

Technical Report



**BROWARD COUNTY
BOARD OF COUNTY COMMISSIONERS**

**TECHNICAL REPORT
DPEP 03-06**

**Water and Sediment Quality of the Lakes at Vista
View Park**

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Conducted by
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**Broward County
Board of County Commissioners**



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EXECUTIVE SUMMARY

Vista View Park is a new recreational facility co-located on the site of the former Broward County Landfill at Davie. Prior to the grand opening of the park, the Broward County Parks and Recreation Division requested that the Department of Planning and Environmental Protection's Environmental Monitoring Division (EMD) conduct sampling and analysis of two lakes in the park. The larger of the two lakes (21 acres) is located in the northeast corner of the park (NE lake). The smaller lake (6 acres) is in the southwest corner of the park (SW lake). EMD collected subsurface and mid depth water samples and shoreline sediment samples from each lake on March 13, 2003. In addition, depth profiles for a number of standard water quality parameters were collected using a YSI data sonde. The stated conclusions are based on a single sampling of the water and sediments at Vista View Park and can only be considered representative of this particular point in time. Lakes are dynamic systems that exhibit seasonal as well as annual cycles.

Water samples collected just below the surface in both lakes were found to be of good water quality. No volatile or semi-volatile organic compounds (chemicals such as selected pesticides, solvents and cleaning agents) were found in the water column of either lake. Water clarity as measured by Secchi depth was 1.8 meters (5.9 feet) in the NE lake and turbidity (the amount of light scattered by particulate matter in the water) was low (<2 nephelometric turbidity units [ntus]). The SW lake had very clear water as indicated by a Secchi depth of 5 meters (16.4 feet). Turbidity was also very low (<1 ntus). Lake waters were saturated with dissolved oxygen. Levels ranged from 8-14 milligrams/l in the two lakes. Microscopic plants (algae) and other lake vegetation supply oxygen to lake waters. Fish populations will not be oxygen limited at these concentrations. Other physical parameters such as hardness, temperature and pH were within expected ranges. Nutrient concentrations fell at the low end of the expected range of values found in other South Florida waterways. Concentrations of chlorophyll-a, the green pigment in plants and algae, were consistent with values noted in other South Florida lakes. This suggests that the nutrients levels in the lakes were appropriate to sustain a balanced level of photosynthetic activity and not to cause microscopic algae blooms (very green lake water). Bacteria levels (fecal coliform) were very low (<10 colonies/100 mls where the single sample standard is 800 colonies/ 100 mls) despite the presence of birds and cattle on or near the lakes. None of the metals (beryllium, copper, aluminum and vanadium) tested for in the water column were detected. The mid-depth water samples reflected a similar water quality to surface waters. Lower water clarity, higher dissolved oxygen values, and higher chlorophyll levels suggest the NE lake is more biological active than the SW lake.

Depth profiles of various water quality parameters were collected by slowly lowering a YSI data sonde down through the water column to the bottom. This was done to check for vertical

stratification within the lakes. Stratification is the tendency of a water mass to separate into distinct zones characterized by unique physical and chemical properties. In general, the YSI profiles indicated that most of the water column was well mixed though some thermal stratification was found near the bottom of both lakes. Overall water quality at the time of sampling, as indicated by the parameters measured by the YSI data sondes, appeared to be good in both lakes.

Sediment samples were analyzed for metals and organic contaminants. Beryllium, cadmium, and copper were tested for but not detected in sediment from either lake. Barium, chromium and manganese were found in the sediments of the SW lake. The NE lake's sediments contained detectable amounts of barium, chromium, lead, nickel, manganese, mercury and zinc but did not exceed the Florida Department of Environmental Protection's (FDEP) sediment quality assessment guidelines. FDEP also recommends normalizing metal concentrations to the aluminum content of the sediments to account for some of the natural variability of metals in sediments and to detect anthropogenic inputs of metals (<http://www.dep.state.fl.us/water/monitoring/fwseds.htm>). Based on this, neither lake contained sediments that were enriched with any specific metal. Values were within the range expected for natural sediments. Semi-volatile organic compounds were not detected in the sediment from either lake.

In conclusion, the quality of both the waters and sediments in the two lakes at Vista View Park was found to be good at the time of sample collection.

INTRODUCTION

In July 2003, the Broward County Parks and Recreation Division opened Vista View Park. At their request, the Broward County Department of Planning and Environmental Protection's Environmental Monitoring Division (EMD) collected water and sediment samples in two of the lakes at the park to determine the habitat quality in the lakes. The park is co-located with the former Broward County Landfill at Davie. Since the lakes are part of the recreational features of the park, the sampling plan was designed to confirm that there were no Chemicals of Concern as identified in United States Environmental Protection Agency's (EPA) Record of Decision regarding the former landfill still present.

