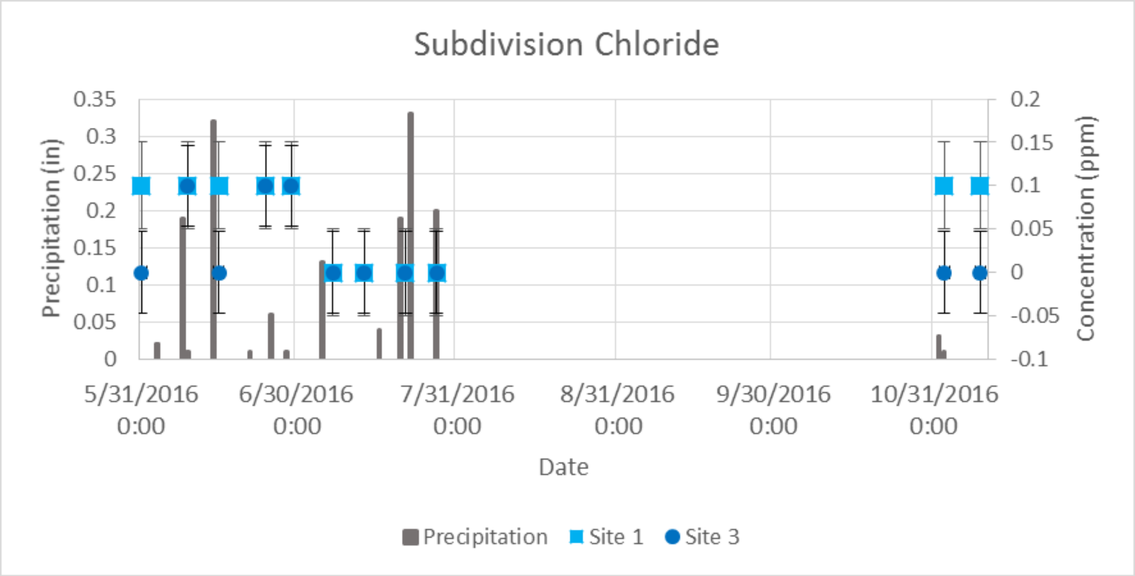

Figure 16. Chloride concentration at site 1 and site 3.

For the chloride concentration at the subdivision sites, the sites had opposite patterns during June, but then similar patterns in July. At site 1, the concentration was constant at 0.1ppm, but site 3 exhibited increases and decreases during the month of June. During the month of July, both sites had a constant concentration of 0 ppm.

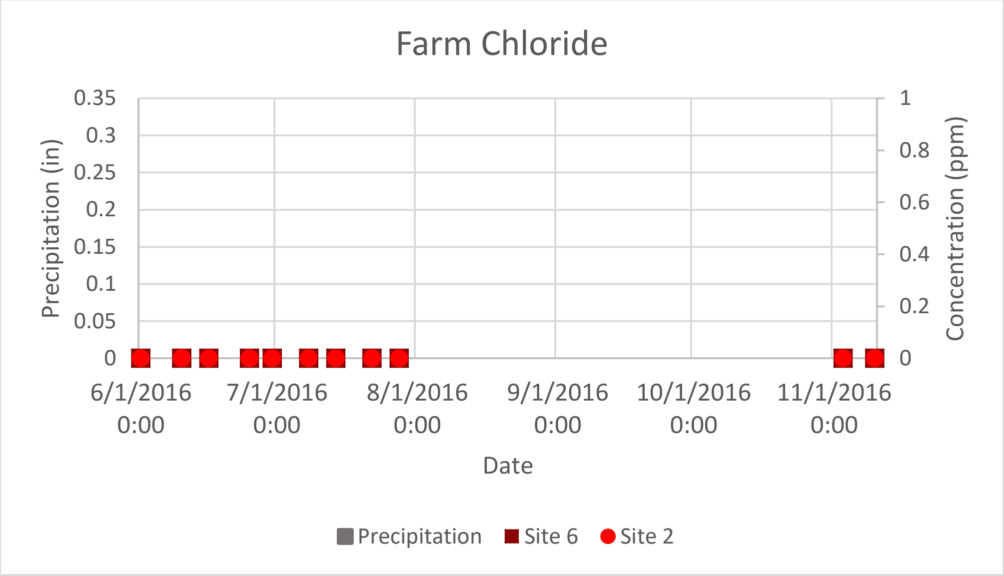

Figure 17. Chloride concentration at site 2 and site 6.

