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Water Quality Assessment

June 23, 2004

Prepared for:

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3650 NE 12th Avenue
Oakland Park, Florida 33334

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Water Quality Assessment

June 23, 2004

Water Quality Assessment for Kimberly Lake Basin Improvements
470109.104.1.0001

Prepared for:

City of Oakland Park
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List of Abbreviations

BMP – Best Management Practice
BOD5 – Biochemical Oxygen Demand (5-day)
Cd – Total Cadmium
COD – Chemical Oxygen Demand
Cu – Total Copper
DO – Dissolved Oxygen
EMC – Event Mean Concentration
FDEQ – Florida Department of Environmental Quality
mg/L – milligrams per liter
MS4 – Municipal Separate Storm Sewer System
N02+NO3 – Nitrate + Nitrite Nitrogen
NPDES – National Pollutant Discharge Elimination System
NTU – Nephelometric Turbidity Unit
Pb – Total Lead
ppt – parts per thousand
SP – Soluble Phosphorus also referred to as orthophosphorus or soluble reactive phosphorus
TKN – Total Kjeldahl Nitrogen
TDS – Total Dissolved Solids
TN – Total Nitrogen
TP – Total Phosphorus
TSS – Total Suspended Solids
Zn – Total Zinc

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1.0 Introduction

Carter & Burgess, Inc. performed a water quality assessment as part of the Kimberly Lake Basin Improvement project for the city of Oakland Park, Florida.

1.1 Purpose and Scope of Work

The purpose of this water quality assessment was to determine environmental impacts of the proposed drainage improvements to the Kimberly Lake basin. The drainage improvements are being proposed to alleviate flood problems within the basin and along the shorelines of Kimberly Lake. The proposed drainage improvement will divert storm water runoff from the Kimberly Lake basin to West Coral Lake.

The scope of services for this assessment included:

- A review of historical water quality data for Kimberly Lake and West Coral Lake
- A review of pertinent water quality standards including state, county and local standards, which may apply to the proposed drainage improvements
- A review of Best Management Practices (BMPs) applicable to the Kimberly Lake drainage area
- Literature review of pollutant removal efficiencies for existing and proposed BMPs
- Pollutant load analysis to determine the impact of proposed drainage improvements
- Recommendations to minimize adverse environmental effects (if necessary)

1.2 Limitations

It was assumed that baseline water quality data was available for both waterbodies and no additional sampling would be conducted.

2.0 Project Area

The project area is defined as the current drainage area for Kimberly Lake and West Coral Lake (**Exhibit 1**) in Oakland Park, Broward County, Florida. The Kimberly Lake drainage basin encompasses approximately 59 acres and consists of primarily two land uses—residential and light industrial. The West Coral Lake drainage basin is roughly 87 acres with similar land uses to that of Kimberly Lake.

3.0 Applicable Water Quality Regulations

3.1 NPDES Storm Water Permits

The Broward County Water Resources Division coordinates the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit with 26 municipalities, Florida Department of Transportation District 4, Florida Turnpike Enterprise and unincorporated Broward County. The city of Oakland Park is a co-permittee on the Broward County MS4 permit (FLS000016) issued on February 6, 2003 and expires February 5, 2008.

3.2 Florida Water Quality Standards

The sections of Florida Administrative Code addressing water quality standards are Section 62-302 - Surface Water Quality Standards and Section 62-302.530 - Criteria for Surface Water Quality Classifications. The current water quality standards became effective April 16, 2003. According the Florida Department of Environmental Protection (FDEP) classification system of waterbodies in Florida, West Coral Lake is considered a Class III waterbody and is predominantly marine due to the chloride concentration at the surface, which is greater than or equal to 1,500 mg/L. The chloride concentration of surface samples from West Coral Lake (see Section 4.0) were computed based on the standard relationship between salinity and chloride concentrations:

$$\text{Chloride concentration (mg/L)} = \frac{\text{Salinity (ppt)}}{1.80655} \times 1000$$

Based on a review of the available water quality data for West Coral Lake (Goldasich and Associates, 2001) collected on two dates (October 27, 2000 and January 16, 2001), which represented both wet and dry weather conditions, the chloride concentration at the surface of ranged from 2,325 mg/L during wet weather conditions to 7,860 mg/L during dry weather conditions. Therefore, the water quality standards for predominately marine Class III waters apply to West Coral Lake (**Table 1**).