PARAMETER SELECTION

According to Ram Tewari of Broward County the Office of Integrated Waste Management, these lakes were historically grab sampled from shore at the mid-point and analyzed for the following parameters - ammonia, chloride, total dissolved solids, alkalinity, sulfates, chemical oxygen demand, iron, fecal coliform, and nitrates. These parameters were sampled, under the direction of the Florida Department of Environmental Protection, based on the potential impact from landfill activities. EPA had issued a Record of Decision on the site on August 11, 1994. This document summarized the Chemicals of Concern, the extent of contamination, the risks to humans and the environment, the options for remediation of the contamination and the selected remedy and the reasons for why it was chosen. The Record of Decision identifies: aluminum, beryllium, copper, vanadium, bis (2-ethylhexy) phthalate, carbon disulfide, alpha-BHC and delta BHC as chemicals of concern in surface waters; vinyl chloride (volatile organic compound-VOC) in groundwater; and antimony, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, zinc and benzo(b) fluoranthene, benzo(k) fluoranthene, and bis (2-ethylhexy) phthalate (semi volatile organic priority pollutants) in sediments.

After careful review of the parameters, EMD chose to sample for the metals listed (except antimony and cobalt), VOCs, and semi volatile organics. EMD chose not to sample for total dissolved solids, chemical oxygen demand, iron, sulfides, or sulfates because these parameters were used to determine the impact of previous activities on the water body as they were occurring. Parks and Recreation was primarily interested in the lakes as fish habitat, so EMD also sampled for those parameters traditionally investigated for natural waters including water clarity, hardness, conductivity, total Kjeldahl nitrogen (TKN), total nitrogen, total phosphorus, dissolved oxygen, alkalinity, chlorophyll, turbidity, pH, ammonia, and fecal coliform.

SAMPLING PARAMETERS

On March 13, 2003, EMD staff collected water and sediment samples from the lakes located on the southwest corner (~ 6 acres) and northeast corner (~21 acres) of Vista View Park. Sediment samples were taken at the pier of the NE lake and in the shallow subtidal zone of the SW lake (Fig. 1). Subsurface water samples were taken just below the surface at the center of each lake and analyzed for the full suite of parameters. Mid depth water samples were also collected in the two lakes and analyzed for nutrients, and chlorophyll-a. Secchi depth, a measure of water clarity, was recorded for each lake. Vertical profiles of temperature, pH, dissolved oxygen, turbidity, chlorophyll-a by fluorescence, and conductivity were also collected using YSI data sondes. Parameters sampled for are shown in Table 1.

SITE DESCRIPTION

Northeast Lake, Vista View Park

The northeast (NE) lake is the larger of the two lakes that were sampled on March 13, 2003. The NE lake has two lobes, the northern lobe is the bigger of the two and is square in shape. The southern lobe is slightly smaller and in the shape of a rectangle (Fig. 1). Sediment and water column samples were collected from the southern lobe of the lake. The lake is ~ 18 feet deep at its center. Plankton were visible in surface waters and imparted a greenish cast to the water. Several species of birds (ducks, and ibises) were observed near the water's edge and on the lake itself. The perimeter of the lake was generally clear of brush and reeds.

Southwest Lake, Vista View Park

The southwest (SW) lake is rectangular in shape but is narrower and deeper than the NE lake (Fig. 1). The SW lake is ~ 26 ft deep at its center. Plankton were not visible in surface waters and the water was brownish in color. Filamentous algae were observed along the littoral zone around the lake. Reeds, cattails, and grasses were also present around the perimeter of the lake. In general, the shoreline was less accessible and not as well maintained as the NE lake. A few birds were spotted. A fence runs along two sides of the lake and was anywhere from ~ 20 to 50 ft away from the edge of the lake. Cattle were present on the other side of the fence.

