Central Park Lake

Watershed Improvement Project
Wastewater System, Wetlands and Water Monitoring
WIRB Agreement #: 1210-007IJ and 1210-007-02

FINAL REPORT for Septic System and Wetland Construction, Lagoon Reclamation and Water Monitoring

Table of Contents

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Financial Accountability

Watershed Improvement Funds –WIRB-IJOBS and WIRB

Grant Agreement Budget Line Item	Total Funds Approved ($)	Total Funds Approved - Amended ($)	Total Funds Expended ($)	Available Funds ($)
Engineering Design and Permits (WIRB-IJOBS)	14,250	11,024	11,023.82	0
Wetland Construction (WIRB-IJOBS)	15,456	2,162	2,162.00	0
Septic System Construction (WIRB-IJOBS)	44,250	74,750	74,750.00	0
Lagoon Reclamation (WIRB-IJOBS)	19,500	5,520	5,520.00	0
Water Monitoring (WIRB)	3,194	3,194	2,618.30	575.88
Totals	**96,650**	**96,650**	**96,074.12**	**575.88**

Engineering Design and Permitting, Septic System and Wetland Construction, Lagoon Reclamation and Water Monitoring Funding

Funding Source	Cash		In-Kind Contributions		Total	
	Approved Application Budget ($)	Actual ($)	Approved Application Budget ($)	Actual ($)	Approved Application Budget ($)	Actual ($)
WIRB IJOBS	93,456	93,456			93,456	93,456
WIRB	3,194	2,618.30			3,194	2,618.30
Jones Co. Supervisors	27,224	26,929		148	27,224	27,077
Jones Co. Conservation Bd.	5,616	5,722	2,220	3,686	7,836	9,408
Jones SWCD			888	685	888	685
Ending Balance-DNR Lake Restoration		38,604				38,604
Totals	**129,490**	**167,329.30**	**3,108**	**4,519**	**132,598**	**171,848.30**

Watershed Improvement Fund contribution:	Approved application budget:		73%
	Actual:	WIRB-IJOBS	54%
		WIRB	2%

Due to the increased actual cost versus projected cost of the project, the percentage of the project that the WIRB Fund allocated dropped. The additional cost of the project was funded by a DNR Lakes Restoration grant.

Environmental Accountability

The old wastewater treatment lagoon serving Central Park Lake was decommissioned and reclaimed for wetland mitigation. Initial monitoring of the lagoon was conducted during 2011. The Iowa DNR in partnership with Iowa State University conducts regular monitoring on the lake (3 times annually). In addition, monitoring of the beach is conducted by the Iowa DNR beach monitoring program to measure E. coli levels for recreation purposes. Additional monitoring has occurred at the discharge of the new wetland site to determine the impacts of converting the old lagoon to a wetland. These samples have been taken for two years, bi-weekly May – July (6 samples), Monthly afterward (Aug – Jan); 3 event samples. Parameters: ammonia, E. coli, nitrate+nitrite, ortho P, CBOD, Total Kjeldahl Nitrogen, Total Phosphate, Total Suspended Solids, water temp (field), Dissolved Oxygen (field), Chloride (field), and pH (field). See Appendix A for a detailed report on water monitoring results.

Table 3. Summary of Practice Goals and Accomplishments

Practice or Activity	Unit	Approved Goal	Accomplishments	Percent Completion
Wetland Construction	No.	2	2	100
Septic System Construction	No.	4	4	100
Lagoon Reclamation	No.	1	1	100

Before this project was initiated effluent from a campground, shower house, camper dump station and residence were being discharged into a single cell lagoon. Now, with the installation of 4 DNR Certified septic systems, all of the effluent material is being treated. The septic systems are designed to treat a combined 3,750 gallons per day. After capping all pipes leading to the lagoon, the effluent and sludge was pumped and removed from the lagoon. Then 6+ inches of soil was dug out and placed outside the watershed. Once completely cleaned out, the basin was reshaped to create a shallow wetland and planted in native prairie and wetland plants.

Another 1/3 acre wetland was created to capture sediment and nutrients. This wetland has a drainage area of 7.8 acres. It is estimated that the average soil loss on the 70% brome grass, 30% crop rotation watershed is 2 tons/acre/year. This translates into nearly 16 tons/year of sediment moving within the watershed and 90% of that making its way to the new wetland (14 tons/year). Before the wetland was built 80% of those 14 tons (11 tons/year) moving through the wetland site made it to the Lake per year.

The 90% sediment trap efficiency of the wetland means that now only 1 ton/acre/year is making its way to the lake. Jeff Tisl (IDALS-DSC Regional Coordinator) assisted with these calculations.

The project has been a success. Several thousand gallons of effluent are now being treated in 4 septic systems instead of flowing into a single cell lagoon in Central Park Lake's watershed. This water treatment technique is limiting excess nutrients and other pollutants from entering the Lake. The 1/3 acre wetland is now holding back 10 tons/year of sediment that would have otherwise flowed into the Lake. Water monitoring data collected over several years before and after this project has been analyzed and is demonstrating tremendous improvement in the lake's and reclaimed lagoon/wetland's water quality.

Program Accountability

In addition to the work completed for this project, last fall a 6.6 acre sediment control structure on the main watershed to the west of the Lake and a 1.5 acre sediment control structure on the main south watershed of the Lake have been completed. These two structures are projected to stop nearly 480 tons/yr of sediment from entering the lake. In addition, work is being done to implement in-park urban design practices to further improve the lake and watershed's water quality.

Appendix A: Water Monitoring Results (Data Compiled and Analyzed by Mary Skopec – DNR IOWATER and Stream Monitoring Coordinator)

Since July 2011, Jones County Conservation Board staff have been collecting samples from the wastewater lagoon located in Central Park on a weekly basis in order to determine the potential impacts of the lagoon on Central Park Lake. The wastewater lagoon consists of a "single cell" that was constructed in the early to mid-1970s. A single cell lagoon has a single area for the wastewater to be treated before discharging any liquid. These lagoons generally provide primary or very basic treatment of wastewater, but do not provide more advanced treatment of pollutants that occurs in systems with secondary or tertiary treatment. Further, the lagoon was located across the park road to the south of the beach area and was implicated in delivery of pollutants to the lake - reducing the lake's water quality and long-term viability for recreation and as a fishery.

To determine the potential impacts of the wastewater lagoon, samples are collected from the lagoon and submitted to the State Hygienic Laboratory at the University of Iowa in Iowa City. Samples are analyzed for ammonia, *E. coli* bacteria, orthophosphate (as phosphorus), carbonaceous biological oxygen demand, total Kjeldahl nitrogen (TKN), total organic carbon, total phosphate (as phosphorus), nitrate plus nitrite (as nitrogen) and total suspended solids. Certain forms of ammonia can be toxic to fish and result in fish kills. Total phosphate, orthophosphate, and Total Kjeldahl nitrogen are nutrients and promote algae growth. If high levels of these nutrients are delivered to the lake, unpleasant algae blooms could result. Suspended solids are also associated with high nutrients and further compound algae problems. Carbonaceous biological demand (CBOD) is a measure of the oxygen consumption the wastewater causes in the lake. High consumption of oxygen results in lower oxygen levels in the lake and may stress or kill fish. Additionally, *E. coli* bacteria levels are used to indicate the suitability of the lake for swimming. If high levels of *E. coli* bacteria are delivered from the lagoon to the lake, swimmers could potentially fall ill.