Table 1. State of Florida Water Quality Standards for Class III Marine Waters

Water Quality Constituent	Water Quality Criteria (mg/L)
Total Suspended Solids (TSS)	—
Biochemical Oxygen Demand, 5-day (BOD5)	Narrative criteria – Shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the 5.0 and, in no case, shall it be great enough to produce nuisance conditions
Chemical Oxygen Demand (COD)	—
Total Phosphorus (TP)	Narrative criteria for nutrients – In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna
Soluble Phosphorus (SP)	
Total Nitrogen (TN)	
Total Kjeldahl Nitrogen (TKN)	
Nitrite plus Nitrate Nitrogen (NO2+NO3)	
Total Dissolved Solids (TDS)	—
Copper (Cu)	0.0037
Lead (Pb)	0.0085
Zinc (Zn)	0.086
Cadmium (Cd)	0.0093

— None

3.3 Broward County Water Quality Standards

Broward County water quality standards (Chapter 27 of the Broward County Code, Section 27-195) also apply to West Coral Lake. For the storm water pollutants examined, Broward

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County standards are as stringent, if not more stringent, than the Florida standards. Whereas the state water quality standards apply to ambient concentrations within the particular waterbody, Broward County standards apply to pollutant concentrations at the outfalls to the waterbodies prior to discharging to the receiving body of water. Since some removal mechanisms occur within receiving waterbodies due to dilution, adsorption, settling, and biological uptake, meeting water quality standards prior to discharge to the lake will ensure that State water quality standards are met and the health of the Coral Lakes system will be preserved. Broward County water quality standards that are applicable to the storm water pollutants that were examined are listed in **Table 2.**

Table 2. Broward County Water Quality Standards

Water Quality Constituent	Broward County Standard (mg/L)
Total Suspended Solids (TSS)	—
Biochemical Oxygen Demand, 5-day (BOD5)	7.0
Chemical Oxygen Demand (COD)	—
Total Phosphorus (TP)	0.05
Soluble Phosphorus (SP)	—
Total Nitrogen (TN)	1.5
Total Kjeldahl Nitrogen (TKN)	—
Nitrite plus Nitrate Nitrogen (NO2+NO3)	—
Total Dissolved Solids (TDS)	—
Copper (Cu)	0.003
Lead (Pb)	0.0056
Zinc (Zn)	0.086
Cadmium (Cd)	0.0050

— None

4.0 Review of Existing Water Quality Data

Available water quality data was requested for Kimberly Lake and West Coral Lake from the various agencies responsible for water resource management in the state including the FDEP, the South Florida Water Management District and Broward County. No water quality data was available for Kimberly Lake. Limited water quality data was available for West Coral Lake and consisted of complaint-based sampling conducted by the Broward County Department of Planning and Environmental Protection (Broward County DPEP, 2000) on June 3, 1999 and an ecological evaluation of the Coral Lakes on October 27, 2000 and January 16, 2001 conducted by J.J. Goldasich and Associates, Inc. (2001). The locations of water quality sampling sites in West Coral Lake are shown in **Exhibit 1**.

Pertinent results and water quality observations that were noted in the reports are summarized below.

- Broward County DPEP sampled West Coral Lake on June 3, 1999 and observed elevated concentrations of copper and total phosphorus that exceeded the Broward County standards. Copper concentration (0.00889 mg/L) was almost three times greater than the county standard of 0.003 mg/L. A total phosphorus concentration of 0.0825 mg/L was observed, which exceeded the current standard of 0.05 mg/L. Only one data point is available to characterize the TP concentration in West Coral Lake. No data is available for soluble phosphorus.

- Total nitrogen to total phosphorus ratios (TN:TP) for the Coral Lakes ranged from 13 to 22 and indicated a healthy, balanced nutrient ratio. TN:TP ratios below 10 indicate unhealthy balances of nutrients, which may promote the growth of undesirable algal species.

- Good water clarity was observed in the Coral Lake system. Turbidity at the surface of West Coral Lake ranged from 1.15 to 8.0 NTUs, which is well below the county standard of 10 NTUs. Turbidity less than 5 NTUs were observed during dry weather conditions at all stations and depths. Higher turbidity levels (3 to 18 NTUs) were observed during wet weather conditions particularly near the lake bottom due to entrainment of bottom sediments.

- The Coral Lakes exhibit high productivity which is apparent from dissolved oxygen concentration above saturation but primary productivity is dominated by rooted aquatic vegetation rather that floating algae. The water clarity allows for light penetration along the margins of the lake (littoral zone) for growth of rooted aquatic vegetation.

- Salinity and conductivity profiles indicated a fairly strong density stratification. The isocline typically occurs between 7 and 10 feet from the surface. Dissolved oxygen (DO) concentrations above the isocline were greater than the State of Florida water quality criteria for DO. Significant differences were observed between the DO concentration above and below the isocline. In West Coral Lake, the DO ranged between 4.4 and 9.3 mg/L above the isocline and ranged between 2.1 and 5.6 mg/L below the isocline. Lower DO concentrations were observed during the wet weather conditions. Super-saturated DO concentrations were observed during dry weather conditions.

- As noted by Goldasich (2001), isolation of the water below the isocline leads to reduced oxygen reaeration from the atmosphere; however, some tidal exchange occurs, which replenishes DO in the bottom layer.

5.0 Nonpoint Source Pollutant Load Model

The PLOAD model (version 3.0) is an ArcView GIS tool to calculate nonpoint sources of pollution in watershed and storm water projects. The PLOAD model is supported by United States Environmental Protection Agency (USEPA) and is recommended for nonpoint source load analyses and Total Maximum Daily Load (TMDL) assessments. The PLOAD model is described below.