For the farm sites, the concentration of chloride was constant at 0ppm for both sites for the entire testing period, shown in figure 17.

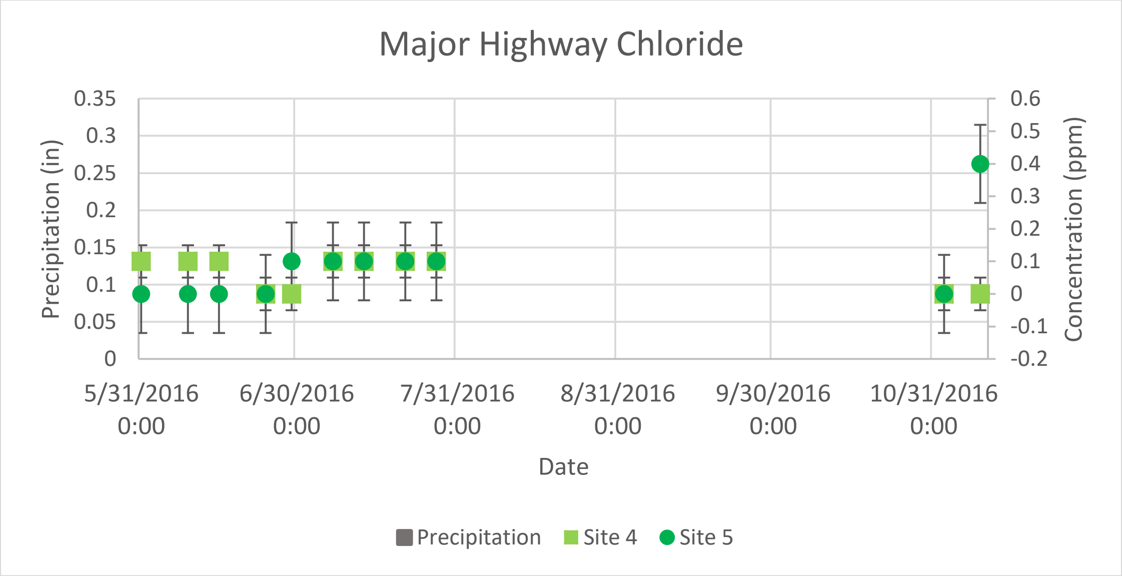

Figure 18. Chloride concentration at site 4 and site 5.

Looking at chloride concentrations at the major highway sites, site 4 had a higher concentration than site 5, shown in figure 18. In June, site 4 had a higher constant concentration at 0.1ppm, while site 5 had a constant concentration of 0ppm. In July though, both sites had the same constant concentration of 0.1ppm.

The concentration levels of chloride during the November testings' were mostly constant at 0 ppm, except for site 1 in the Marengo subdivision and site 5 of the major highway site on route 47 in Woodstock. Site 1 had a concentration of 0.1ppm for both testings and site 5 had a high concentration of 0.4ppm on the last day of testing. Since there was no snow accumulation prior to testing the water bodies in November, there was no need for road salts to be applied, thus making the Cl^- concentrations similar to the concentrations in June and July.