Monitoring of the beach located on Central Park Lake through a partnership between Jones County and the Iowa Department of Natural Resources has shown highly variable bacteria (*E. coli*) levels since 2004, ranging from below detection (<10 CFU/100ml) to nearly 10,000 CFU/100ml. During the 12 years of monitoring, the median E. coli value was 31 and the average was 219 CFU/100ml. Approximately 84% of the samples were below the one-time sample maximum value recommended for primary contact recreation of 235 CFU/100ml. Data prior to the close of the Central Park wastewater lagoon (for purposes of this report identified as November 15, 2013) show that the median bacteria value was 41 and the average was 235 CFU/100ml. Seventy-five percent of samples were below the single sample maximum recommended for recreation from 2004-2013. Since the waste water lagoon was closed and converted to a modified wetland system, the median bacteria level at the beach has been 10 and the average 148 CFU/100ml. Additionally, 96% of samples taken at the beach have been below the one-time sample maximum since the lagoon has been decommissioned (Figure 1).

Data taken from water discharging from immediately below the lagoon area showed that *E. coli* bacteria levels were extremely high prior to 2014 with values ranging from 20,000 to 1.7 million and a median concentration of 290,000 CFU/100ml. After the lagoon was closed, these numbers dropped to a maximum of value of 2700 and a median of 75 CFU/100ml (Figure 2). The proximity of the beach to the lagoon/wetland discharge area and the change in bacteria following conversion of the lagoon to a wetland is strongly suggestive that leachate from the lagoon was negatively impacting bacteria levels observed at the beach (Figure 3; beach is located in the southeast arm of the lake). Factors such as rainfall, wind and wave action, and animal deposition of feces at the beach may also impact *E. coli* values at Central Park Lake and occasional spikes may continue to occur. However, the reduction in median concentrations and the increase in percent of days meeting the swimming threshold after the lagoon was decommissioned provides encouraging results to support the management decision made at Central Park Lake.

Sampling of the lake water primarily occurs by Iowa State University under a contract with the Iowa Department of Natural Resources. Samples are drawn from the lake at the deepest water location in the northeast quadrant of the lake (Figure 4). Water quality in Central Park lake has showed increasing trends in TP (Total Phosphate as P) from 2001 through 2013 with the highest value occurring in late summer 2012 (0.38 mg/L; Figure 5). From 2013 on, TP values appear to decrease back to values observed in the early 2000's. Trends in OP (Orthophosphate as P) are much more muted, with little evidence of an increasing or decreasing trend prior to or after the lagoon closure. Data for samples taken from the lagoon leachate showed very high levels of both TP and OP prior to when the lagoon was decommissioned (12.0 and 9.6 mg/L; TP and OP, respectively).

Prior to the decommissioning of the wastewater lagoon, the leachate from the lagoon area had a very high ratio of TP to OP, which is indicative of human waste sources rather than sediment-bound phosphorus. Following conversion of the lagoon to a wetland system, TP and OP values drop significantly (Figures 6 and 7) and other than an occasional spike in TP, levels are very low. The cumulative impact of the wastewater lagoon on the overall TP and OP levels in the lake are unknown and other sources of phosphorus are undoubtedly having an impact on the water quality of the lake. Erosion from near shore areas and gullies have likely contributed sediment and related phosphorus to the lake. The construction of three ponds or basins in the western portion of the watershed may reduce the delivery of sediment and phosphorus to the lake, but resuspension of sediment and nutrients is typically a problem in impoundments such as Central Park Lake. Further monitoring will be needed to show the cumulative impact of all the best management practices on Central Park Lake including any dredging that may occur.

Central Park lake ammonia levels have varied throughout the past decade with levels consistently between 0.01 and 0.4 mg/L until 2011. In August of 2011, ammonia levels jumped dramatically and peak over 0.8 mg/L (Figure 8). Following the drought years of 2011 and 2012, ammonia levels appear to decrease, but are still higher than values seen prior to 2011. Samples taken from leachate downgradient of the wastewater lagoon show very high levels of ammonia (as N) with values in excess of 50 mg/L (Figure 9). Following the conversion of the lagoon to a wetland, the ammonia levels drop to below detection limits (<0.05 mg/L) for the majority of the samples. As with the phosphorus numbers, the ability to link in-lake ammonia levels to changes in the wastewater lagoon is difficult as other sources of ammonia and in-lake processes may overwhelm the water quality signal created by the lagoon conversion.

Total Kjeldahl Nitrogen (TKN) provides insight on the organic nitrogen in the Central Park Lake system. As with TP and Ammonia, the TKN data show a strong upward trend from the early monitoring period (2005-2010) to the later monitoring period (2011 to 2014) with a nearly doubled TKN value in the later part of the monitoring record (Figure 10). TKN values seem to have decreased since 2014 to pre-2011 levels. As with the other parameters, other factors such as climate (drought of 2011-2012), watershed activities and lake processing of nutrients may be driving the TKN values. However, much like the TP and Ammonia data, TKN values from water taken below the lagoon dropped significantly following the closure and conversion of the wastewater lagoon to a wetland system. Values of TKN dropped from a high of >60 mg/L to near the detection limit (<0.1 mg/L, Figure 11).

Central Park Lake levels of nitrate have been consistently low throughout the period of monitoring, with the exception of one value in late August of 2011 (Figure 12). As with the other lake parameters, the spike in nitrate during 2011/12 suggests an anomalous event occurred to drive nutrient levels quite high during this time period. Unlike the other parameters, nitrate levels drop rapidly back to pre-2011 levels by 2013 and onward. Data from the decommissioned lagoon show a slightly different pattern than the other nutrients (Figure 13). Nitrate levels prior to wetland conversion are at the detection limit (<0.1 mg/L) and spike in the months immediately following the decommissioning of the lagoon. This result is to be expected as the leachate nitrogen form was as ammonia and TKN prior to the drawdown of water in the lagoon. Following the addition of oxygen to the system, nitrogen converted to nitrate and was leached out of the system immediately following the lagoon decommissioning.

Values of Total Suspended Solids (TSS) in Central Park Lake have varied during the 15 years of monitoring and have ranged from <5 mg/L to over 40 mg/L (Figure 14). Unlike TP and Ammonia, TSS levels are not the highest in 2011 and 2012, but appear to correlate well with years of high rainfall (2007, 2008 and 2013). However, samples taken of the wastewater lagoon leachate showed very high levels of TSS prior to 2013 with a maximum of 160 mg/L (Figure 15). Following the decommissioning of the lagoon, levels were peaking at 20 mg/L, but have decreased to roughly 10 mg/L in the past year. As with the other water quality parameters, it is difficult to link changes in the overall lake water quality taken in samples away from the in-let location of the wastewater lagoon. Additional monitoring should help to show the cumulative impacts of improvements made in the watershed to the overall lake health.

