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Wetland Project Results
August 7, 2013

Plan for Retrieving Samples:

The initial step in assessing the wetland's ability to remove nutrients and sediments is to collect samples of water for testing. Four samplers, purchased from Teledyne Isco, Inc., were used to collect samples from the wetland based on chosen increments of time or flow. The settings used for the samplers in this project are described in Table 1. Ideally, one sampler would retrieve samples from the inlet and the other from the outlet of each of the two wetland cells, referred to as North and South, in accordance with their respective location. A comparison between the influent and effluent water ultimately shows the best overall assessment of nutrient and sediment removal. Because data from the middle cells is not crucial in this comparison, samples from the cells were collected less frequently as individual grab samples.

Each sample collected was tested at the Bucknell Environmental Engineering and Science Laboratory for total suspended solids, volatile suspended solids, and concentrations of nitrate, phosphate, and ammonia. On site, the water was tested for pH, dissolved oxygen content, depth, and turbidity. All of the tests were conducted in accordance with *Standard Methods for the Examination of Water and Wastewater* (APHA 2012). The data from these tests was then compared with data collected about the amount of rainfall at the each day to determine how different amounts of rain affect the quality of the water. This rainfall data was found from WunderGround's weather history (WunderGround 2013). Each of these tests helps determine if the wetland is filtering the run-off well enough to decrease nutrient pollution and improve overall

water quality.

Table 1. Locations and programming of the different samplers on the wetland site. Note that sampler number 1 was faulty and removed from the site.

SAMPLER POSITIONS			
DATE	*SAMPLER*	*LOCATION*	*INCREMENT OF FLOW (gal/min) OR TIME (min)*
6/12/2013 THRU 6/16/2013	1	N. OUTLET	TIME: 60
	2	N. INLET	TIME: 60
	3	S. INLET	FLOW: 500
	4	S. OUTLET	FLOW: 500
6/16/2013 THRU 6/17/2013	2	N. INLET	TIME: 120
	3	S. INLET	FLOW: 300
	4	N. INLET	FLOW: 300
6/18/2013 THRU PRESENT 7/30/2013	2	N. INLET	TIME: 360
	3	S. INLET	FLOW: 200
	4	N. INLET	FLOW: 200

Results:

North Inlet – Since the start of research, the North inlet has had significant nitrate concentrations, ranging from about 13 to 71 ppm, as seen in Figure 1. Concentrations of phosphate and ammonia were much lower. As shown in Figure 2, phosphate concentrations remained below 4 ppm and ammonia concentrations were all below 1 ppm. Recently, all nutrient concentrations have decreased to below 1 ppm, including nitrates. Other information about the North inlet, including pH, dissolved oxygen, turbidity, and depth can be viewed in Table 2. Recently, with the lack of rain, the depth of the inlet has decreased until it finally disappeared, so tests have not been conducted recently.

The total suspended solids and volatile suspended solids showed a similar pattern of

increases and decreases in Figure 3, though the total suspended solids reached concentrations slightly above 300 mg/L while volatile suspended solids remains under 100 mg/L.

North Middle – Table 3 shows information about pH, dissolved oxygen, turbidity, and depth. The depth of the North cell has decreased recently with the lack of rain. Figure 4 shows that nitrate concentration in the middle cell initially increased but most recently has decreased significantly but overall does not exceed 3.5 ppm. These concentrations of nitrate were far less than the concentrations found in the inlet. Phosphate was absent in the middle of the wetland, existing only in trace amounts if at all. Ammonia, however, continuously remained below 1 ppm.

The amount of solids in the North middle seemed to increase at a steady rate overall with one large increase towards the end of June that quickly leveled off again. Both total suspended solids and the volatile suspended solids maintained this pattern in Figure 5. Amounts of total suspended solids remained between 14 and 71 mg/L, volatile suspended solids was just slightly lower with a range of 7 to 62 mg/L.

North Analysis – When the North inlet and middle were compared, it was clearly seen that the nitrate concentration has significantly decreased. The wetland was very effective in removing the high concentration of nitrate flowing into the system. Though the phosphate concentrations remained in a similar range in both the inlet and the middle, the phosphate concentration has decreased slightly in the middle cell. The same was apparent for ammonia; both the inlet and middle had a similar range of ammonia concentration, but the middle does in fact contain less ammonia. The following are the average removal percentages for nitrate, phosphate, and ammonia, respectively: 97.1%, 100%, and 27.8%. The removal of ammonia appears to be low in comparison to the other nutrients, but ammonia was present very

infrequently and in trace amounts. Overall, these three significant nutrients have lower concentrations in the middle of the wetland than in the inflow of water which suggests the wetland was successful in nutrient removal.

The overall amount of solids in the North part of the wetland showed a significant decrease when compared in Figure 10. Water flowing into the system may have more than 300 mg/L of solids, but in the middle the amount did not exceed 71 mg/L. On average, the removal percentage for total suspended solids was 43.1%, while the removal percentage for volatile suspended solids was 58.7%. This decrease in solids is also a sign of the wetland's success at filtering runoff.