5.1 Model Description

The PLOAD model uses the EPA Simple Method (U.S. EPA 1992) to calculate pollutant loads. The model uses event mean concentration (EMC) values for particular land uses along with average annual runoff to calculate gross pollutant loads. All EMCs, runoff coefficients and percent impervious areas were taken from local data when available. When regional specific data was unavailable, state or national data was used to estimate EMCs and pollutant load reductions associated with BMPs. A default correction factor of 0.9 was used to account for the small rainfall events that do not result in any runoff. The total volume of runoff for the drainage area was determined by aggregating the calculated runoff for each land use polygon within that basin. The contribution of each land use to the storm water runoff that discharges to West Coral Lake was calculated as average annual

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runoff flow. The average annual rainfall for the Oakland Park area was used to calculate expected annual pollution loads.

According to the Simple Method, non-point source pollutant loads were calculated using the following formulas. The runoff coefficient for each land use type was derived with the equation:

$R_{VU} = 0.05 + (0.009 * I_U)$

Where:

R_{VU} = Runoff Coefficient for land use type u, inches of runoff / inches of rain
I_U = Percent Imperviousness

The pollutant loads were then calculated with the following equation:

$L_P = \Sigma U (P * P_J * R_{VU} * C_U * A_U * 2.72 / 12)$

Where: L_P = Pollutant load, lbs
P = Precipitation, inches/year
P_J = Ratio of storms producing runoff (default = 0.9)
R_{VU} = Runoff Coefficient for land use type u, inches of runoff / inches of rain
C_U = Event Mean Concentration for land use type u, milligrams/liter
A_U = Area of land use type u, acres

5.2 Model Input

5.2.1 Watershed Boundary

The watershed boundary for Kimberly Lake and West Coral Lake are depicted in **Exhibit 2**. The Kimberly Lake drainage basin encompasses approximately 59 acres and consists of 4 percent water, 57 percent residential and 39 percent light industrial land uses. The West Coral Lake drainage basin is roughly 87 acres with 10 percent water, 75 percent residential and 15 percent light industrial land uses.

5.2.2 Land Use

Land use in project area is a combination of residential and light industrial. The acreage of land uses in the Kimberly Lake and West Coral Lake watersheds are listed in **Table 3**. Land uses in the project area are depicted in **Exhibit 3**.

Table 3. Land Uses Identified in the Project Area

Watershed	Land Use	Drainage Area (acres)
Kimberly Lake	Kimberly Lake	2.33
	Residential	33.34
	Light Industrial	23.11
West Coral Lake	West Coral Lake	8.43
	Residential	65.09
	Light Industrial	13.32

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5.2.3 Urban Storm Water Characteristics

Urban storm water runoff can contain significant concentrations of harmful pollutants that can contribute to adverse water quality impacts in receiving streams. Sources of urban storm water contaminants are listed in **Table 4.**

Table 4. Sources of Contaminants in Urban Storm Water Runoff

Contaminant	Contaminant Sources
Sediment and Floatables	Streets, lawns, driveways, roads, construction activities, atmospheric deposition, drainage channel erosion
Insecticides and Herbicides	Residential lawns and gardens, roadsides, utility right-of-ways, commercial and industrial landscaped areas, soil wash-off
Organic Materials	Residential lawns and gardens, commercial landscaping, animal wastes
Metals	Automobiles, bridges, atmospheric deposition, industrial areas, soil erosion, corroding metal surfaces, combustion processes
Oil and Grease / Hydrocarbons	Roads, driveways, parking lots, vehicle maintenance areas, gas stations, illicit dumping to storm drains
Bacteria and Viruses	Lawns, roads, leaky sanitary sewer lines, sanitary sewer cross-connections, animal waste, septic systems
Nutrients - Nitrogen and Phosphorus	Lawn fertilizers, atmospheric deposition, automobile, exhaust, soil erosion, animal waste, detergents

Urban storm water runoff has been the subject of intensive research. There have been numerous studies conducted to characterize urban storm water runoff and the performance of storm water BMPs. Federal data sources include:

- "208 Studies," the area-wide waste treatment management plans conducted by states under section 208 of the 1972 Clean Water Act
- EPA's Nationwide Urban Runoff Program (NURP)
- U.S. Geological Survey (USGS) Urban Stormwater Database
- Federal Highway Administration (FHWA) study of storm water runoff loadings from highways

Data has also been collected by universities, state environmental agencies, counties, water districts and municipalities. Municipal data is often available for cities regulated under the Phase I NPDES storm water regulations, which require the collection of storm water quality data from five representative sites during a minimum of three storm events. Although storm water monitoring is required as part of the Broward County MS4 permit, the estimates of seasonal loadings and event mean concentrations are not required to be reported until the third year of the five year permit cycle as part of the 2006 annual report.