Values of Carbonaceous Biological Oxygen Demand (CBOD) were very high downgradient of the wastewater lagoon prior to the decommissioning of the lagoon (max value of 64 mg/L; Figure 16). Leachate with such a high CBOD content would have a negative impact on the lake as bacteria in the water column would consume organic materials associated with CBOD and cause depression of oxygen levels in the area impacted by the leachate. Following the lagoon conversion to a wetland, CBOD levels drop precipitously and by late 2014 are below detection level for the remainder of the monitoring program.

Summary:

Data collected on Central Park Lake, the beach and wastewater "leachate" provide strong evidence that the decommissioning of the lagoon has had a positive impact on water quality. E. coli bacteria concentrations have dropped at the beach and are now supporting primary contact recreation uses as evidenced by fewer than 10% of the samples violating the A1 standard (235 CFU/100ml). TP, OP, Ammonia, TSS, and CBOD concentrations from the lagoon leachate have all dropped significantly and are the delivery of these contaminants to the lake have undoubtedly improved. While the impacts on the lake water directly are more difficult to discern given the input of other sources of contaminants and overriding factors such as climate, it is likely that the elimination of these contaminants from the lagoon will have a measureable impact on the lake through time.

<u>Figures</u>

Figure 1. *E. coli* concentrations at Central Park Beach in Jones County (2004-2015).

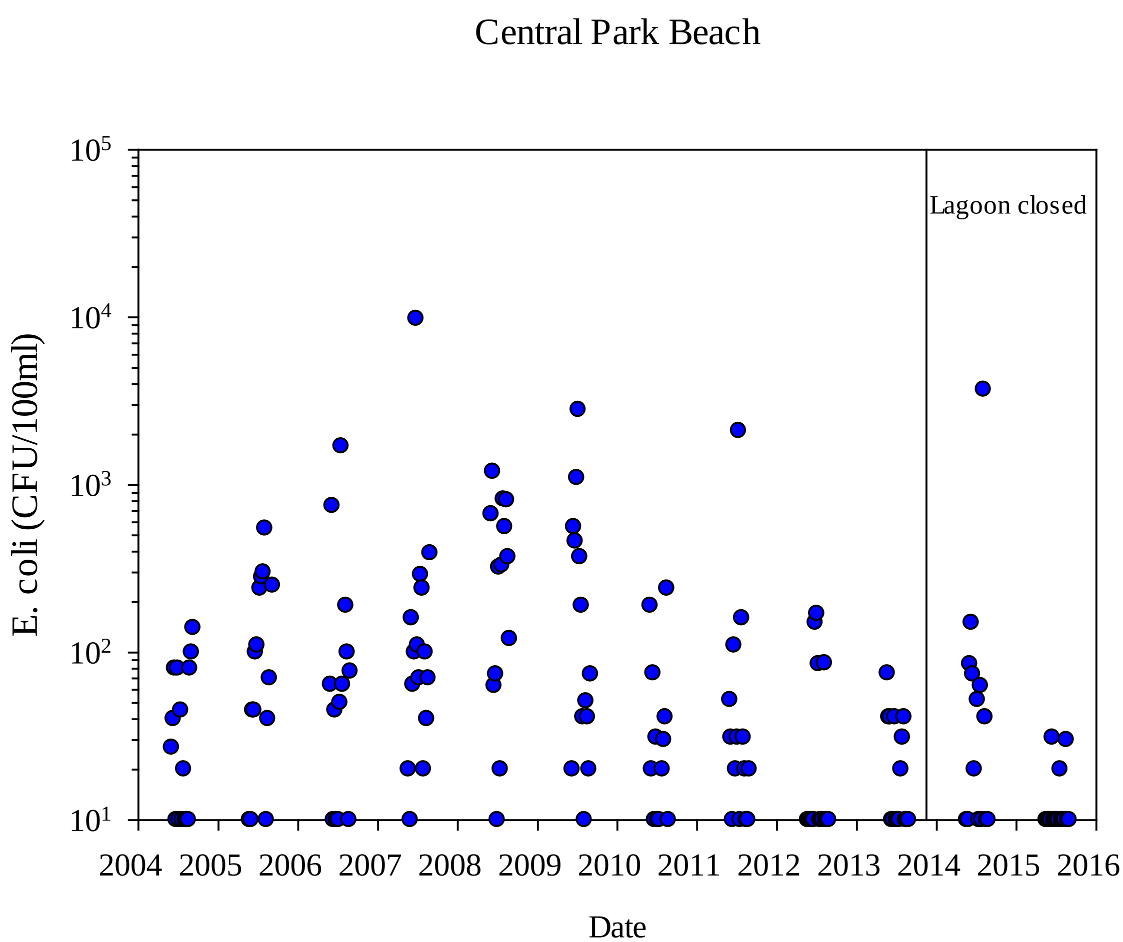


Figure 2. *E. coli* concentrations before and after wastewater lagoon closure.

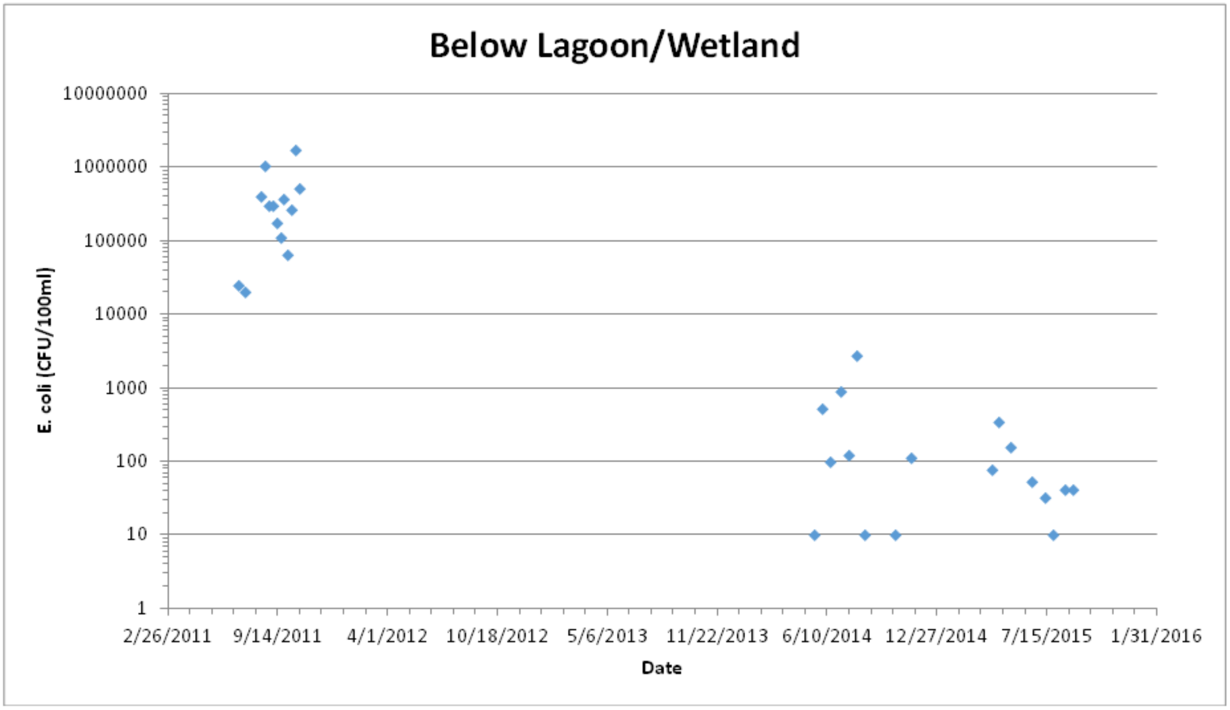


Figure 3. Map of Central Park Lake. Beach area is highlighted by the red circle. Location of wastewater lagoon is indicated by red arrow.