South Inlet – The South inlet does not have a steady inflow, so the data in Figure 6 is sparse. With what has been collected, the overall nitrate concentration decreased steadily from about 3 ppm to 1 ppm. Phosphate followed a similar pattern to that of the nitrate, though from the last sample the phosphate concentration increased again. The concentration of phosphate remained close to 1 ppm in general. Ammonia was present only in trace amounts, if at all. The South inlet pH, dissolved oxygen, turbidity, and depth can be found in Table 4. Data for the South inlet is limited, however.

The total suspended solids and total volatile solids both have increased and followed a similar pattern in Figure 7. Both maintained a steady concentration until the most recent sample from mid-July which showed a great increase. The total suspended solids remained within a range of 23 to 138 mg/L while total volatile suspended solids were between 7 to 50 mg/L.

South Middle – Figure 8 showed that the nitrate concentration in the South middle cell remained within 0 to 4 ppm, starting with an initial increase and has been decreasing since late June. Phosphate was only briefly present in mid-June and did not exceed 1.75 ppm and was

absent in the rest of the samples. Ammonia was not present in this section of the wetland. Table 5 shows pH, dissolved oxygen, turbidity, and depth. As with the other parts of the wetland, depth has decreased significantly with the hot weather and lack of precipitation.

The total suspended solids and volatile suspended solids both followed a similar pattern in Figure 9 of increases and decreases. TSS remained within a range of 5 to 14 mg/L and VSS remains within 2.5 to 7.33 mg/L.

South Analysis – All three nutrients were present in lower concentrations, if at all, in the South middle when compared to the South inlet. The average removal percentages of nitrate, phosphate, and ammonia are as follows, respectively: 31.5%, 34.4%, and 100%. These percentages are based on limited data because of the lack of water flowing into the South wetland. The South side of the wetland appears to be removing nutrients effectively.

The amount of solids also showed an overall decrease between the inflowing water and the middle of the wetland. The percent removal of TSS was 85.4%, and 72.6% for VSS. Though there had not been much flow occurring in the South wetland, the sparse data still showed improvement.

Data:

Table 2. Data for the North inlet including pH, dissolved oxygen, turbidity, and depth.

NORTH INLET				
DATE & TIME	*PH*	*DO (mg/L)*	*TURBIDITY (NTU)*	*DEPTH (IN.)*
6/14/13 2:00 PM	6.9	-	4.22	2+
6/18/13 12:00 PM	7.56	4.87	4.31	2+
6/28/13 12:00 AM	7.35	4.51	3.72	2+
7/1/13 1:30 PM	7.11	5.5	2.58	3
7/11/13 12:00 PM	7.02	5.8	2.46	2
7/15/13 11:00 AM	-	-	-	0
7/18/13 10:30 AM	-	-	-	0

Table 3. Data for the North middle wetland cell including pH, dissolved oxygen, turbidity, and depth.

NORTH MIDDLE				
DATE& TIME	*PH*	*DO (mg/L)*	*TURBIDITY (NTU)*	*DEPTH (IN.)*
6/14/13 2:00 PM	6.4	X	39.7	X
6/28/13 12:00 AM	7	2.63	104	X
7/1/13 1:30 PM	7.23	13.1	12.1	5+
7/11/13 12:00 PM	X	X	12.9	6+
7/30/13 12:00 PM	7.05	8.59	31.1	<5

Table 4. Data for the South inlet including pH, dissolved oxygen, turbidity, and depth.

SOUTH INLET				
DATE& TIME	*PH*	*DO (mg/L)*	*TURBIDITY (NTU)*	*DEPTH (IN.)*
6/14/13 2:00 PM	6.38	-	42.8	-
6/28/13 12:00 AM	-	-	110	-
7/1/13 1:30 PM	9.22	15.73	246	1.75+
7/30/13 12:00 PM	-	-	-	0

Table 5. Data for the South middle wetland cell including pH, dissolved oxygen, turbidity, and depth.

SOUTH MIDDLE				
DATE & TIME	*PH*	*DO (mg/L)*	*TURBIDITY (NTU)*	*DEPTH (IN.)*
6/14/13 2:00 PM	6.39	X	9.55	X
6/28/13 12:00 AM	X	X	6.76	X
7/1/13 1:30 PM	8.2	8.53	13.8	8+
7/11/13 12:00 PM	X	X	4.23	6+
7/30/13 12:00 PM	7.21	17.27	6.89	<6