Conclusions

A general trend between all six sites is that the concentration levels were higher during testing in June, and as time went on, concentration levels decreased during July. November testing was conducted to see if there were any major changes from the last date of testing in July, and to see any potential spikes of chloride and sodium due to the application of road salts. Since there was no accumulation of snow prior to or during the testings in November, the concentration levels of chloride and sodium were similar to the concentrations collected in June and July. High level of nutrients comes from fertilizers and animal waste, and when a rain event occurs with runoff into the water body, concentrations will either increase or decrease depending on solubility. This is apparent between the second and third testing date, where a rain event occurred with P^+ increasing and NO_3^- decreasing at site 2. This happens because of the solubility of P^+ and NO_3^-. P^+ is not soluble in water, but is easily attached to the soil, so when erosion rates are high and soil from a nearby farm field enters a water body then the concentration of P^+ increases, while NO_3^- is soluble in water, so when runoff occurs during a rain event, the concentration is diluted. High levels of nutrients at the farm sites make sense, but the concentrations between the two sites vary dramatically. This because of a buffer zone between the cornfield and the water body at site 6, which shows low levels of nutrients, while there is no buffer at site 2 making it vulnerable to high levels of nutrient concentrations. Site 2 is the only site that showed high concentrations above the EPA drinking water standards for nitrate, phosphorus, and sodium; other sites had natural occurring concentration levels, except for a couple outsiders at each site. Agriculture is a huge part of our nation's economy, but managing resources and having healthy drinking water is just as important. There are plenty of ways to reduce runoff from agricultural fields that improve water quality; just by implicating a buffer between a crop field and a water body will increase the water quality, as shown in this study between the two farm sites.

Further Research

As I was collecting data during June and July, driving around the county got me thinking that I should have tested the Kishwaukee River. If I were to continue research on water quality in McHenry County, I would look at the Kishwaukee River and test at different locations on the river throughout the county for nutrients.

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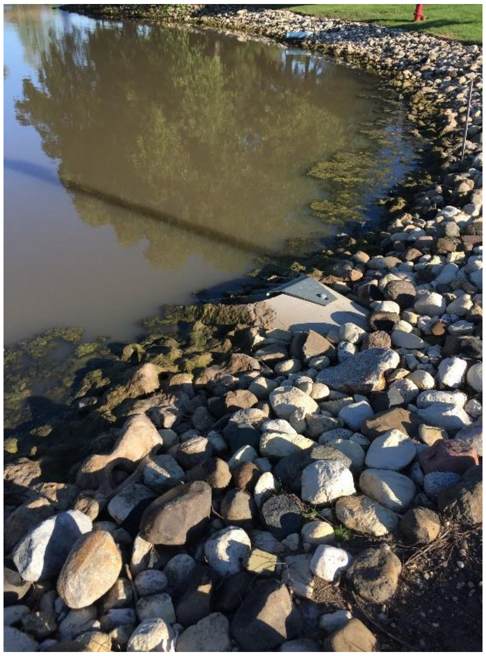
Appendix

Site 1 – Subdivision – Marengo

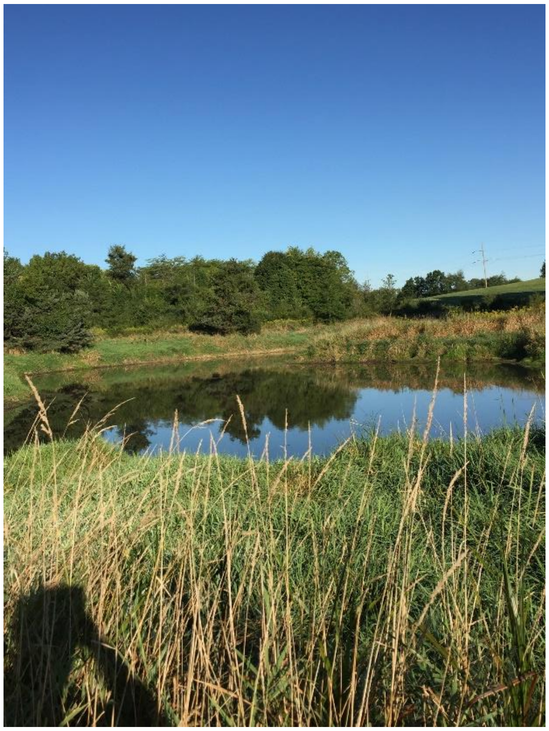
Site 2 – Farm – Union

Site 3 – Subdivision – Lake in the Hills

Site 4 – Major Highway – Crystal Lake



Site 5 – Major Highway – Woodstock



Site 6 – Farm – Marengo