Figure 4. Bathymetric Map for Central Park Lake, Jones County. Lake sampling location is indicated by red dot.

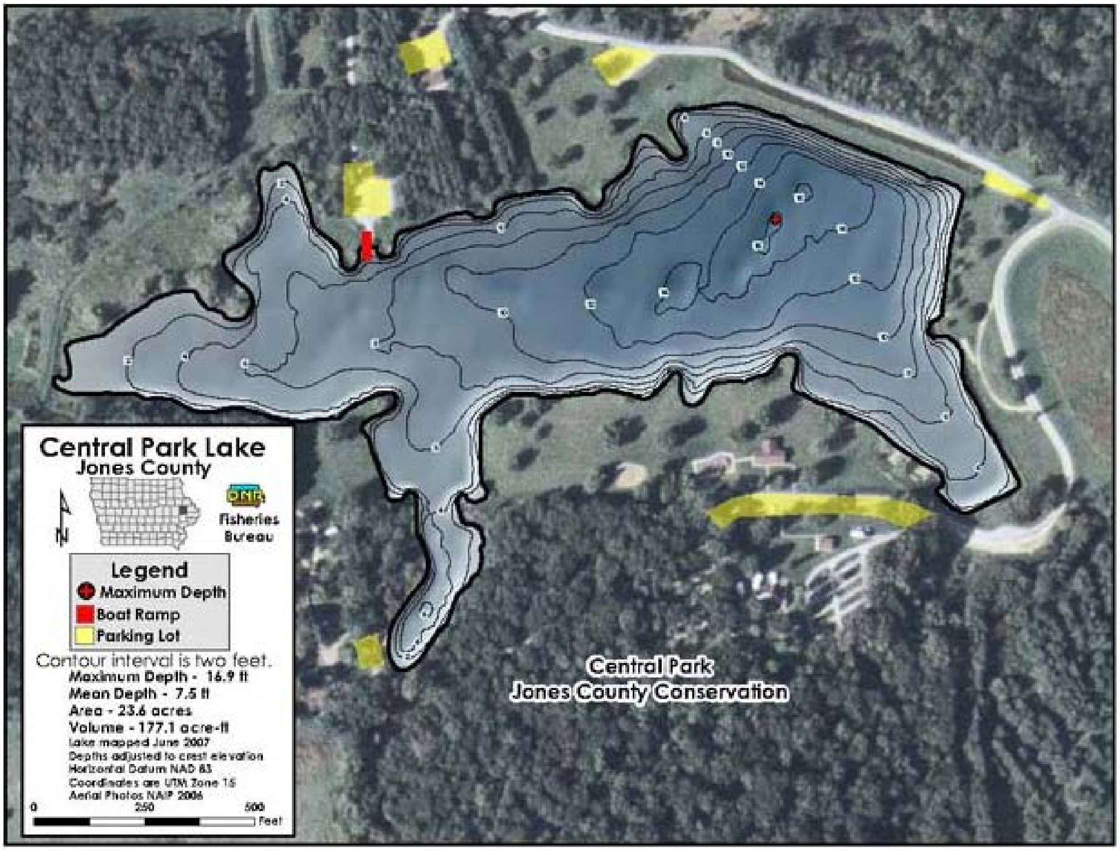


Figure 5. Total Phosphorus and Orthophosphorus concentrations in Central Park Lake (2001-2015).

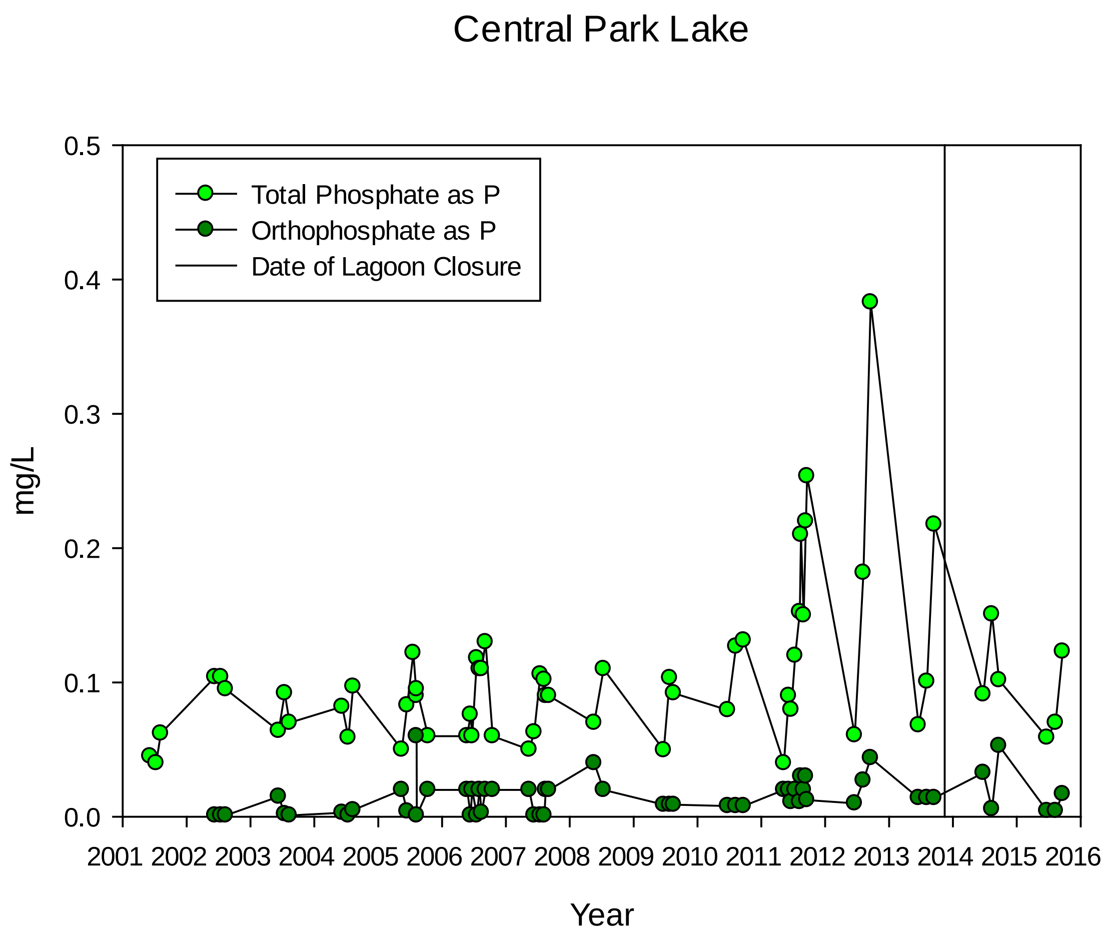


Figure 6. Total Phosphorus concentrations before and after wastewater lagoon closure.