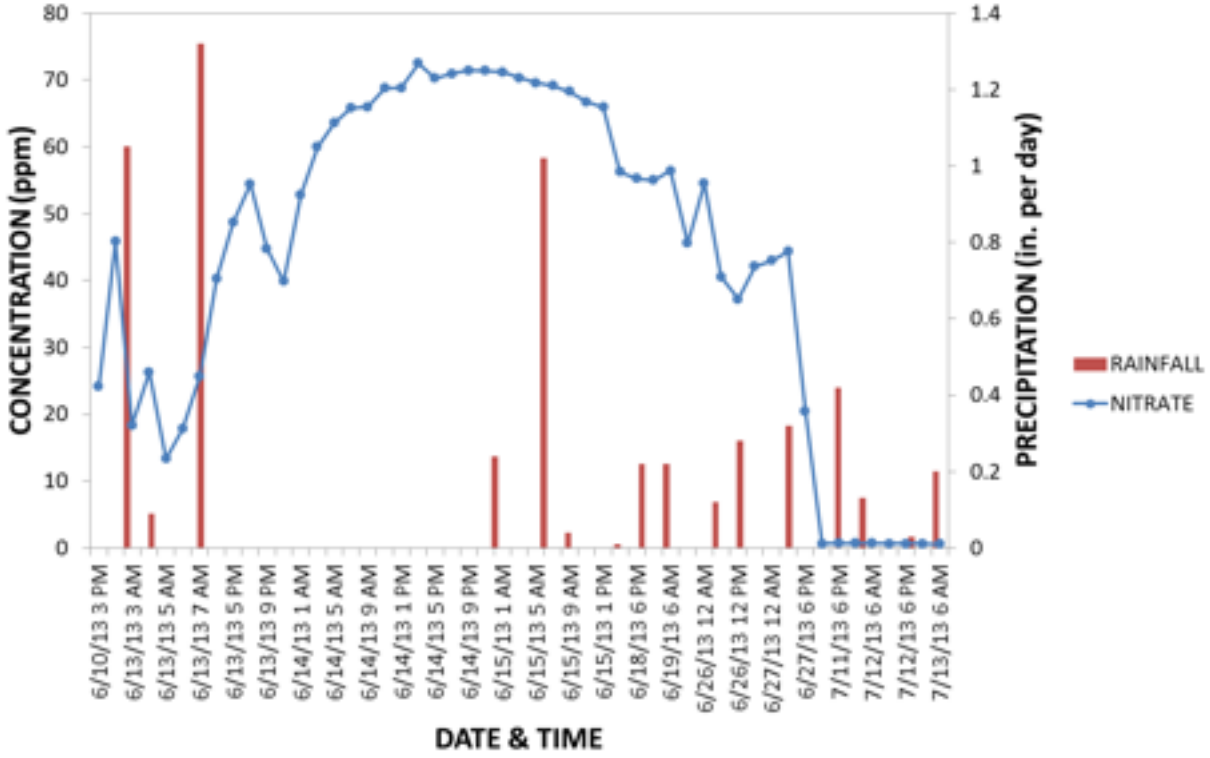

Figure 1. North inlet nitrate concentrations in parts per million with relation to rainfall in inches per day.

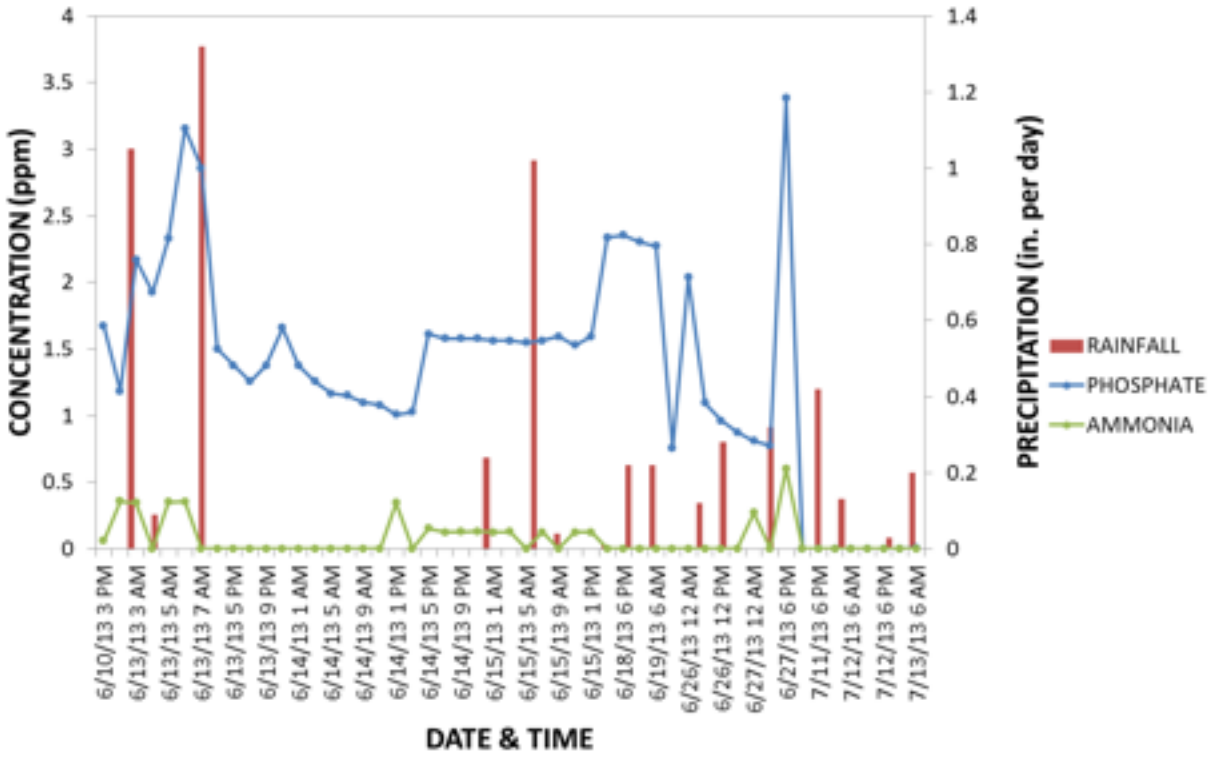

Figure 2. North inlet phosphate and ammonia concentrations in parts per million with relation to rainfall in inches per day.

