Appendix E

Baseline Water Quality Sampling Report

PRELIMINARY DRAFT

Restoration of Northwest and Northeast Ponds, Hempstead Lake State Park, Nassau County, NY

Baseline Water Quality

Sampling Report

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1.0 Introduction

NYS Office of Parks, Recreation and Historic Preservation (OPRHP) is in the planning phase of the restoration of the Northwest Pond and Northeast Pond areas in Hempstead Lake State Park. The two ponds are located in an underutilized area of the park in the northern part of the park, on the north side of Southern State Parkway. Both ponds are part of the waterway system that collects runoff and drainage from the upper watershed area north of the park, and discharges downstream to Hempstead Lake and the Mill River System, which ultimately discharges to Hewlett Bay. Based on site investigations and bathymetric surveys performed by Cashin Associates (CA), a significant amount of sediment and debris has accumulated in the two northern ponds. In addition, preliminary sediment sampling conducted by CA in 2015 demonstrated some high levels of sediment contamination. Due to these conditions, water sampling was conducted to capture the current water quality conditions in each pond.

Understanding the water quality issues in the pond system will help advance the preliminary restoration concepts already envisioned by OPRHP as presented in the recent planning documents (Road Map to a Safe and Sustainable Mill River Water System, 2015 and Resiliency by Design - Mill River Corridor, 2015). Restoration of the two northern ponds represents a substantial benefit to the park and downgradient surface waters by providing for environmental remediation, improved resiliency to future storm events, and additional recreational/educational opportunities for the community. The restoration will utilize sustainable design concepts including constructed wetland filtration systems.

This sampling effort is part of a larger study that will help identify ways to improve and manage water quality by reducing point and non-point source pollution, as well as reducing accumulation of sediments and debris. Current conditions contribute to water quality degradation by allowing bacteria, nutrients, debris, sediment, and contaminants to enter the Northeastern and Northwestern pond system. The results of this sampling can help identify the problems related to stormwater. This can be used to identify alternative management options and capital improvements that can prevent or mitigate the negative

effects from stormwater. The results of this sampling will also serve as the water quality baseline on which the effectiveness of improvements can be measured.

2.0 Known Water Quality Issues

- Fine-grained sediments represent the small solid particles that enter the ponds through stormwater inputs. Due to the organophilic nature of many toxins, these fine-grained sediments tend to harbor a disproportionately higher concentration of contaminants than larger sediments. In addition, these fine-grained sediments can be easily re-suspended which can cause harm to fish and other aquatic animals. Furthermore, they can cover the pond beds which can smother the benthos and lead to hypoxia due to excessive bacterial decomposition of the organic material (Owens, 2005)

- Phosphorous and Nitrogen enter the system through non-point and point sources. They are the nutrients responsible for excessive plant growth. Sources of this pollution include lawn fertilizers, wastewater, and animal waste. Excessive inputs of these nutrients can result in excessive growth of algae and other plant life which can create ecological imbalances in the pond system, as well as deficiencies in dissolved oxygen (USEPA, 2016a).

- Coliform and Enterococci bacteria are pathogens that are indicators used to trace improperly treated or untreated sewage, animal waste, and water fowl waste. Both of these bacteria are considered indicator organisms because if they are detected in large quantities, they signal the possibility of more harmful pathogens such as viruses. Fecal coliform (a component of total coliform) usually indicates the presence of mammal or bird feces. Enterococci bacteria can be used as an indicator of the presence of feces from warm blooded animals, and typically human-specific feces (USEPA, 1997).

- Floatables including plastics and other light-weight debris are visible evidence of polluted waters. While obviously aesthetically offensive, floatables can also be ecological harmful. They may entangle wildlife or be mistakenly eaten by aquatic life. Furthermore, plastics, which are highly persistent, can leach toxic substances such bisphenal A (BPA) and phthalates into the environment (WCDOH, 2016). The floatables are generally entering the pond system through stormwater drainage and human activity (USEPA, 2002)

3.0 Field Sampling Program

The purpose of this sampling effort was to characterize the baseline water quality of the ponds, as well as to determine the impacts stormwater has on the water quality of the pond system. Surface water samples were collected during both dry and wet weather conditions. The intent of the dry weather sampling event was to establish the background levels of pollution which may be derived from previous stormwater inputs, sediment-water column fluxes, or groundwater inputs. The intent of the wet weather sampling event was to determine the impact stormwater has on contaminant loading in the pond system. The dry weather sampling event was conducted on November 3, 2016 following a week without any significant rainfall. The wet weather sampling event was conducted on November 15, 2016 during heavy rain in which approximately 1.5 inches of rain fell.