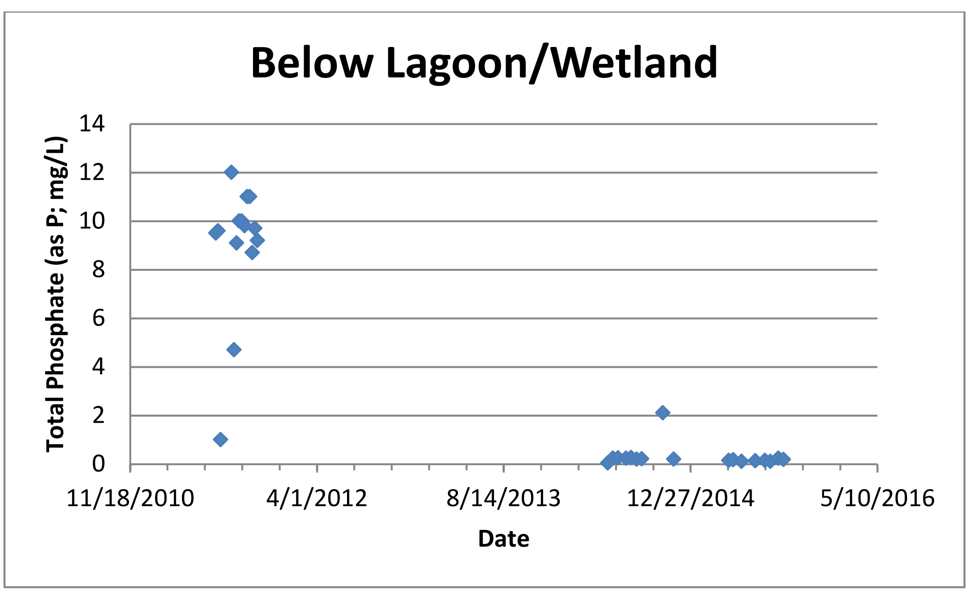


Figure 7. Orthophosphorus concentrations before and after wastewater lagoon closure.

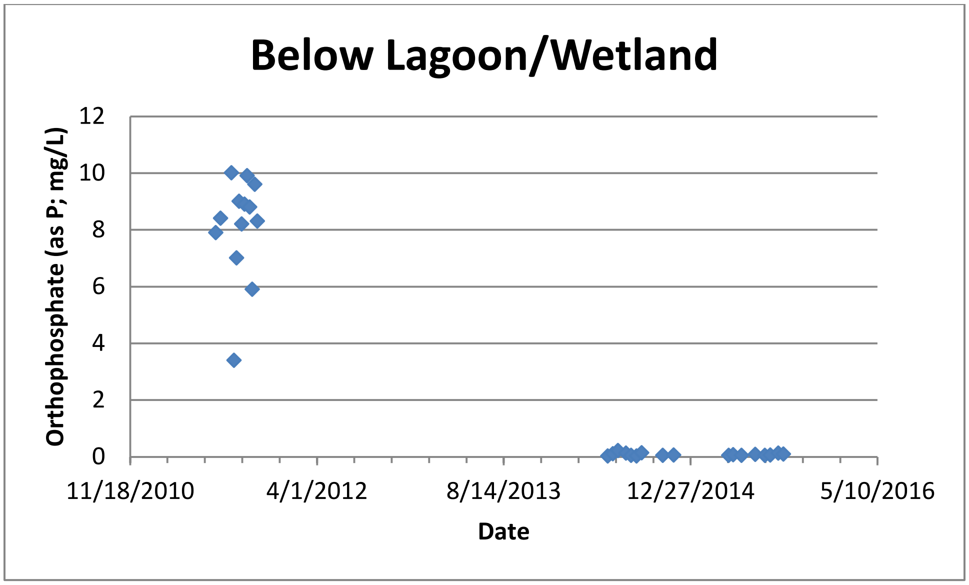


Figure 8. Ammonia concentrations in Central Park Lake, Jones County.

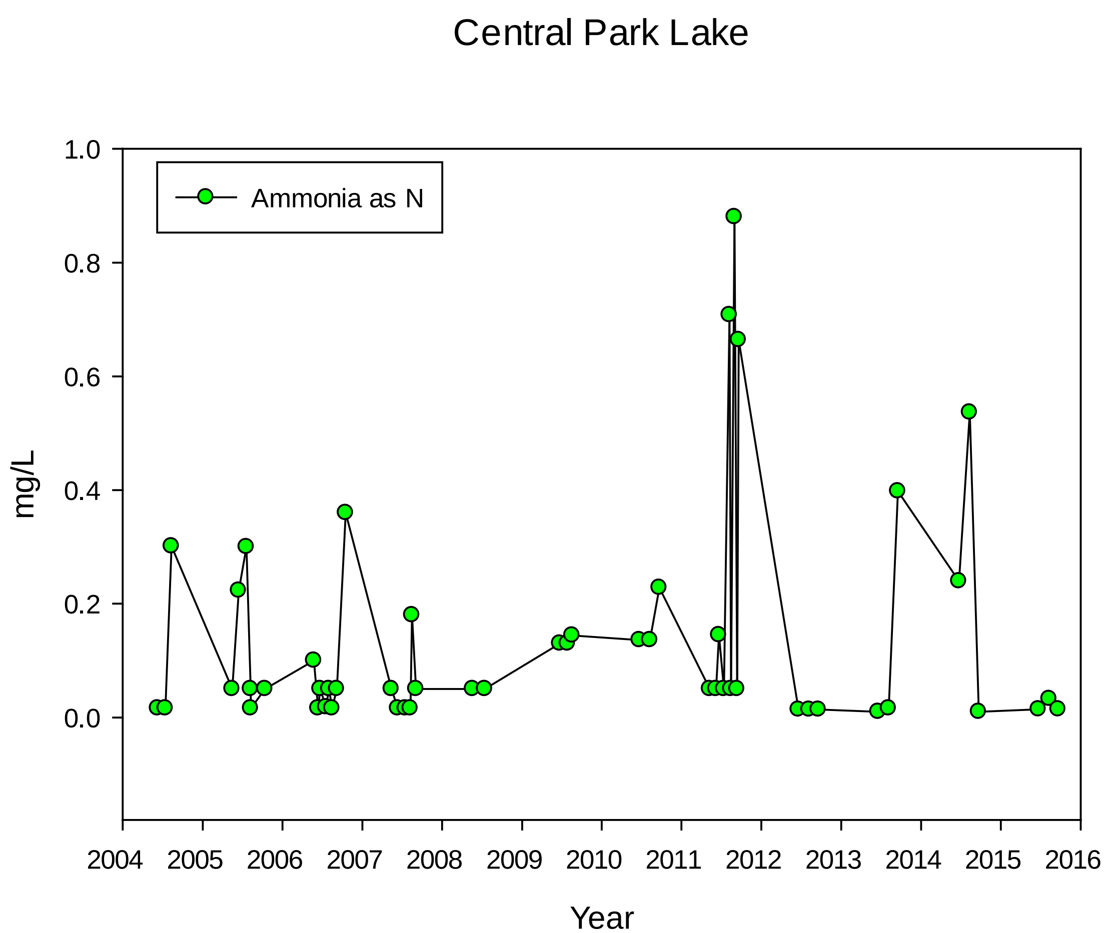


Figure 9. Ammonia concentrations before and after wastewater lagoon closure.