The Nationwide Urban Runoff Program (NURP) was the most comprehensive study of urban runoff that was conducted by the USEPA between1978 and 1983. The objectives of the NURP study were to examine the characteristics of urban runoff and similarities or differences between urban land uses, the extent to which urban runoff contributes to water quality problems nationwide, and the performance

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characteristics and effectiveness of management practices to control pollution loads from urban runoff (US EPA, 1983). Storm water sampling was conducted for 28 NURP projects which included 81 specific sites and more than 2,300 separate storm events. The NURP study focused on the following ten constituents:

- Total Suspended Solids (TSS)
- Biochemical Oxygen Demand (BOD5)
- Chemical Oxygen Demand (COD)
- Total Phosphorus (TP)
- Soluble Phosphorus (SP)
- Total Kjeldahl Nitrogen (TKN)
- Nitrate + Nitrite (N02+NO3)
- Total Copper (Cu)
- Total Lead (Pb)
- Total Zinc (Zn).

The NURP study yielded national estimates of event mean concentrations for different land use types (**Table 5**).

Table 5. National NURP estimates of event mean concentrations
(U.S. EPA, 1983)

Land Use	Event Mean Concentration (mg/L)									
	TSS	BOD5	COD	TP	SP	TKN	NO2+ NO3	Cu	Pb	Zn
Residential	101	10.0	73	0.383	0.143	1.900	0.736	0.033	0.144	0.135
Mixed	67	7.8	65	0.262	0.056	1.288	0.558	0.027	0.114	0.154
Commercial	69	9.3	57	0.201	0.080	1.179	0.572	0.029	0.104	0.226
Open/Nonurban	70	NA	40	0.121	0.026	0.965	0.543	NA	0.030	0.195

Local estimates of event mean concentrations for storm water runoff were available for Broward County, Miami/Dade County and the State of Florida **(Table 6)**. Local estimates of event mean concentrations were not available for soluble nutrients such as soluble phosphorus (SP) and nitrate plus nitrite (NO2+NO3). Additional data was available locally for:

- Total Nitrogen (TN)
- Total Dissolved Solids (TDS) and
- Cadmium (Cd)

The atmospheric deposition of pollutants directly to Kimberly Lake or West Coral Lake were considered negligible.

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Table 6. Florida EMC estimates based on regional data

Landuse	Location	Event Mean Concentration (mg/L)										
		TSS	BOD5	COD	TP	TKN	Cu	Pb	Zn	TN	TDS	Cd
Commercial	Broward County	-----	5.4	-----	-----	2.00	0.015	0.383	0.121	1.10	-----	0.0009
Highway	Broward County	15.0	9.0	61.0	0.10	1.03	0.031	0.250	0.114	0.96	-----	0.0007
Residential	Broward County	28.0	8.3	51.0	0.52	1.60	0.008	0.166	0.080	2.00	-----	0.0008
Commercial	Miami/Dade County	267.3	3.3	75.7	0.21	2.49	0.757	1.128	0.653	-----	119.4	-----
Highway	Miami/Dade County	-----	-----	223.0	0.25	-----	0.054	0.680	0.370	2.65	-----	0.0010
Industrial	Miami/Dade County	517.7	17.5	186.8	1.71	-----	0.031	0.397	0.880	-----	173.1	-----
Commercial	State of Florida	93.8	7.9	67.0	0.21	1.75	0.231	0.558	0.351	1.82	149.7	0.0082
Highway	State of Florida	38.5	6.7	111.7	0.28	-----	0.036	0.399	0.189	2.00	102.5	0.0073
Industrial	State of Florida	517.7	17.5	186.8	1.71	-----	0.031	0.397	0.880	-----	173.1	-----
Open/ Recreation	State of Florida	11.1	1.5	-----	0.05	-----	-----	-----	0.006	1.25	-----	-----
Residential	State of Florida	47.2	10.6	66.3	0.53	1.67	0.016	0.104	0.058	2.53	105.0	0.0035
Light Industrial	Hillsborough County	18.2	2.87	-----	0.332	2.088	0.024	0.0055	0.096	2.275	-----	0.001

(State and local data are averages from individual sampling programs)

5.2.4 Storm Water Best Management Practices

Best Management Practices (BMPs) are devices, practices, or methods for removing, reducing, retarding, or preventing targeted stormwater runoff constituents, pollutants, and contaminants from reaching receiving waters. A BMP system includes the BMP and any related bypass or overflow. The pollutant concentration of storm water from the Kimberly Lake drainage area will be affected by existing and proposed stormwater BMPs prior to entering West Coral Lake.

Several programmatic BMPs that are listed in the Broward County MS4 permit, particularly those dealing with public education and public involvement, are not easily quantified as to their pollutant removal effects. For example, the "Stormwater Management Program 6. Control of Pollutants Related to Application of Pesticides, Herbicides and Fertilizers" listed in the Broward County MS4 permit, specifies the distribution of public education materials related to pesticide, herbicide and fertilizer application. Oakland Park, as a co-permittee, is required to comply with this element, which can be met through participation, support, and promotion of the Florida Yards and Neighborhoods program administered by the Broward County Extension Service. Public education is considered to be highly effective in reducing soluble nutrients that cause euthrophication (over-enrichment) of urban surface waters. Primary sources of soluble nutrients (nitrogen and phosphorus) are commercial fertilizers applied to residential lawns. It is likely that public education

BMPs such as the Florida Yards and Neighborhoods program are highly effective in reducing urban storm water pollution but insufficient research data is available to quantify the removal efficiency. Therefore, this water quality analysis considered only the effects of structural and mechanical BMPs.