RESULTS AND DISCUSSION

Water Quality

The NE lake had a Secchi depth, a measure of the transparency of the water column, of approximately 6 feet. As indicated by the temperature profile, a thermocline is present between 10 and 13 feet. Chlorophyll-a levels (5.31 ug/l) confirmed the presence of algae in the water. Microscopic algae and other lake vegetation are responsible for the production of dissolved oxygen in lakes. Dissolved oxygen values in the NE lake ranged from 8-14 mg/l indicating the water was saturated with oxygen (Wetzel 1983). The highest concentration was associated with the thermocline. Fish populations will not be oxygen limited at these concentrations. Fecal coliform bacteria levels were very low in the lake (<2 colonies/100 mls water). Chapter 27 of Broward County's municipal code states that fecal coliform levels shall not exceed 800 colonies/100 mls water in any sample <http://www.broward.org/dni01100.htm>. It is worth noting that the presence of large numbers of birds at the site could result in increased levels of fecal coliform bacteria in the lake. Nutrient levels were within expected ranges for South Florida fresh water bodies (U.S. EPA 1999, Broward County DPEP 2001). No VOCs were detected. Metal concentrations in the water column were all below analytical detection limits.

The SW lake had a Secchi depth of 16.5 ft. Chlorophyll levels were less than 2 ug/l demonstrating an overall lower primary productivity (photosynthetic activity) in the water column. The brownish tint of the water is likely due to the presence of tannic and humic acids in the water. These are typical compounds in South Florida ground water derived from the muck soils. A thermocline is also present in this lake. Dissolved oxygen concentrations remained relatively constant throughout the water column both above and below the thermocline. Lake waters had a dissolved oxygen of approximately 9 mg/l which is adequate to support fish populations. Fecal coliform bacteria levels were low and similar to NE lake

levels (6 colonies/100 mls water). However, the presence of cattle at the site could, at times, be a source of fecal coliform bacteria to the lake. Nutrient levels were within expected ranges for South Florida fresh waters bodies (U.S. EPA 1999, <http://www.epa.gov/waterscience/criteria/nutrient/database/>, Broward County DPEP 2001).

VERTICAL DEPTH PROFILES

Vertical profiles of the following parameters were collected in both lakes, using a YSI datasonde: depth (m), temperature (°C), dissolved oxygen (mg/l), turbidity (ntus), Chl_a (ug/l), pH and specific conductance (uhmos/cm) (Fig. 2). Efforts were made to collect profiles from the center of each lake but the boat did drift particularly in the SW lake. This drifting introduced some variability in the data but did not affect overall trends.

Vertical profiles of the various YSI parameters were similar between lakes and followed expected trends for freshwater systems (Wetzel 1983). Temperature and pH decreased with depth while specific conductance increased with depth. Temperature data also suggested the development of a thermocline (rapid change in temperature over a short vertical distance) in both lakes, though the depth of the thermocline differed between lake. The thermocline was located between 10 and 13 ft. in the NE lake and between 13 and 16.5 ft in the SW lake. The SW lake had better water clarity than the NE lake as indicated by the deeper Secchi depth (16.5 ft. vs. 6 ft. respectively) (Table 2). pH values for both lakes ranged between 6.5-9.0 pH units, which is typical of freshwater lakes and within the range preferred by most aquatic organisms (U.S. EPA 1986) (Fig. 3). Specific conductivity ranged from ~ 200 to 350 uhmos/cm in the two lakes. The NE lake has slightly higher conductance than the SW lake. EPA (1999) guidelines suggest that lakes and streams with conductivity values between 150 and 500 uhmos/cm meet water quality criteria and are able to support good mixed fisheries (Fig. 4).

Depth profiles show the waters of both lakes to be well mixed and oxygenated on the sample date. Values ranged from slightly undersaturated to supersaturated throughout the water column except near the sediment surface where values drop off. The presence of oxygen throughout the water column suggests both lakes should be able to support healthy biological communities. Subsurface peaks in oxygen coincide with the thermocline in both lakes and suggest higher productivity in this zone. Low dissolved oxygen in the shallower portions of the water column is often considered an indicator of an unhealthy system or pollution and was not noted in these systems at this time. However, the vertical distribuion of dissolved oxygen along with other water quality parameters will vary both with seasonal and year.

Overall water quality, as indicated by the parameters measured by the YSI sondes, appears to be good in both lakes. The shallower Secchi depth and higher dissolved oxygen values suggest the NE lake is more productive and biological active than the SW lake. Both lakes meet Florida's surface water criteria based on The Florida State Trophic Index (TSI). The nutrient data also suggests that both lakes are phosphorus limited with N:P ratios greater than 30 (Table 2) (FDEP 2002a). The TSI is used by FDEP to classify lakes based on nutrient and chlorophyll concentrations (FDEP 2002a).