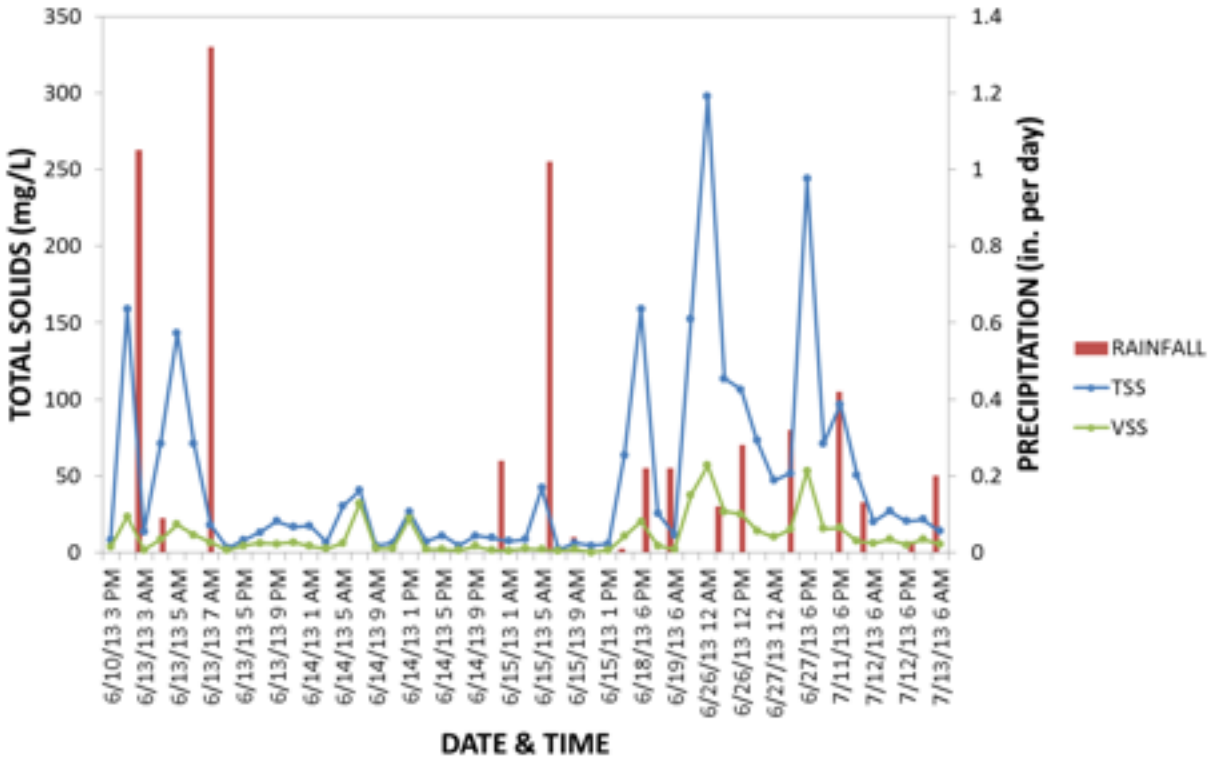

Figure 3. Total suspended solids and total volatile solids in milligrams per liter with relation to rainfall in inches per day.