3.1 Station Locations

Seven stormwater sampling locations were identified, as follows: a stream located in the northeast corner of the Northeast Pond (WQ-1); an outfall located along the northern shoreline of the Northwest Pond (WQ-2); and three outfalls from Southern State Parkway along the southern boundary of Northeast Pond (WQ3-5). In addition, water quality samples were collected at the culvert leading from the Northeast Pond to Northwest Pond (WQ-6), and the culvert leading from the Northwest Pond into Hempstead Lake (WQ-7). Figure 1 is a map which shows the location of the seven sampling sites.

north

0 200' 400'

Scale: 1" = 200'

Figure 1 - Sample Site Locations

Cashin Associates, P.C.
ENGINEERING • PLANNING • CONSTRUCTION MANAGEMENT
Est. 1959

Hempstead Lake State Park
Northeast and Northwest Ponds

3.2 Sampling Parameters

The sampling parameters analyzed were chosen based on their common presence in stormwater. Table 1 details the parameters that were analyzed.

Table 1. List of Analysis and Parameters Tested.

Analysis	Parameter
Bacteria Counts	Enterococci, Total and Fecal Coliform
Nutrient Concentrations	Ammonia (NH_3), Nitrate (NO_3), Total Nitrogen, Total Kjeldahl Nitrogen (TKN), Total Phosphorous
Particle Concentrations	Total Suspended Solids (TSS)
Volatile Organic Compounds	Total BTX, Benzene
Semi-Volatile Organic Compound	Total PAHs
Heavy Metals	Arsenic, Mercury, Cadmium, Lead, Chromium, Nickel, Silver, Zinc, Copper
Pesticides	Diledrin, DDT, DDE, DDD, Mirex PCBs

4.0 Results

4.1 Bacteria Counts

The surface water samples were analyzed for three bacterial indicators (enterococci, total coliform, and fecal coliform) by Long Island Analytical Laboratories, Inc. The bacterial analysis for the surface water samples indicated that fecal coliform levels exceeded the standard value at each sampling location during both sampling events.

The New York water quality standards for coliforms (6 CRR-NY 703.4) state that:

- For Total Coliforms (measured as number per 100 millimeters [ml]) "the monthly median value and more than 20 percent of the samples from a minimum of five examinations, shall not exceed 2,400 and 5,000, respectively."
- For Fecal Coliforms (measured as number per 100 ml) "the monthly geometric mean from a minimum of five examinations shall not exceed 200."

All but three samples analyzed for total and fecal coliform were found to be above the maximum detection limit. These results demonstrate that the ponds are highly polluted with bacteria. However, since most samples exceeded the maximum detection limit, the exact differences in total and fecal coliform levels between the dry and wet sampling events could not be determined (all results found above the maximum detection limit were reported as greater than 1600 MPN/100 ml). On the contrary, results for *Enterococci* were variable; only one sample exceeded the maximum detection limit. For the dry and wet sampling events, the average *Enterococci* sample reading was 54 MPN/100 ml and 1,992 MPN/100 ml, respectively. This large increase during the wet sampling event suggests that the majority of bacteria is being introduced into the pond system via stormwater (Figure 2).