SEDIMENT QUALITY

Sediment samples were collected from the two lakes and analyzed for metals and organic contaminants. Beryllium, cadmium and copper concentrations were below detection limits for both lakes. Low levels of barium, chromium and manganese were found in sediments from the two lakes. The NE lake sediments also contained lead, nickel, manganese and zinc. Neither lake's sediment contained metal concentrations that exceeded the Florida Department of Environmental Protection's (FDEP) sediment quality assessment guidelines. The FDEP developed a computer program, the Interpretative Tool for Assessment of Metal Enrichment in Florida Freshwater Sediments, which determines if metal concentrations in freshwater sediment in Florida, are higher than expected background concentrations (FDEP 2002b). This tool is based on the relatively constant relationship that exists between metals and aluminum and iron concentrations in natural sediments. A series of graphs were developed using the sediment data from the SW and NE lakes in Vista View Park. Metal / aluminum regressions and prediction limits were constructed for barium, chromium, nickel, lead, zinc, and mercury. Metals data from these graphs were used to determine whether metal concentrations represent natural concentrations or metal enrichment. The graphs consist of an aluminum-normalized regression line and the 95% prediction lines. Any data points that plot above these lines would indicate that the sediments are enriched with that particular metal. Data from both lakes at Vista View lake sediment fell within 95% prediction lines indicating metals concentrations were not in excess of expected natural concentrations. Semi-volatile organic compounds were not detected in the sediment from either lake.

SUMMARY

Results from water and sediment quality sampling on March 2003 indicate that the lakes at Vista View Park meet water quality criteria set by state and federal authorities (FDEP 2002a & 2002b, U.S. EPA 1986 & 1999). At the time of sampling, both lakes had oxic, well mixed water columns, with low levels of bacteria, and metals. Nutrient and chlorophyll concentrations were also low compared to other Florida lakes and the data suggests that both lakes are phosphorus limited with N:P ratios greater than 30 (FDEP 2002a). VOC compounds were not detected in either water column or sediment samples. Neither lake contained sediments enriched with any particular metal.

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Fig. 1 Location map of Vista View Park and the surrounding area.