Two existing BMPs and two proposed BMPs were considered in this analysis. The existing BMPs included street sweeping and a wet detention pond, Kimberly Lake, which serves the surrounding residential area. The City currently contracts street sweeping to Sweep Corporation of American. Sweeping is currently performed with a mechanical broom-type sweeper (Elgin Eagle).

Because the project area is fully developed, the use of additional structural BMPs such as detention or retention basins, grass swales, filter strips or constructed wetlands to control storm water pollution is not a viable option. The best options for consideration are improved sweeper technologies or retrofitted filtration devices for storm water inlets. The two proposed BMPs that were considered in this analysis were:

- Vacuum assisted dry sweepers
- Storm drain filtration devices such as Stormceptors® or Continuous Deflective Separation (CDS™) technology

Efficiency is a measure of how well a BMP or BMP system removes or controls pollutants and is typically quantified by "percent removal". Researchers often determine the efficiency of BMPs through storm water monitoring before and after the BMP or BMP system. Monitoring of loads and event mean concentrations is focused on obtaining quantitative information about the amount of pollutants transported to the receiving water from overland, channel and pipe, tributary, or groundwater flow. Load and concentration monitoring data were available for wet pond detention systems in Florida residential areas (**Table 7**). The removal efficiencies for existing and proposed BMPs that were used in the PLOAD model are listed in **Table 8**.

Table 7. Pollutant Removal Efficiencies for Wet Pond Detention Systems in Florida Residential Areas

Study Site/Land Use	Type of Efficiencies Reported	Mean Removal Efficiencies (%)								
		TSS	BOD	TP	SP	TKN	NO2+NO3	Cu	Zn	TN
Boca Raton/ Residential	Concentration	68	*	55	93	-31	93	*	*	12
	Mass	64	*	60	82	0	87	*	*	15
Orlando/ Residential	Mass	82	90	91		90	95	90	90	*
DeBary/ Residential	td = 14 days	85	60	70	60	*	70	50	85	30
	Mean Values	**75**	**75**	**69**	**78**	**20**	**86**	**70**	**88**	**19**

* not reported

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Table 8. Assumed Removal Efficiencies for Existing and Proposed BMPs

BMP (Reference)	TSS	BOD5	COD	TP	SP	TKN	NO2+ NO3	Cu	Pb	Zn	TN	TDS	Cd
Mechanical Street Sweeping (Walker and Wong, 1999)	57	43	20	8	0	36	0	49	49	49	36	0	49
Wet Detention Pond (England, 2001)	75	75	75	69	78	20	86	70	70	88	19	0	70
CDS™ Device (Strynchuk, 2001; Allison et al. 1998)	52	40	40	31	5	40	5	50	50	50	40	0	50
Street Sweeping (small micron) (Walker and Wong, 1999; Sutherland, 2001)	83	75	79	72	25	79	25	81	81	81	79	25	81

5.2.5 Percent Impervious Area Used in the PLOAD Model

The percent impervious area was assigned to land use categories based on accepted ranges published in the scientific literature and adjusted based on aerial photography data for the Kimberly Lake and West Coral Lake watersheds (**Table 9**).

Table 9. Percent Impervious Areas

Land Use	% Impervious (I_U)
Water	100
Light Industrial	85
Residential	40

5.2.6 Weather Data

The National Oceanographic and Atmospheric Administration (NOAA) National Weather Service (NWS) data from the weather station located at Pompano Beach in Broward County was used in the modeling analysis. The Pompano Beach station is located at about 26.23°N and 80.15°W. The height of the weather station is about 4 meters above sea level. Pompano Beach, Broward County weather data was derived from Nation Climatic Data Center (NCDC) Cooperative Station data. Thirty-nine complete years of data between 1940 and 1995 were used in the computation of average rainfall (**Table 10**).

Table 10. Average rainfall in inches for the Oakland Park area

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
2.5	2.7	2.8	4.0	6.4	9.1	6.4	7.2	8.4	7.8	4.0	2.8	64.1

5.3 Model Output

The PLOAD model was used to analyze three Scenarios:

- Baseline Scenario – Current Conditions
  Under the Baseline Scenario, the drainage area for Kimberly Lake consists of a residential area (*catchment 1*) and a light industrial area (*catchment 2*) as shown in **Exhibit 4**. Both catchment areas currently drain to Kimberly Lake and at flood stages drain via overland flow to West Coral Lake. The light industrial area denoted as catchment 3 currently drains to West Coral Lake directly.
  The BMPs that were applied under the Baseline Scenario included:
  - mechanical (broom-type) street sweeping on all residential and light industrial areas in both Kimberly Lake and West Coral Lake watersheds
  - the treatment of storm water runoff from catchment 1 (*residential*) and catchment 2 (*light industrial*) through Kimberly Lake, which acts a wet detention pond