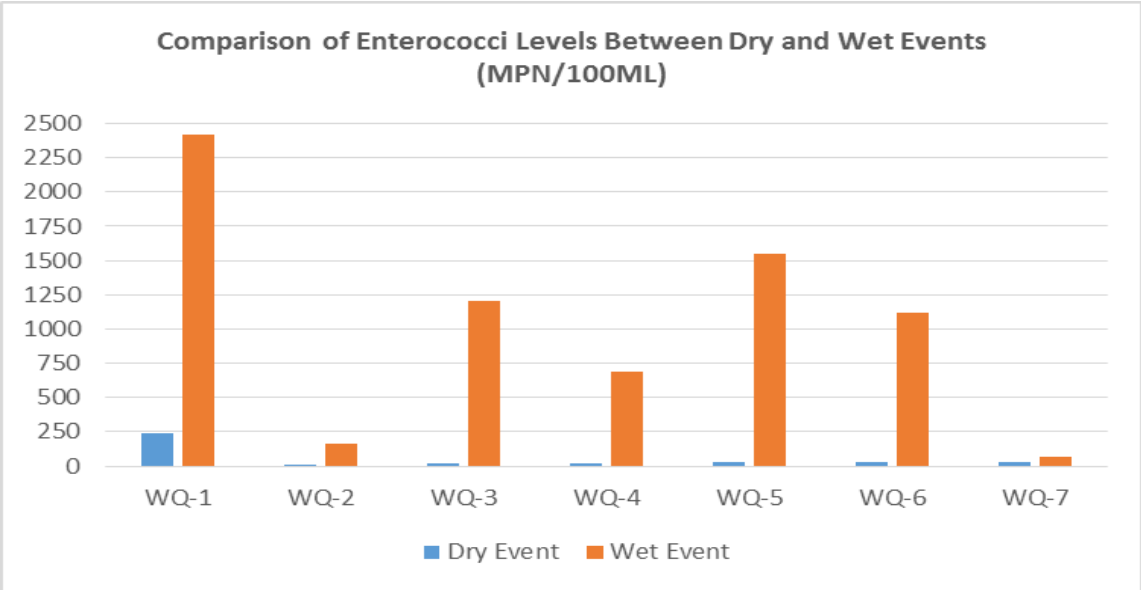
These bacteria are indicator species which represent the relative concentration of pathogens in a water body. Pathogens are bacteria, viruses and other microorganisms that cause infections and disease. The ecological effect of high bacteria concentrations

includes the risk of diseases for aquatic species and, if the source is improperly treated sewage, many additional problems including increased biological oxygen demand and eutrophication (USEPA, 1997). Table 2 shows the result of the bacteria analyses.

Table 2. Results of the Bacterial Analysis (measurements expressed in MPN/100ml).

Sample ID	Dry Event			Wet Event		
	Enterococci	Total Coliform	Fecal Coliform	Enterococci	Total Coliform	Fecal Coliform
WQ-1	236	>1600	>1600	>2419.6	>1600	>1600
WQ-2	14.10	>1600	>1600	166	>1600	>1600
WQ-3	18.3	>1600	>1600	1200	>1600	>1600
WQ-4	20.1	500	500	687	1600	1600
WQ-5	25.3	>1600	>1600	1550	>1600	>1600
WQ-6	31.5	1600	1600	1120	>1600	>1600
WQ-7	29.8	>1600	>1600	68.3	350	350

Figure 2. Comparison of Enterococci Levels Between the Dry and Wet Events.



4.2 Nutrient Concentrations

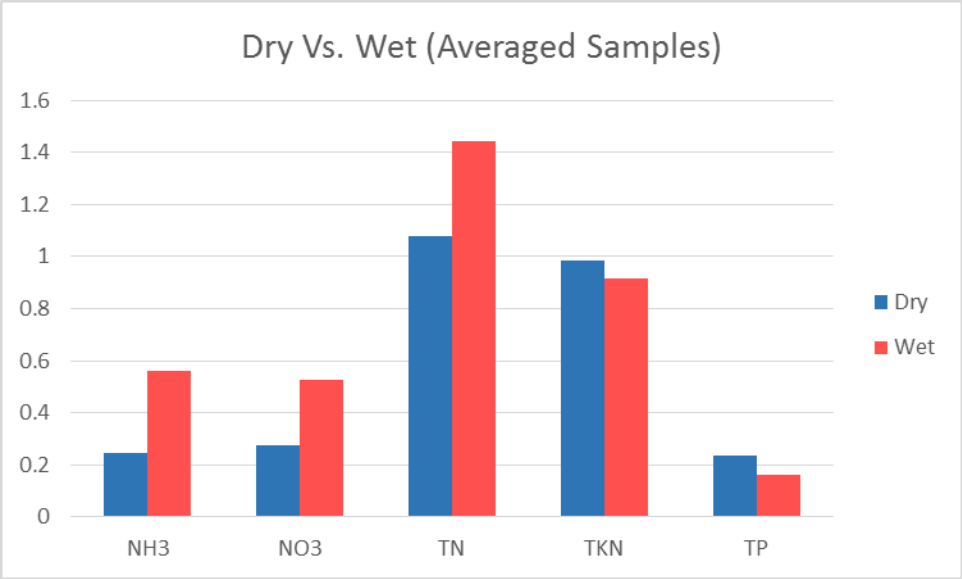
The nutrient concentration analysis consisted of ammonia (NH_3), nitrate (NO_3), total nitrogen (TN), total kjeldahl nitrogen (TKN), and total phosphorous (TP). Increased inputs of nutrients into a system is a known contributing factor to the growth of harmful algal blooms which can result in depleted dissolved oxygen supply and ultimately, eutrophic conditions (USEPA 2016).