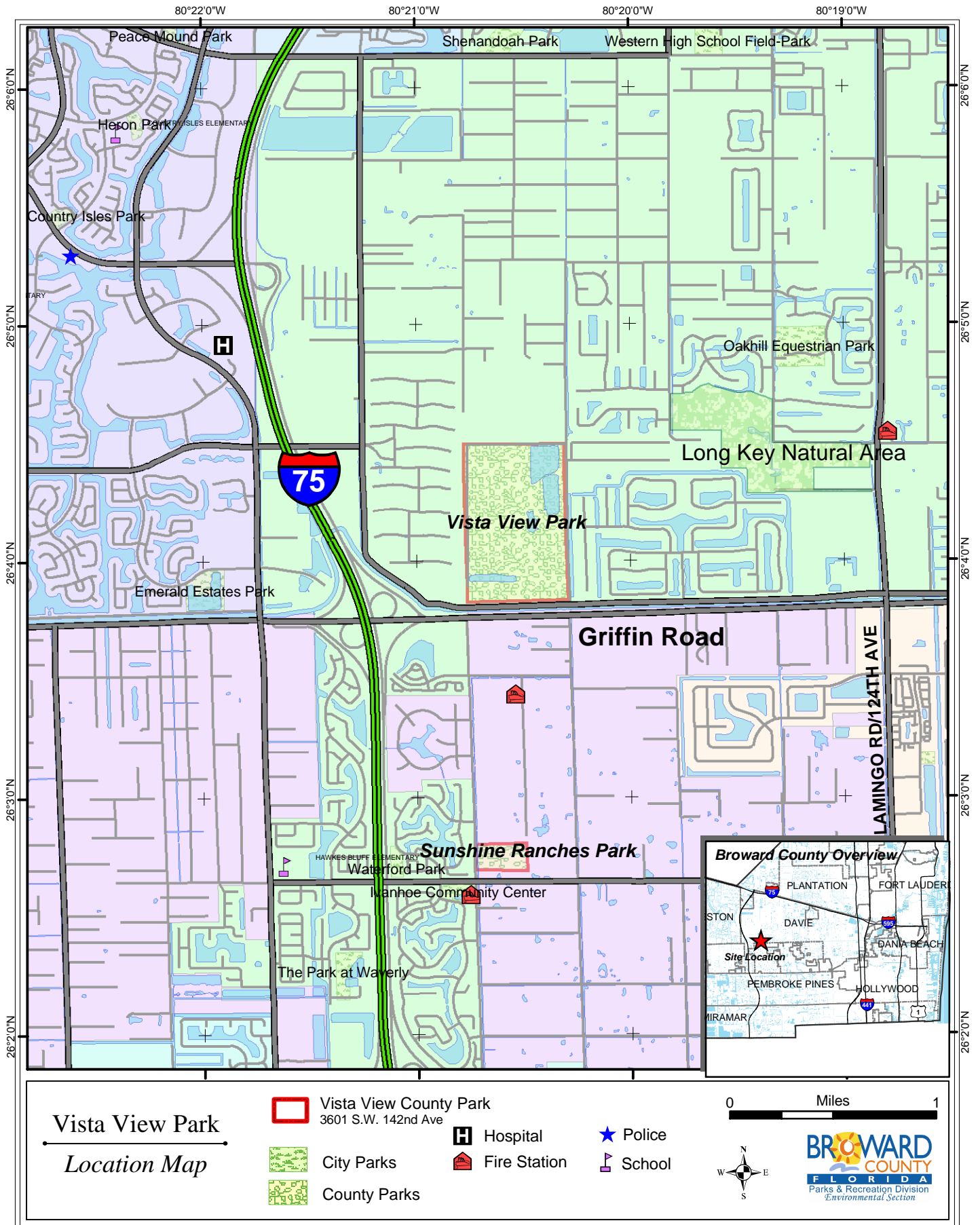
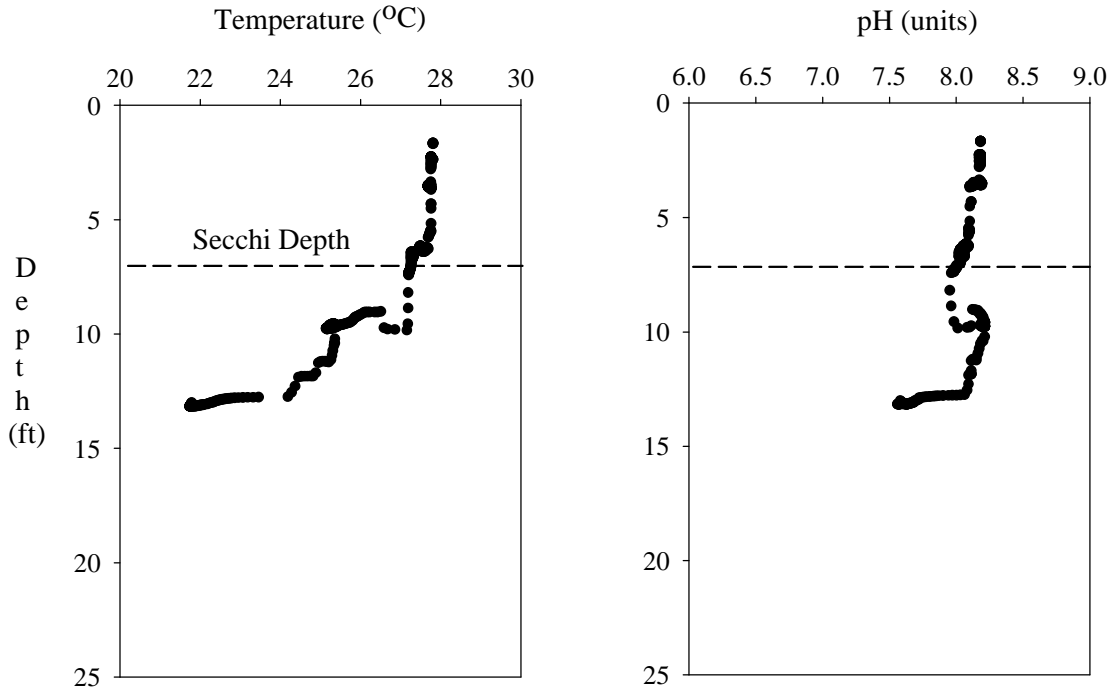


Fig. 2 DPEP employees collecting vertical profiles of various water quality parameters using a YSI sonde.