- Scenario 1 – Post-Flood Improvement Scenario with CDS™ Device
  Under this scenario, the light industrial land use that currently drains into Kimberly Lake (*catchment 2*) will be diverted along with the storm water runoff from the industrial area (*catchment 3*) directly to West Coral Lake. The residential area surrounding Kimberly Lake (*catchment 1*) will continue to flow into Kimberly Lake; however, an inter-connection between Kimberly Lake and West Coral Lake will prevent flooding. Excess storm water in Kimberly Lake will be transferred via a 42-inch pipe to West Coral Lake at flood stages.
  The BMPs that were applied under Scenario 1 included:
  - CDS™ filtration devices installed at the industrial (*catchments 2 and 3*) and residential (*catchment 1*) outfalls
  - Continued sweeping with mechanical (broom-type) sweeper currently used by the City
  - Continued treatment of residential runoff from catchment 1 through Kimberly Lake (wet detention pond)

- Scenario 2 – Post-Flood Improvement Scenario with High Efficiency Street Sweepers
  Under this scenario, the same flood improvements as Scenario 2 were simulated including diversion of industrial runoff from catchment 2 and catchment 3 to West Coral Lake and the inter-connection of Kimberly Lake with West Coral Lake to alleviate flooding. High efficiency street sweeping technology was also simulated in Scenario 2. The street sweeping reductions were applied to the entire project area (Kimberly Lake and West Coral Lake watersheds). The difference between Scenarios 2 and 3 is the substitution of high efficiency street sweeping for mechanical broom sweepers and the CDS™ devices.
  The BMPs that were applied under Scenario 2 included:
  - High efficiency street sweeping used in the project area
  - Continued treatment of residential runoff from catchment 1 through Kimberly Lake (wet detention pond)

The PLOAD model output is shown below in **Table 11**. The post-flood improvement pollutant loads with additional BMPs (*Scenarios 1 and 2*) were compared to the existing loads to West Coral Lake (Baseline Scenario). The objective of the analysis was to restrict the pollutant loads to those computed for the existing (i.e., current) conditions to ensure that no degradation of the water quality in West Coral Lake occurs as a result of this project. Model results indicated that the installation of storm water filtration devices at the two proposed outfalls lowered the pollutant loads to below the existing conditions for all pollutants other than a slight increase (<5 percent) in chemical oxygen demand (COD), total phosphorus (TP) and zinc (Zn) loads and small increases in soluble nutrients, 11 percent for nitrite+nitrate nitrogen (NO2+NO3) and 35 percent for soluble phosphorus (SP). The average annual pollutant loads for the Baseline Scenario and Post-Flood Improvement Scenarios (Scenarios 1 and 2) are depicted in **Figure 1** through **Figure 3**.

This analysis does not take into account the pollutant removal mechanisms within West Coral Lake itself due to settling, adsorption, algal uptake, tidal flushing, etc., nor does it take into consideration the reduction in pollutants that will be realized due to flood prevention. Inundatation of flood-prone areas can be a significant source of storm water pollution particularly floatable debris, soluble nutrients from flooded lawn areas and sediment from highly erodable areas. Flood prevention can be considered a source control BMP for storm water runoff; however, no data is available on pollutant removal efficiencies for inclusion in this analysis. Therefore, the percent change listed for each pollutant in Table 10 is a conservative estimate. It is likely that the post-flood improvement scenarios will have lower annual pollutant loads than are predicted by the PLOAD model. The reductions predicted under Scenario 1 with the CDS™ device may be sufficient to protect the water quality in West Coral Lake even with a 35 percent increase in soluble phosphorus due to the conservative estimates used in the modeling analysis.

The second option that was considered (Scenario 2) included high efficiency street sweeping for the entire project area (Kimberly Lake and West Coral Lake watersheds). The use of this technology resulted in substantially lower annual pollutant loading than the Baseline Scenario. Pollutant loads reductions ranged from approximately 15 percent to 65 percent. Soluble nutrients also showed a net reduction in pollutant loads. Soluble phosphorus (SP) loads were comparable (± 5%) to current conditions. Soluble nitrogen (NO2+NO3) was reduced by 15 percent.

Table 11. Predicted Annual Average Pollutant Loads (in pounds/acre/year) for Existing Conditions and Post-Flood Improvements with BMPs

Scenario	TSS	BOD5	COD	TP	SP	TKN	NO2 +NO3	Cu	Pb	Zn	TN	TDS	Cd
Baseline Scenario – Current Conditions	43.49	15.08	185.22	1.77	0.63	6.57	2.12	0.029	0.238	0.161	7.75	779.7	0.002
Scenario 1- Flood Improvements w/CDS Device	40.64	14.83	191.04	1.82	0.85	5.20	2.36	0.027	0.222	0.166	6.16	779.7	0.002
% Change	- 6.5	- 1.7	+ 3.1	+ 2.7	+ 34.7	- 20.9	+ 11.4	- 8.8	- 6.7	+ 2.8	- 20.6	0.0	- 8.0
Scenario 2- Flood Improvements w/High Efficiency Sweeper	21.12	7.52	66.47	0.65	0.66	2.30	1.79	0.016	0.090	0.087	2.70	584.8	0.001
% Change	- 51.4	- 50.1	- 64.1	- 63.4	+ 4.2	- 64.9	- 15.4	- 44.4	- 62.2	- 45.9	- 65.2	- 25.0	- 50.8