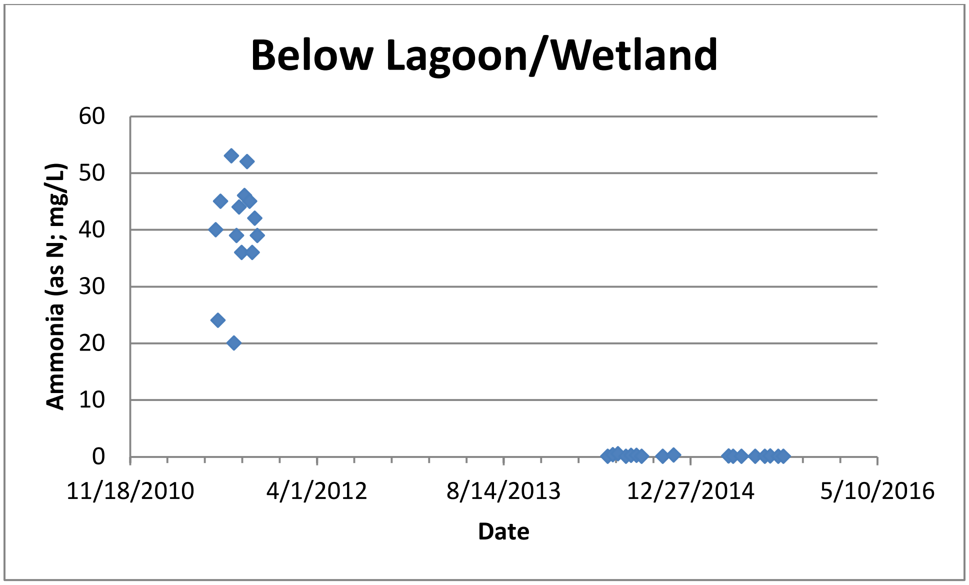


Figure 10. Total Kjeldahl Nitrogen concentrations in Central Park Lake, Jones County.

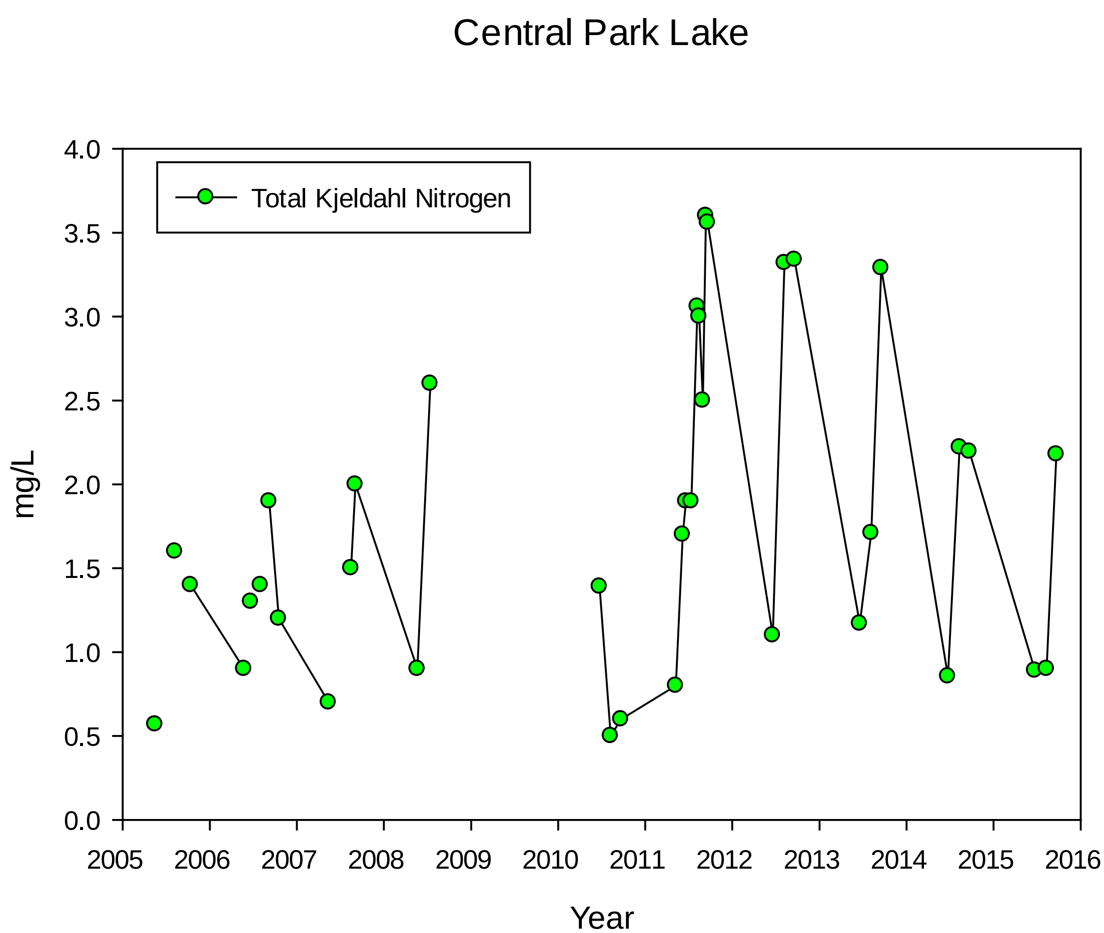


Figure 11. Total Kjeldahl Nitrogen concentrations before and after wastewater lagoon closure.