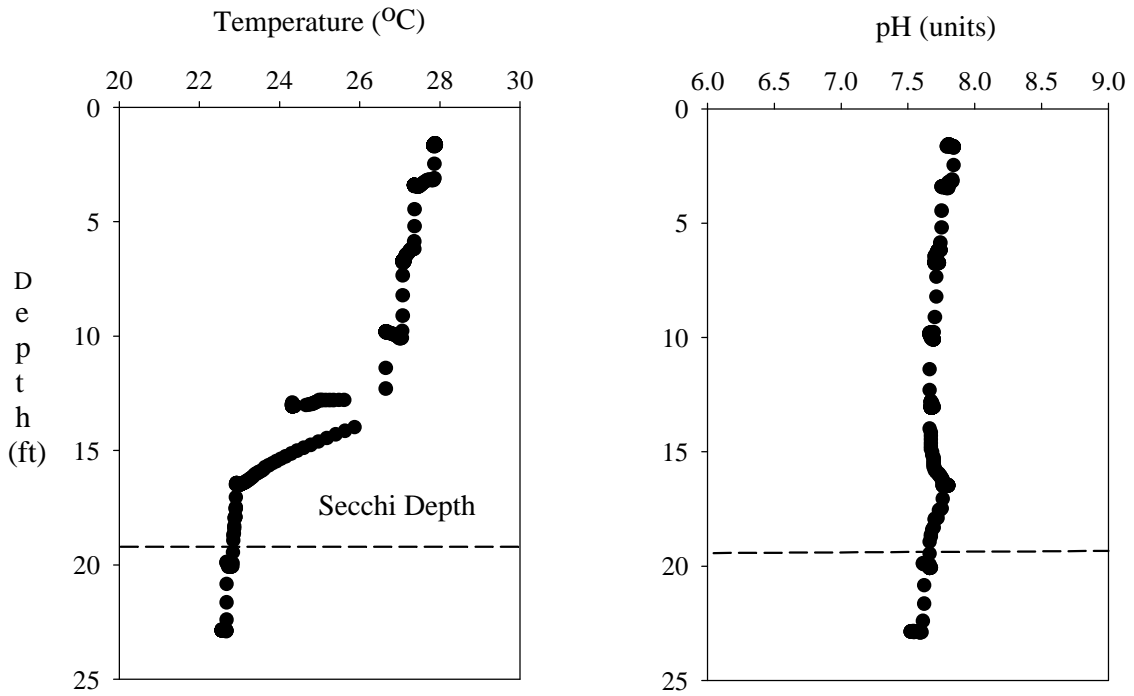


Fig. 3

NE Lake - Vista View

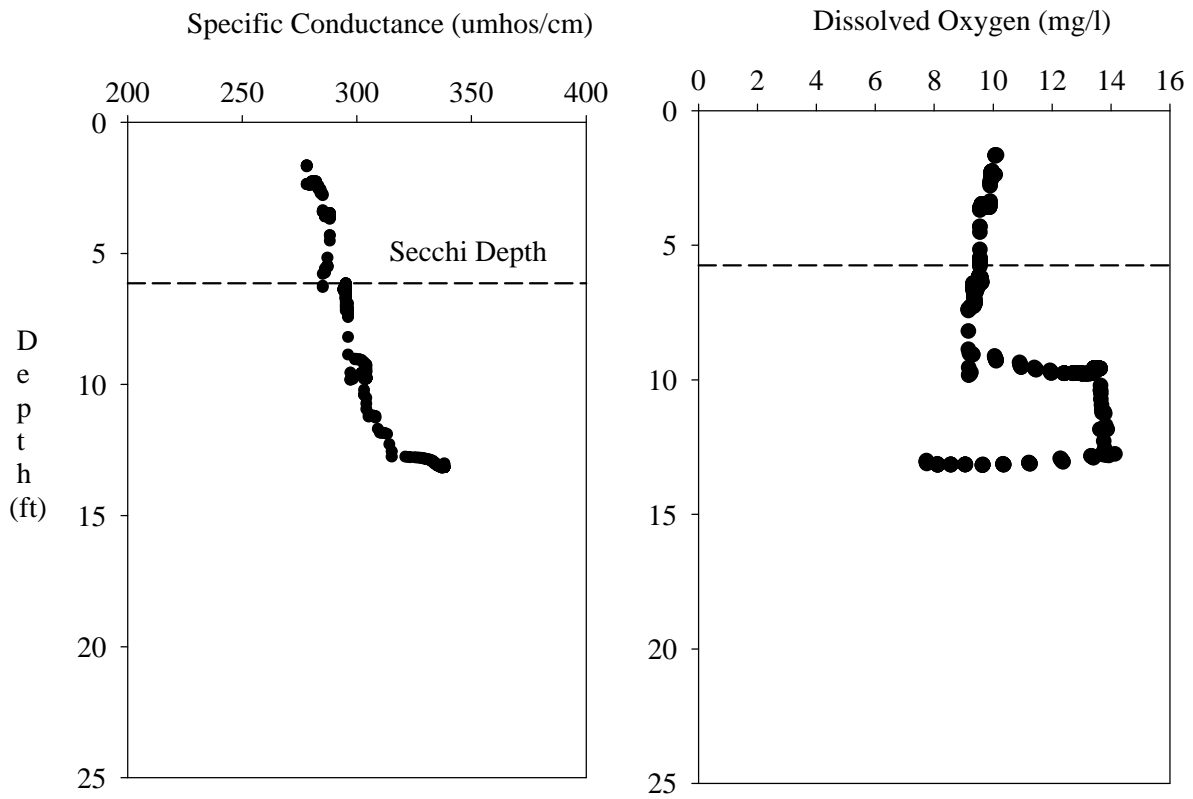


SW Lake - Vista View