Negative (-) % change indicates a reduction in average annual pollutant load
Positive (+) % change indicates an increase in average annual pollutant load

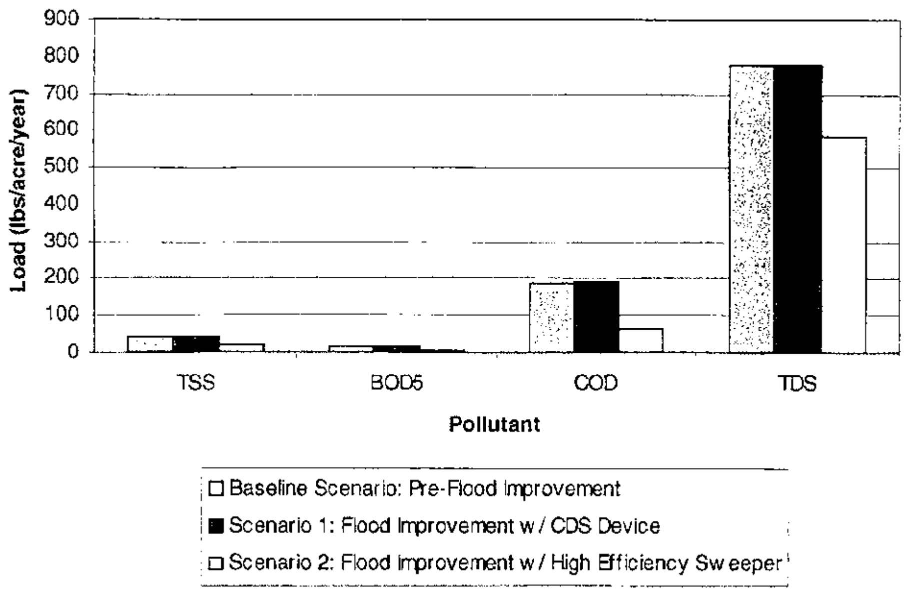

Figure 1. Annual Pollutant Loads Predicted for Total Suspended Sediment, Total Dissolved Solids and Biochemical Oxygen Demand and Chemical Oxygen Demand

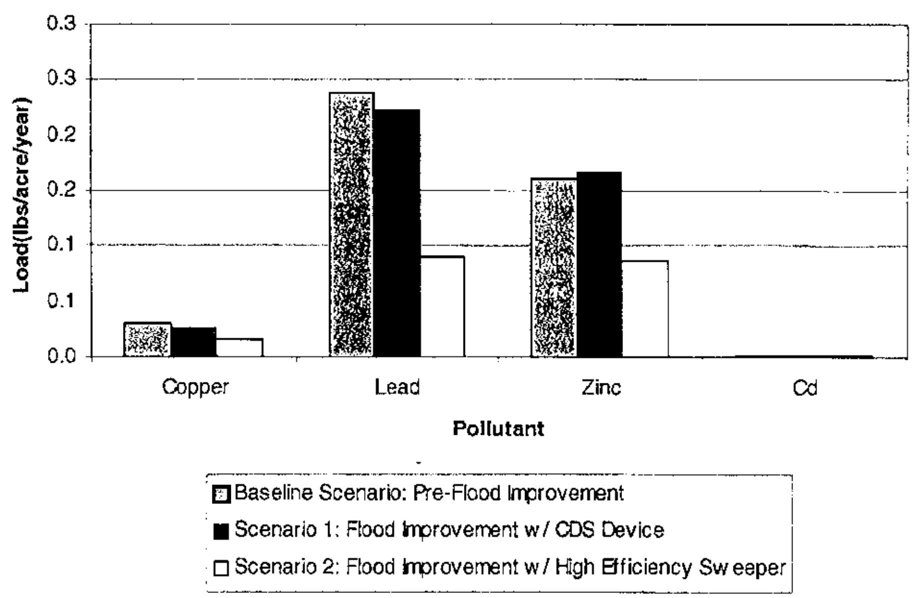

Figure 2. Annual Pollutant Loads Predicted for Metals (Copper, Lead, Zinc, and Cadmium)