As indicated in Table 3, the majority of the nutrient constituents analyzed had increased values as a result of stormwater input into the pond system. Site WQ-1 appears to have the highest increase in nutrient input into the pond system from stormwater runoff. Figure 3 shows the averaged nutrient levels across all stations obtained in the dry versus wet sampling events. Nutrient levels were found to be higher during the wet event versus the dry event for three out of the five nutrients. These three nutrients were ammonia (NH_3), nitrate (NO_3), and total nitrogen (TN).

Table 3. Results of the Nutrient Concentration Analysis
(Measurements are expressed in mg/L).

Sample ID	Dry Event					Wet Event				
	NH_3	NO_3	TN	TKN	TP	NH_3	NO_3	TN	TKN	TP
WQ-1	0.189	0.250	0.392	0.392	0.052	0.687	0.810	2.25	1.44	0.300
WQ-2	0.160	0.250	0.732	0.732	0.866	0.069	0.950	1.31	0.362	0.061
WQ-3	0.365	0.340	1.26	0.915	0.254	0.814	0.490	1.74	1.25	0.143
WQ-4	0.347	0.340	3.17	2.83	0.060	0.751	0.450	1.43	0.976	0.128
WQ-5	0.185	0.250	0.837	0.837	0.258	0.820	0.450	1.50	1.05	0.143
WQ-6	0.193	0.250	0.677	0.677	0.109	0.214	0.250	0.797	0.547	0.155
WQ-7	0.265	0.250	0.496	0.496	0.058	0.559	0.290	1.08	0.792	0.189

Figure 3. Comparing Averaged Results for Nutrients between Dry and Wet Events.



4.3 Particle Concentrations

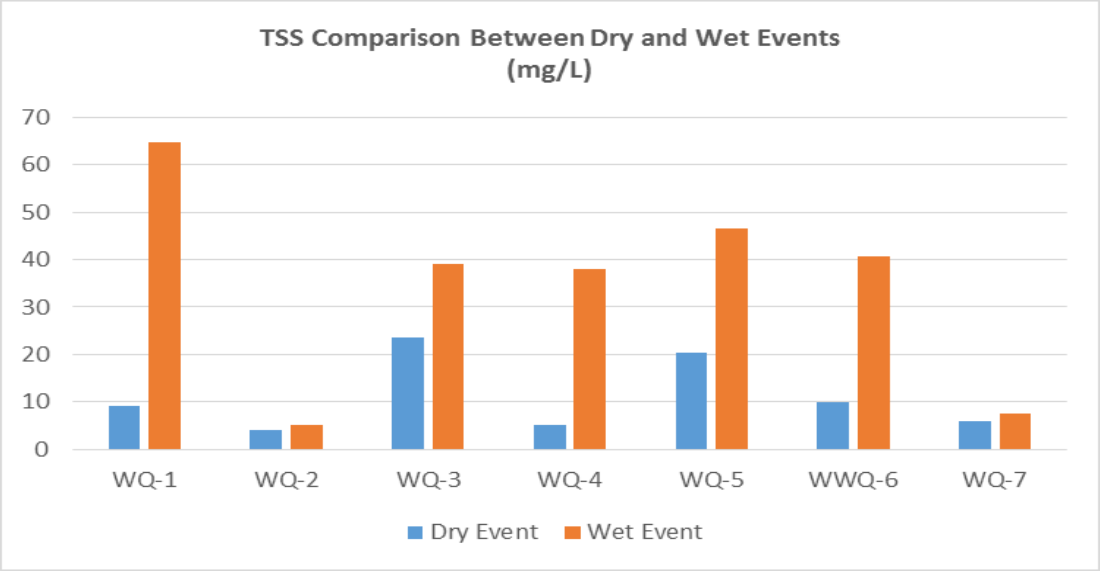
For the purpose of this study, particle concentrations were measured as total suspended solids (TSS). Table 4 and Figure 4 show the results of these findings. Expected particle concentrations increased during the wet event as a result of total dissolved solids entering into the pond system from stormwater runoff. Site WQ-1 shows the highest increase in TSS entering the pond system, with an increase of 55.8 mg/L during wet event.