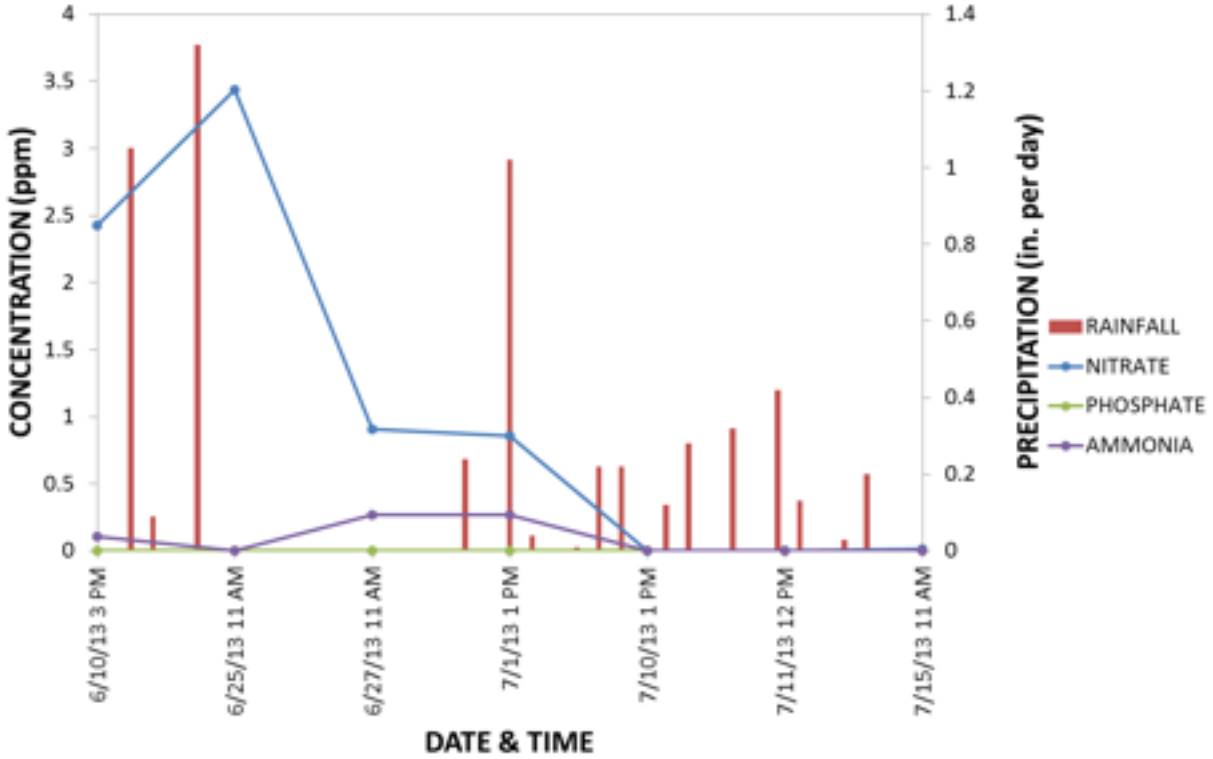

Figure 4. Nitrate, phosphate, and ammonia concentrations in parts per million in the North middle wetland cell with relation to rainfall in inches per day.

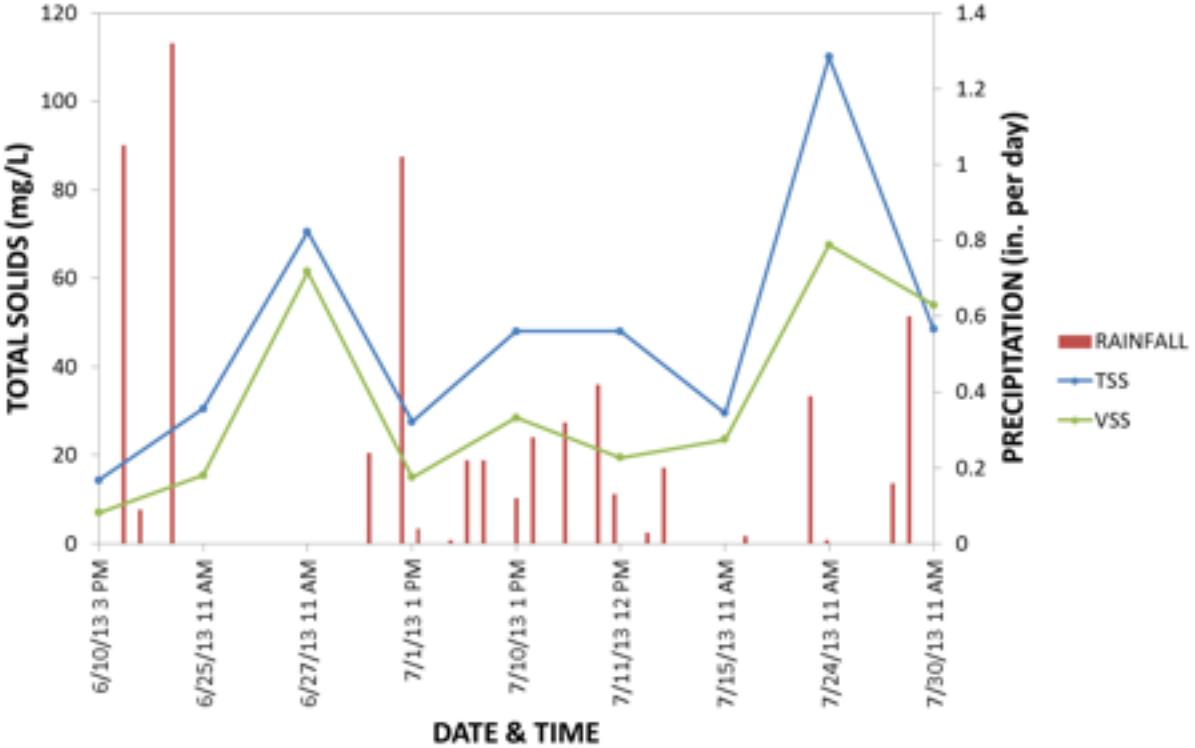

Figure 5. Total suspended solids and total volatile solids in milligrams per liter in the North middle wetland cell with relation to rainfall in inches per day.