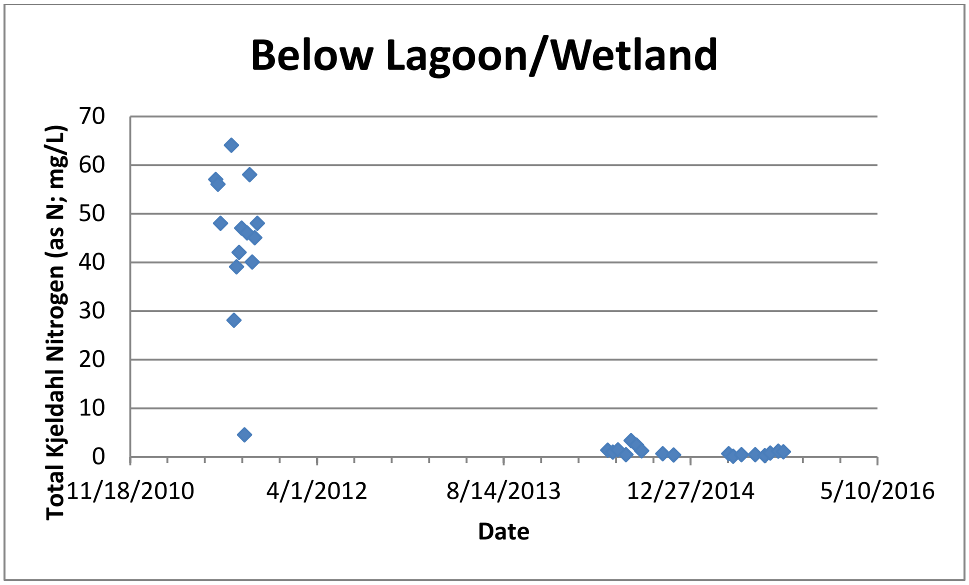


Figure 12. Nitrate plus Nitrite concentrations in Central Park Lake, Jones County.

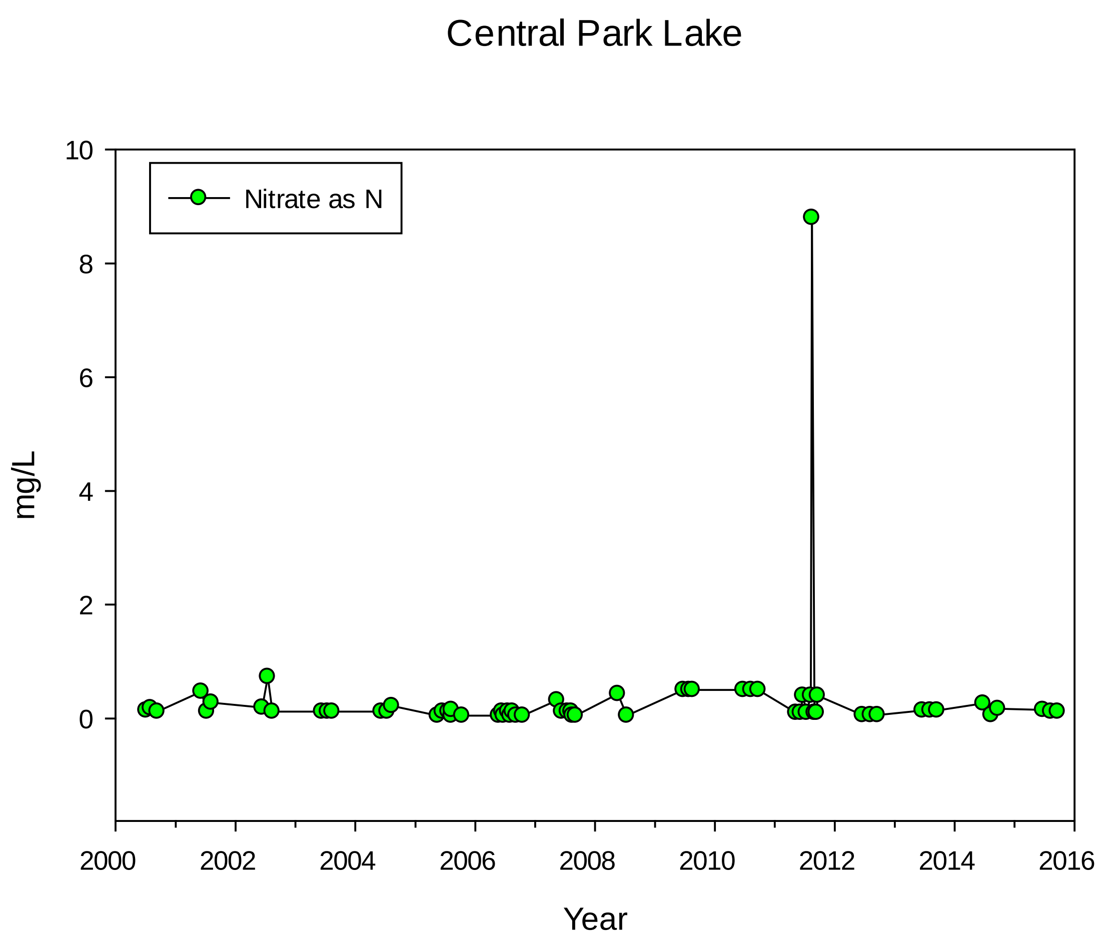


Figure 13. Nitrate plus Nitrite concentrations before and after wastewater lagoon closure.

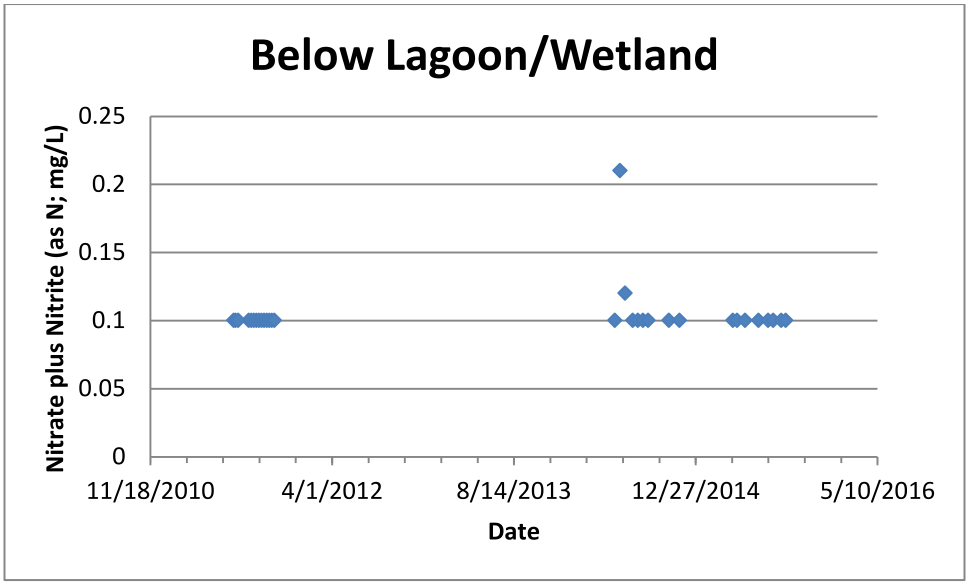


Figure 14. Total Suspended Solids concentrations in Central Park Lake, Jones County.