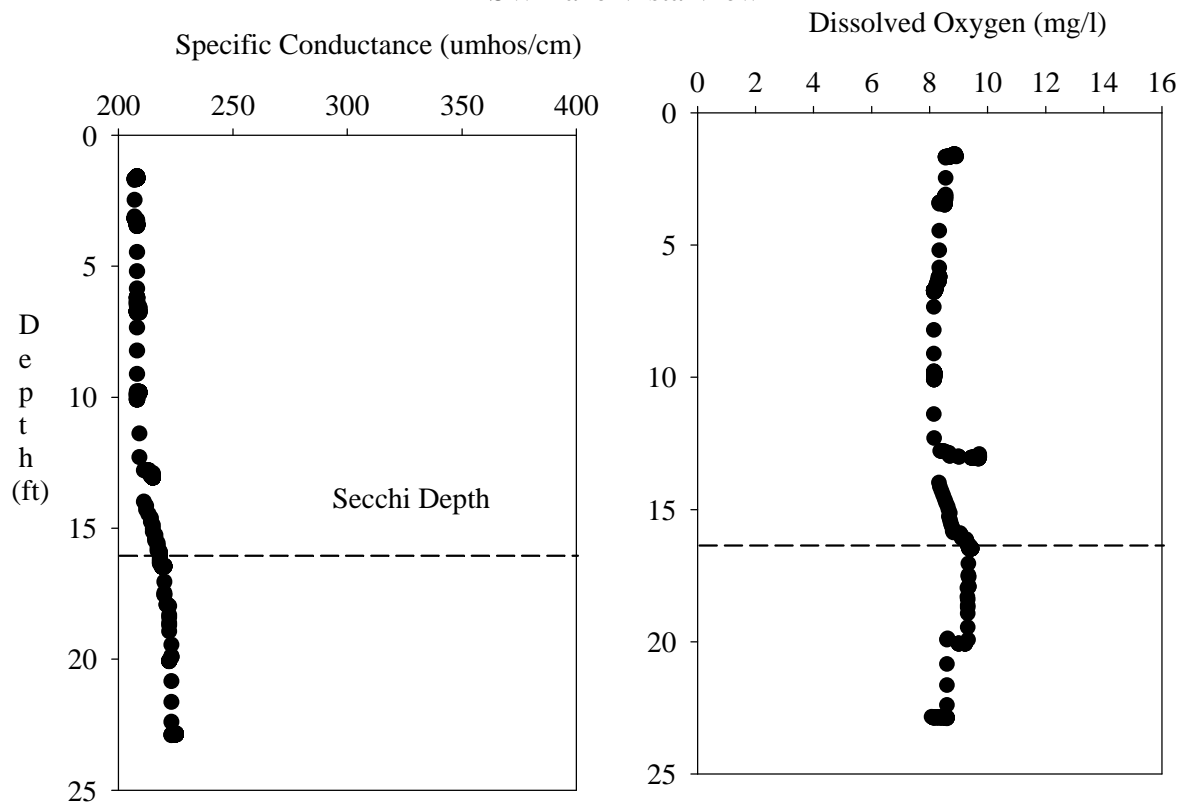


NE Lake Vista View

Fig. 4



SW Lake Vista View



Appendix A

Table 1 - Sampling Parameters at Vista View Park on March 13, 2003.