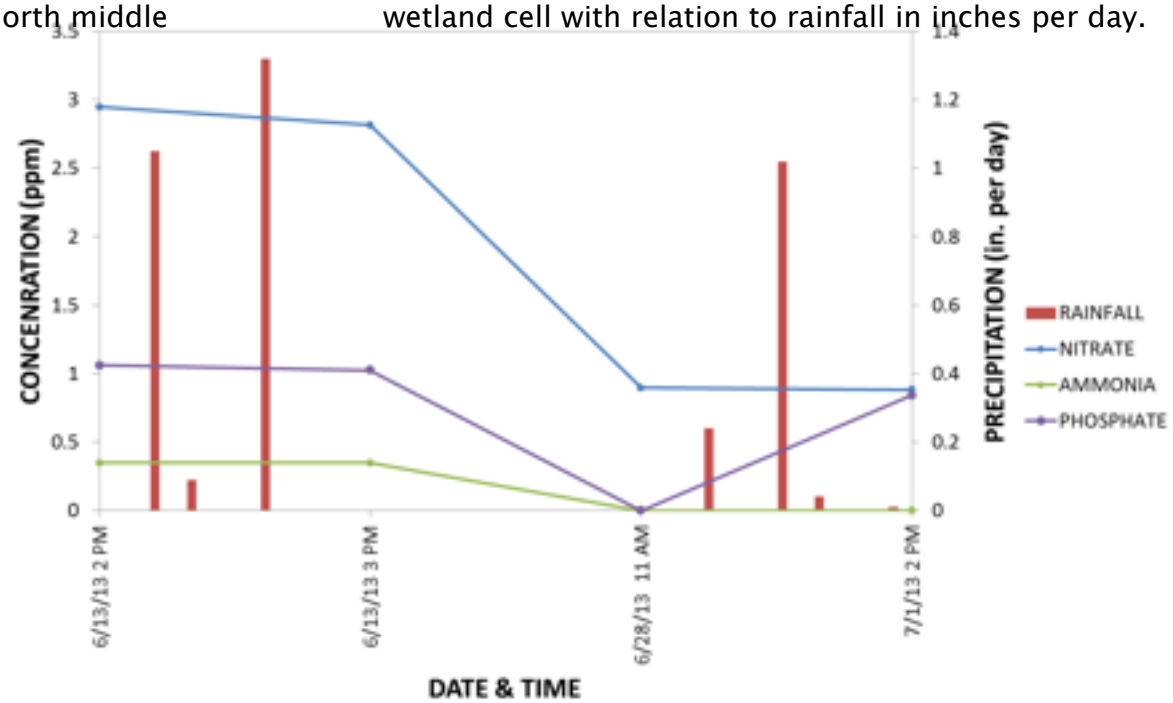

Figure 6. Concentrations of nitrate, phosphate, and ammonia in parts per million in theSouth inlet with relation to rainfall in inches per day.

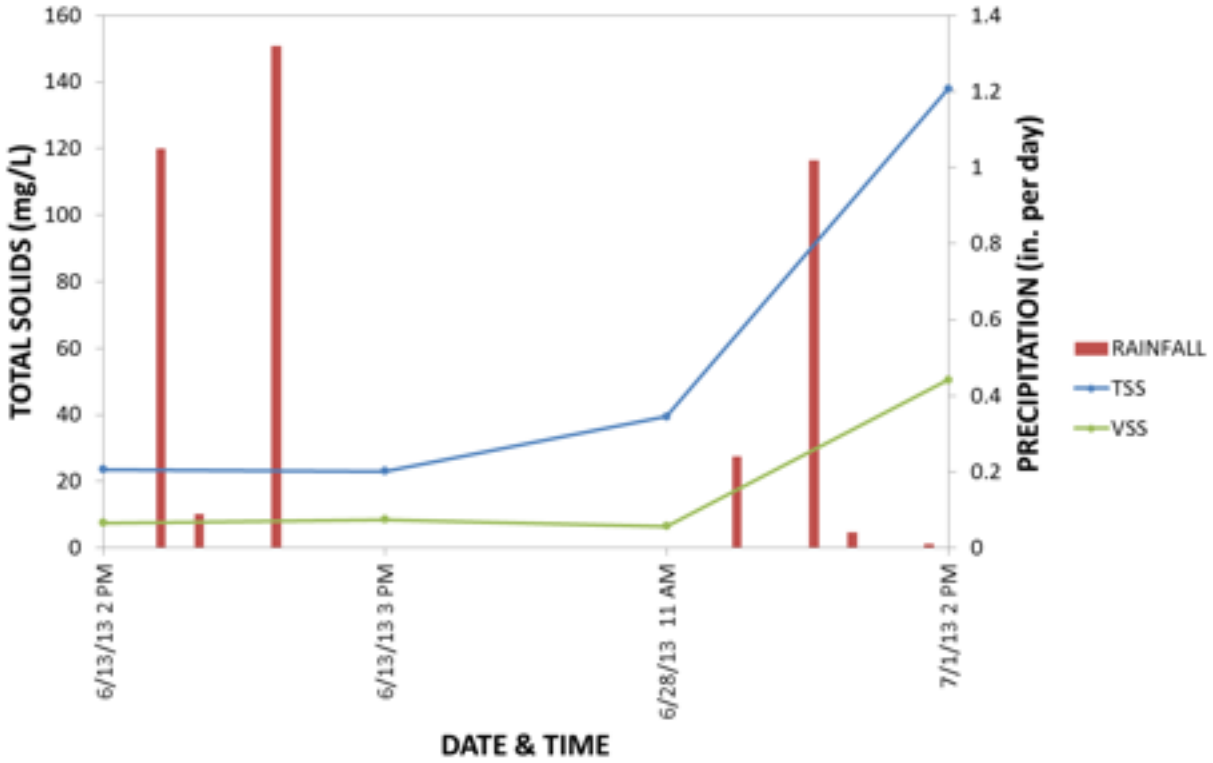

Figure 7. Total suspended solids and total volatile solids in parts per million in the South inlet with relation to rainfall in inches per day.