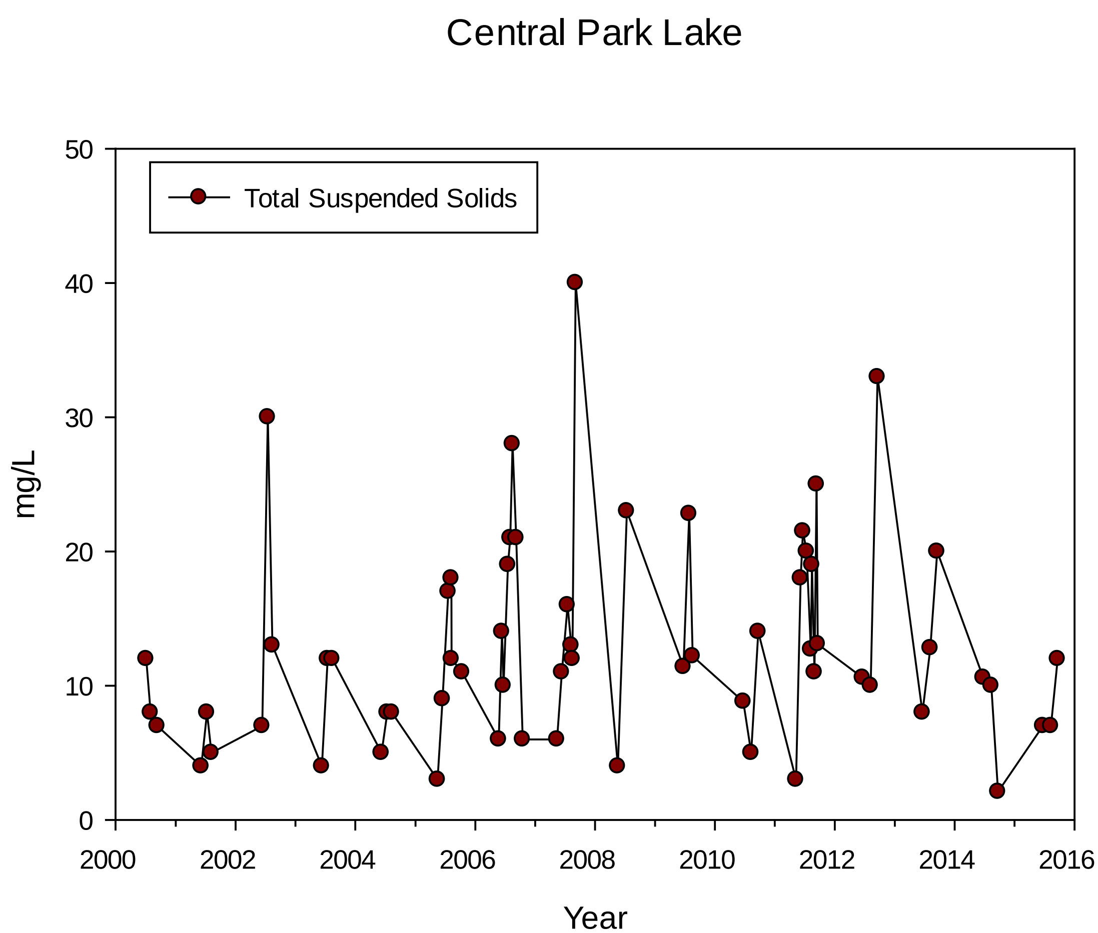


Figure 15. Total Suspended Sediment concentrations before and after wastewater lagoon closure.

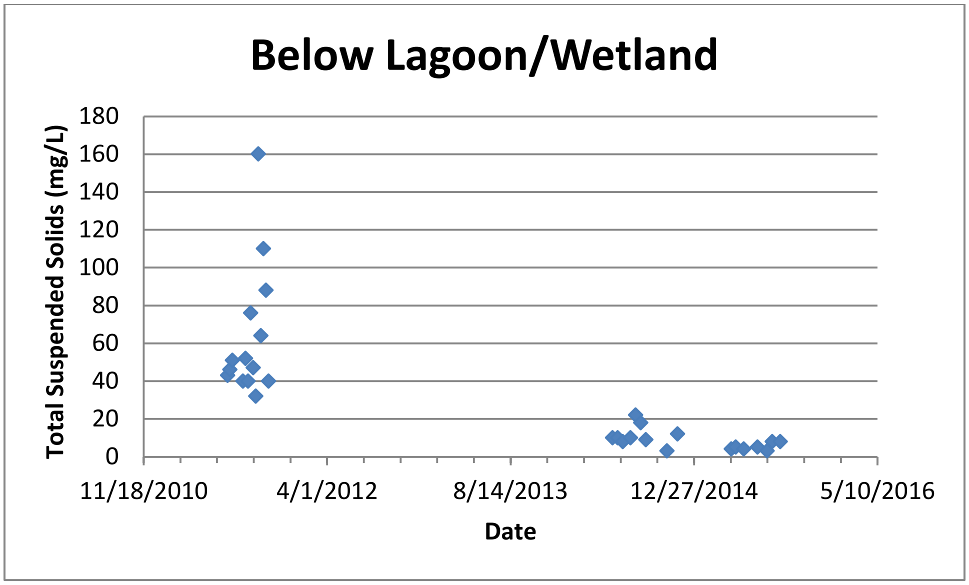
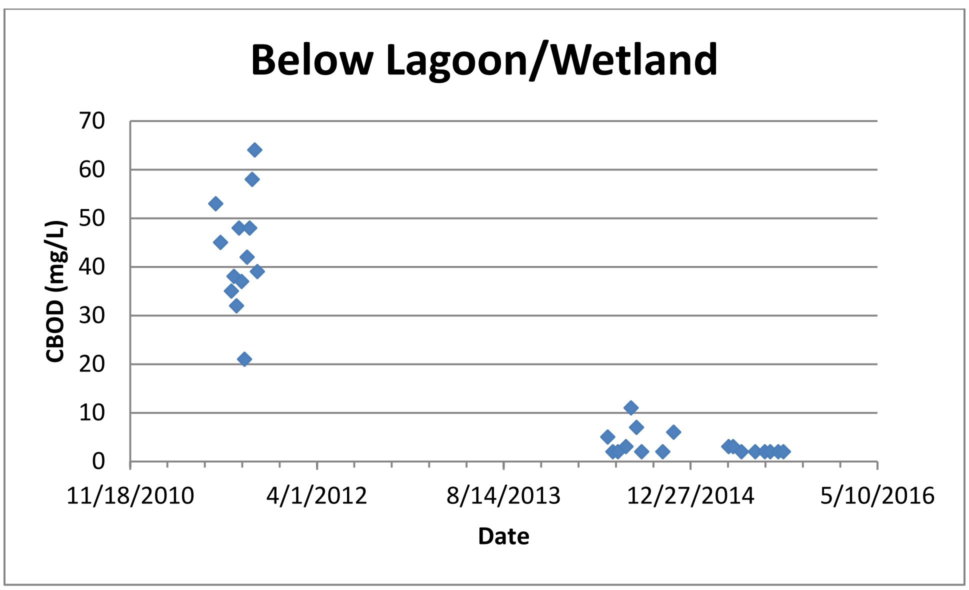


Figure 16. Carbonaceous Biological Oxygen Demand (CBOD) concentrations before and after wastewater lagoon closure.



Appendix B: Photographic Journal

Northwest Wetland

Reclaimed Lagoon/Wetland "Before"

Reclaimed Lagoon/Wetland "After"

Residence Septic Field

Shower House Septic Field

Campground Septic Field

Dump Station Septic Field