Subsurface Water Samples - NE lake and SW lake (1 sample per lake)		
PHYSICAL PARAMETERS		
pH by probe	Alkalinity (total)	Hardness as CaCO ₃
Dissolved oxygen by probe	Conductivity	Turbidity
Secchi depth (water clarity)		
NUTRIENTS		
Total Nitrogen	Ammonia	Total Phosphorus
TKN	Nitrate+Nitrite	
BIOLOGICAL MEASURES		
Chlorophyll	Fecal Coliform	
METALS		
Aluminum	Beryllium	Copper
Vanadium		
ORGANICS		
Volatile Organic Compounds	Semi volatile organics (Method 625)	
Mid-depth lake sample NE lake and SW lake (1 sample per lake)		
PHYSICAL PARAMETERS		
pH by probe	Dissolved oxygen by probe	Conductivity
Turbidity		
NUTRIENT		
Total Nitrogen	Ammonia	Total Phosphorus
TKN	Nitrate+Nitrite	
BIOLOGICAL MEASURES		
Chlorophyll		
Depth Profile - NE lake and SW lake (12 readings per lake)		
PHYSICAL PARAMETERS by datasonde -		
Dissolved Oxygen	pH	Conductivity
Fluorescence	Depth	Turbidity by probe
Sediment - NE lake at pier and SW lake on shoreline		
METALS		
Barium	Beryllium	Cadmium
Chromium	Copper	Lead
Manganese	Mercury	Vanadium
Zinc		
ORGANICS		
Semi volatile organics (Method 625)		

Table 2 - Analytical Results Summary from the March 13, 2003 Sample Collection in Vista View Park.

Parameter	Subsurface sample	Mid-depth sample	Sediments
SW Lake			
Alkalinity (total)	90.3 mg/l		
Chlorophyll	<0.955 ug/l	1.79 ug/l	
Fecal Coliform Bacteria	<2 colonies/100 mls		
Hardness	89.2 mg/l		
Metals (total)			
Aluminum	<47.7 ug/l		1226.73 mg/kg
Barium			4.36 mg/kg
Beryllium	<0.551 ug/l		<0.0011 mg/kg
Cadmium			<0.341 mg/kg
Chromium			2.07 mg/kg
Copper	<3.90 ug/l		<0.81 mg/kg
Lead			<1.06 mg/kg
Manganese			5.42 mg/kg
Mercury			<0.053 mg/kg
Nickel			<1.31 mg/kg
Vanadium	<0.906 ug/l		
Zinc			<1.96 mg/kg
Minerals			
Calcium	31.4 mg/l		
Magnesium	2.61 mg/l		
Nutrients			
Ammonia	<0.024 mg/l	<0.024 mg/l	
Nitrate+Nitrite	<0.007 mg/l	0.008 mg/l	
Total Kjeldahl Nitrogen	0.475 mg/l	0.300 mg/l	
Total Nitrogen	0.481 mg/l	0.308 mg/l	
Total Phosphorus	<0.009 mg/l	<0.009 mg/l	
Secchi depth		5 meters	
Semi Volatile organic compounds	not detected		not detected
Turbidity	0.80 ntus	0.6 ntus	
Volatile organic compounds	not detected	not detected	not detected

Parameter	Subsurface sample	Mid-depth sample	Sediments
NE Lake			
Alkalinity (total)	112 mg/l		
Chlorophyll	5.31 ug/l	5.35 ug/l	
Fecal Coliform Bacteria	6 colonies/100 mls		
Hardness	97.1 mg/l		
Metals (total)			
Aluminum	<47.7 ug/l		2830 mg/kg
Barium			10.6 mg/kg
Beryllium	<0.552 ug/l		<0.0011 mg/kg
Cadmium			<0.341 mg/kg
Chromium			8.26 mg/kg
Copper	<3.90 ug/l		<0.81 mg/kg
Lead			2.49 mg/kg
Manganese			21.4 mg/kg
Mercury			0.0653 mg/kg
Nickel			2.90 mg/kg
Vanadium	<0.906 ug/l		
Zinc			7.89 mg/kg
Minerals			
Calcium	32.8 mg/l		
Magnesium	3.7 mg/l		
Nutrients			
Ammonia	<0.024 mg/l	0.0439 mg/l	
Nitrate+Nitrite	0.0827 mg/l	0.0689 mg/l	
Total Kjeldahl Nitrogen	0.616 mg/l	0.752 mg/l	
Total Nitrogen	0.699 mg/l	0.821 mg/l	
Total Phosphorus	0.0134 mg/l	0.0123 mg/l	
Secchi depth		1.8 meters	
Semi Volatile organic compounds	not detected		not detected
Turbidity	1.10 ntus	1.80 ntus	
Volatile organic compounds	not detected	not detected	not tested

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11. ABSTRACT <i>Results from a one time sampling of sediments and water quality parameters from two lakes at Vista View Park suggests both lakes meet both EPA's and FDEP's surface water quality criteria. Organic compounds were not detected and metal concentrations in sediments were within the expected range for natural sediments in the state of Florida. Vertical profiles of various water quality parameters indicate both lakes are generally well mixed and oxygenated. Fecal coliform levels were low and did not exceed requirements of Chapter 27 of Broward County's municipaL code.</i>		
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