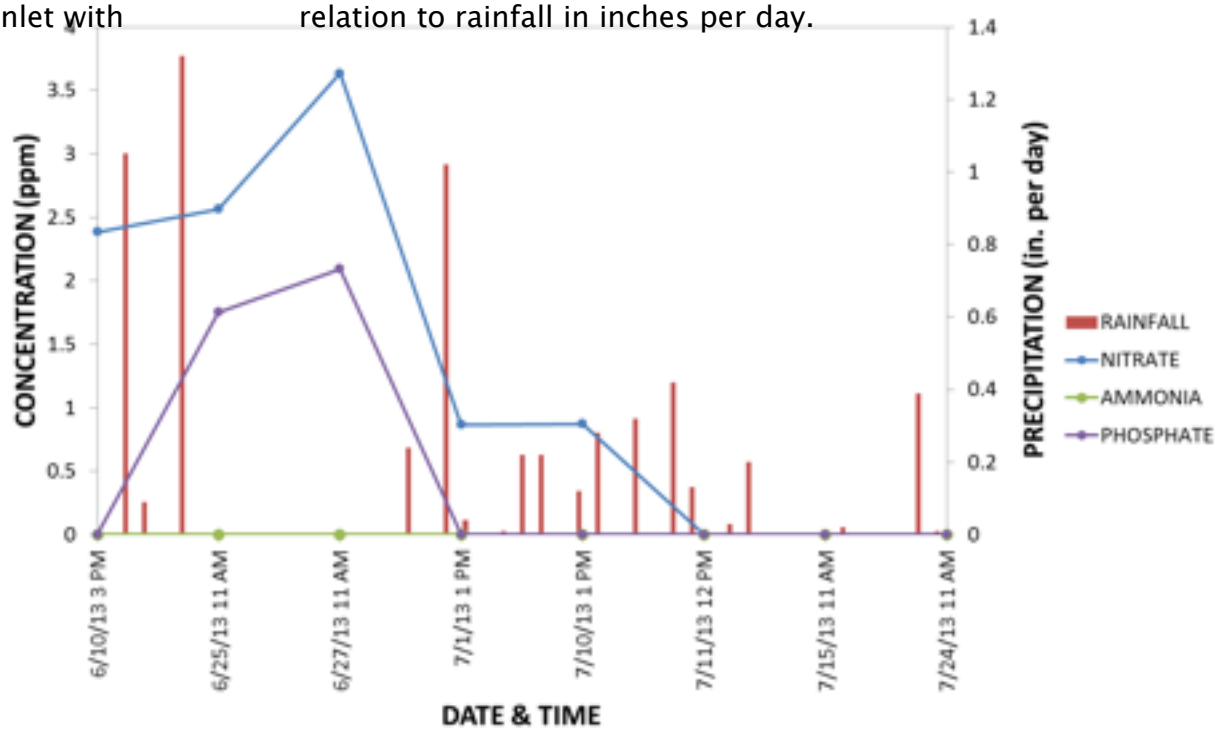

Figure 8. South middle wetland cell concentrations of nitrate, phosphate, and ammonia in parts per million with relation to rainfall in inches per day.