Total suspended solids (TSS) are a measure of the amount of particulate matter that is floating in the water column. It is comprised of sediment, phytoplankton, bacteria, and other organic detritus and inorganic solids. High levels cause light attenuation that decreases the ability of submerged aquatic vegetation to photosynthesize. It can also clog the gills of fish, increase contaminant loading, decrease dissolved oxygen levels, and can smother the benthos once deposited (Owens, 2005).

Table 4. Results of the Particle Concentration Analysis by Total Suspended Solids (measurements are expressed in mg/L).

Sample ID	Dry Event	Wet Event
WQ-1	9.0	64.8
WQ-2	4.0	5.1
WQ-3	23.5	39.0
WQ-4	5.0	38.0
WQ-5	20.3	46.6
WQ-6	10.0	40.6
WQ-7	6.0	7.4

Figure 4. Comparison of TSS Levels Between the Dry and Wet Events.



4.4 Volatile Organic (VOC) and Semi-Volatile Organic Compounds (SVOC)

Only one VOC compound (toluene) was detected during both the dry and wet event. This compound's concentration was less than the quantitation limit, but greater than minimum detection limit (MDL) for this analysis. No SVOC compounds were detected above the MDL.

4.5 Heavy Metals

The metal concentration analysis consisted of: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), silver (Ag), and zinc (Zn). Table 5 depicts the metals detected above the MDL.

Chromium, copper, lead, nickel and zinc were the only metal compounds that were detected above the MDL (Table 5 and Figure 5). The majority of the detectable concentration levels of these compounds increased significantly as a result of stormwater runoff. Zinc was the only metal present in all samples and also the metal with the highest concentration.

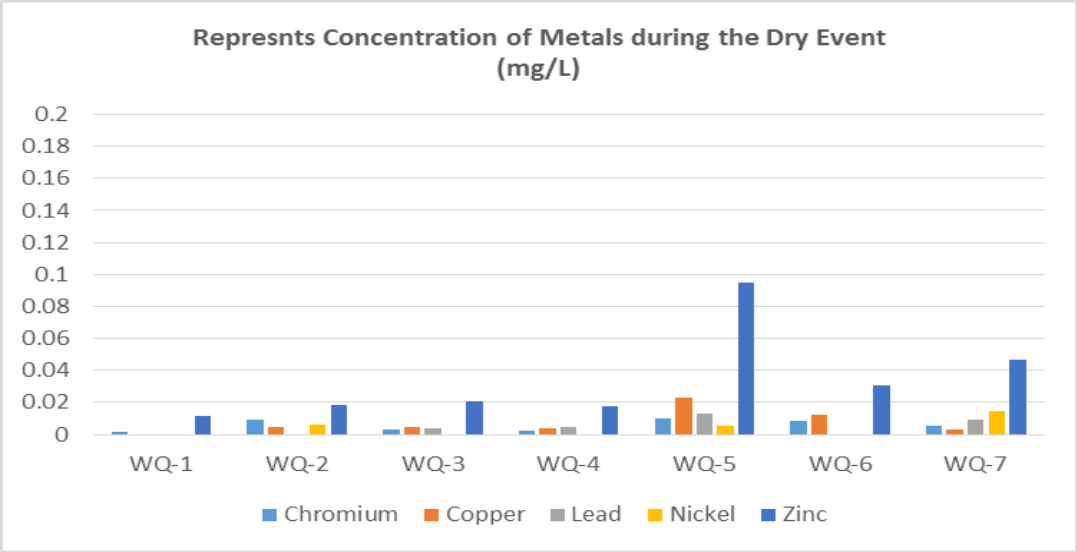
Metal contamination in surface waters can have damaging effects on ecosystems. Metals can bioaccumulate within species and biomagnify within ecosystems. At high concentrations, metals become toxic, they also can affect the neurosystem and some are considered cancerous (Solomon, 2008.)