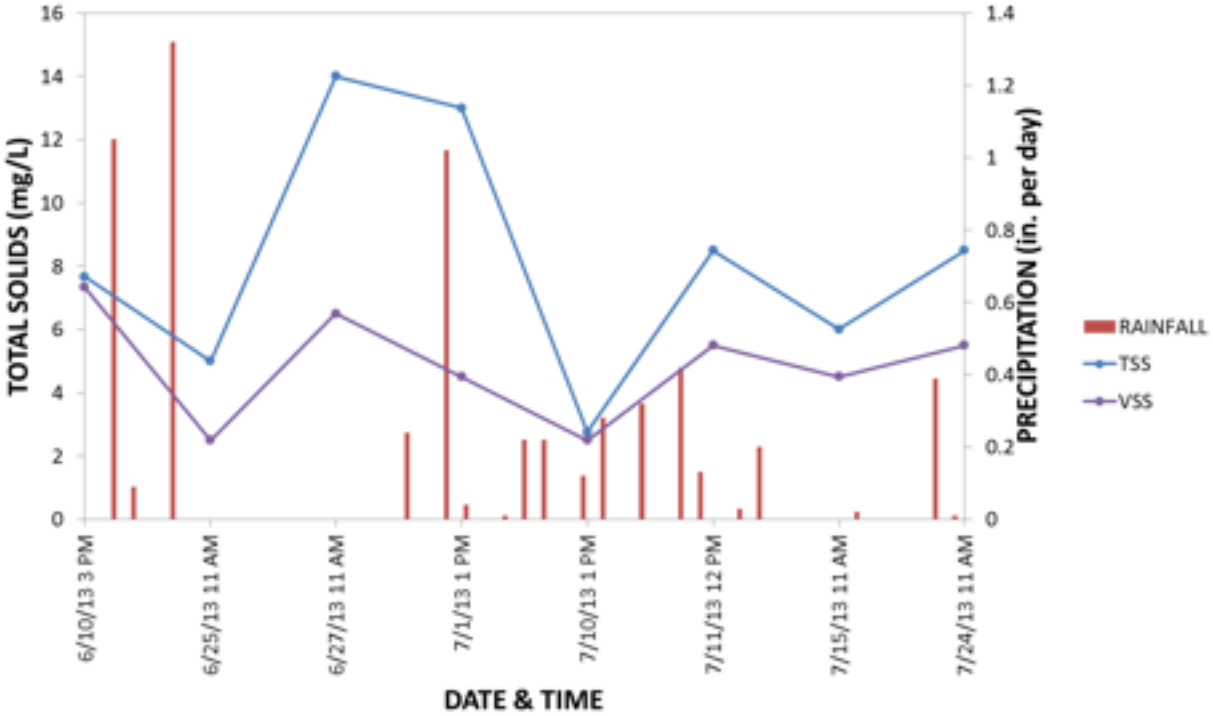

Figure 9. Total suspended solids and total volatile solids in parts per million in the South middle wetland cell with relation to rainfall in inches per day.

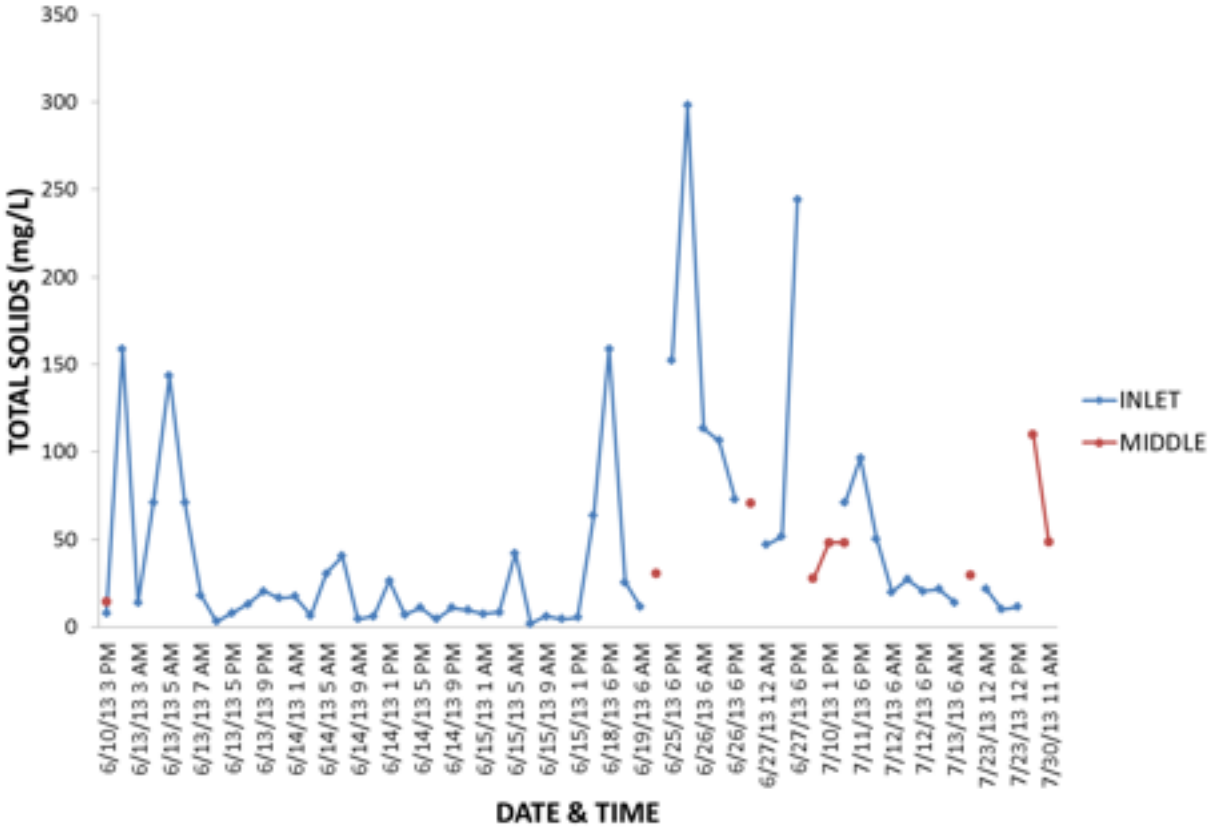

Figure 10. Comparison of the total suspended solids in milligrams per liter found in the North inlet and the North middle wetland cell.