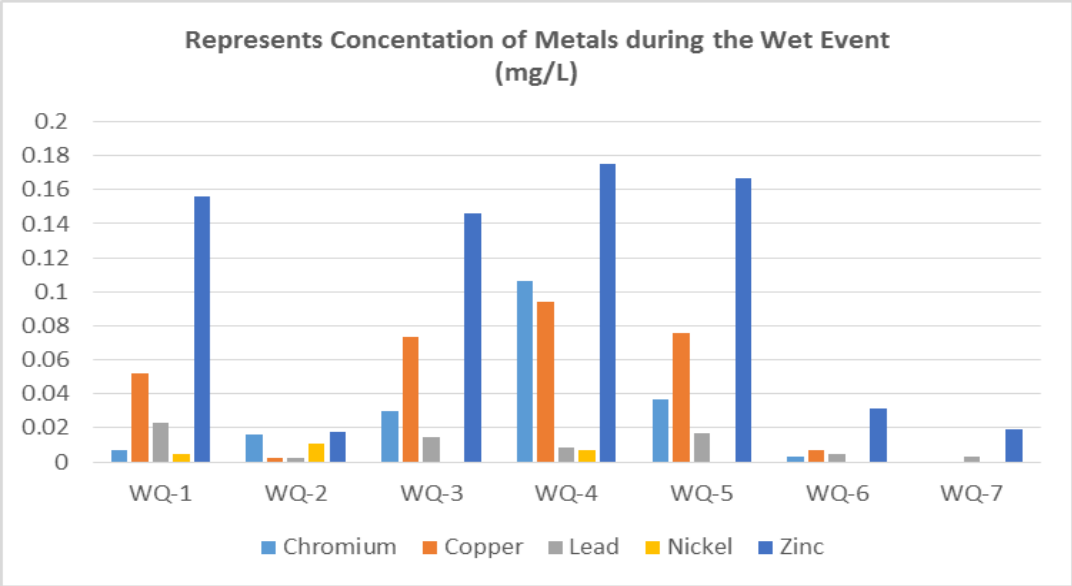
Table 5. Heavy Metal Concentrations Detected Above the MDL
(Measurements are expressed in mg/L).

Sample ID		Compound				
		Cr	Cu	Pb	Ni	Zn
WQ-1	Dry	0.00142	N/D	N/D	N/D	0.01160
	Wet	0.00678	0.05220	0.02260	0.00435	0.15600
WQ-2	Dry	0.00911	0.00436	N/D	0.00627	0.01830
	Wet	0.01570	0.00262	0.00219	0.01040	0.01740
WQ-3	Dry	0.00289	0.00471	0.00421	N/D	0.02300
	Wet	0.03010	0.07330	0.01420	N/D	0.14600
WQ-4	Dry	0.00267	0.00376	0.00438	N/D	0.01750
	Wet	0.10600	0.09440	0.00835	0.00663	0.17500
WQ-5	Dry	0.00995	0.02260	0.01320	0.00556	0.09470
	Wet	0.03710	0.07610	0.01670	N/D	0.16700
WQ-6	Dry	0.00856	0.01200	N/D	N/D	0.03040
	Wet	0.00305	0.00673	0.00497	N/D	0.03160
WQ-7	Dry	0.00551	0.00269	0.00932	0.01420	0.04700
	Wet	N/D	N/D	0.00292	N/D	0.01940

N/D represents the compound was not detected at the MDL concentration.

Figure 5. Concentrations of Metals during Both Events.





4.6 Pesticides

Still awaiting analysis results from lab.

5.0 Summary and Conclusion

A review of the baseline data appears to indicate that indicator bacteria levels were high. Based on the results of *Enterococci*, stormwater appears to be a major contributor to the high bacteria levels. Stormwater entering the system at the WQ-1 site appeared to be the major source of these bacteria. Nitrogen was the most prevalent nutrient and Site WQ-1 showed the highest increase of this nutrient during the wet sampling event. Particle concentration, measure by total suspended sediments, also increased significantly due to stormwater runoff. Toluene (at very low concentrations), was the only volatile organic compound detected during either sample event and no semi-volatile organic compounds were detected. Zinc was the most prevalent and the only metal detected in all samples. At the time of this draft report, laboratory results for pesticides were still not available. This surface water sampling effort provided baseline data on water quality within the ponds during two specific conditions. The first, the dry sampling event, was conducted following an extended drought in which the two ponds were not receiving or discharging any considerable amounts of surface water or stormwater. The second, the wet sampling event, was conducted during heavy rainfall in which over 1.5 inches of rain fell. Results indicate that stormwater runoff appears to be a major contributor to contaminants entering the pond system. Further in-depth analyses would be required to better understand the dynamics of the pond system and surrounding wetlands as it relates to sources of contamination, as well as contaminant loading, retention and the effects of contamination on downstream water quality.

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