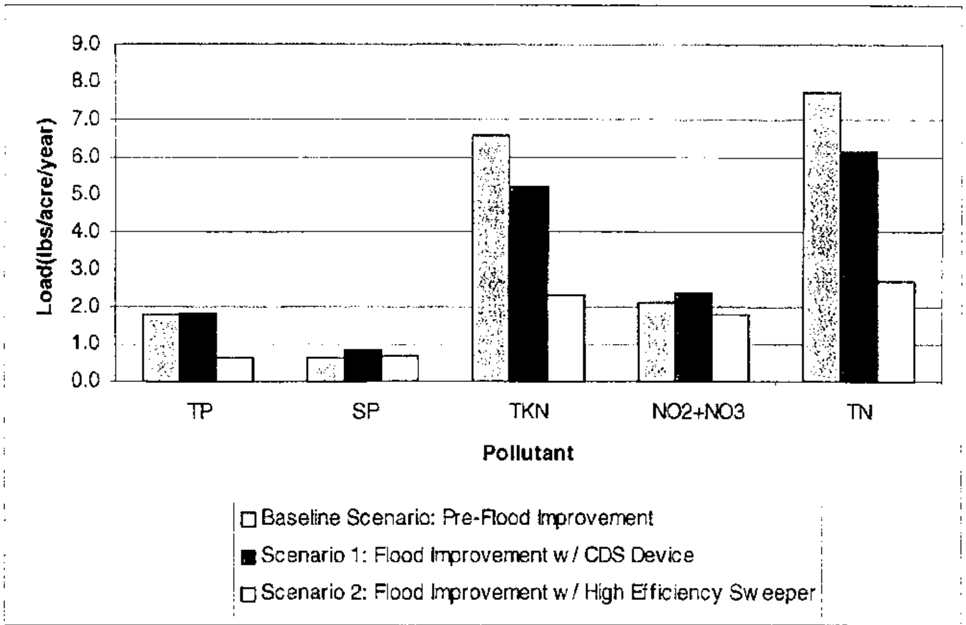

Figure 3. Annual Pollutant Loads Predicted for Nutrients (Total Phosphorus, Soluble Phosphorus, Total Kjeldahl Nitrogen, Nitrate + Nitrite Nitrogen and Total Nitrogen)

6.0 Temperature and Salinity Impacts

The temperature and salinity impacts of proposed flood improvement project and associated Best Management Practices (BMPs) were not able to be evaluated by the pollutant load (PLOAD) model. More sophisticated computer modeling techniques would be required to examine these impacts in detail.

A review of available water quality data for West Coral Lake indicated that, under current conditions, the tidally influenced lake is subject to a wide range of salinity concentrations in response to storm water runoff and tidal cycle. During a dry-weather sampling event (1/16/01) conducted by Goldasich and Associates, the salinity in West Coral Lake ranged from 12.4 to 15.4 parts-per-thousand (ppt) compared to salinities that ranged from 4.2 to 7.5 ppt during a wet-weather sampling event (10/27/00). Water temperatures during both sampling events were relatively uniform with less than a 0.5°C change throughout the water column. During the dry-weather sampling, the water temperatures were comparable to the air temperatures. Water temperatures measured during the wet-weather sampling were 1 to 2 degrees warmer that the mean daily air temperature and may indicate a temperature impact from inflowing storm water. However, the wet-weather sampling was conducted during high, flood tide and measured water temperatures were similar to the mean daily ocean water temperatures measured in the area. Therefore, it is not possible to determine if West Coral Lake is currently experiencing temperature impacts from urban runoff. The observed temperature for both sampling events were within the temperature limits set by Broward County water quality standards (see below).

The range of salinity values observed by Goldasich (2001) indicate that West Coral Lake is classified as mixo-mesohaline. Estuarine fish are generally euryhaline (i.e., tolerant of wide ranges of salinities). Available data suggests that salinities currently range from 4 to 15 ppt. Additional data is needed to fully assess the impact of reduced salinities immediately following storm events but given the degree of tidal flushing it is unlikely that the fish population will be significantly impaired.

Temperature impacts to fisheries are also a concern for area residents. Given the current state-of-knowledge about the lake system, fish community and the storm water outfall characteristics, temperature impacts to fish health and reproduction cannot be assessed. The residential area within the Kimberly Lake drainage area is similar to the residential area of the West Coral Lake basin with respect to vegetation, management and imperviousness. It is unlikely that the proposed residential outfall will lead to significant changes in the current temperature regime in West Coral Lake. However, the storm water outfall from the industrial area may pose a problem with respect to temperature. The high impervious area associated with rooftop and parking lots within the industrial area could potentially raise temperatures and affect the fish populations. In addition to the direct impacts on fish, water temperature regulates photosynthesis, respiration, dissolved oxygen saturation, and the rate of virtually all biochemical reactions in aquatic ecosystems. Some of the temperature increases may be mitigated by the exfiltration trenches and swales that are proposed to convey the storm water from the industrial area to West Coral Lake. However, the effectiveness of these BMPs with respect to mitigating temperature changes is not well documented.

It is recommended that the City closely monitor outfall temperatures to insure that Broward County temperature limits are maintained. State and County water quality standards related to thermal criteria are listed below. In addition to outfall monitoring of physical and chemical properties, we recommend that the City implement an in-lake water quality monitoring program to document long-term trends and aquatic community health.

FAC 62-302.520 Thermal Surface Water Criteria
(b) Coastal Waters – Heated water with a temperature at the point of discharge (POD) more than 2° F higher than the ambient (natural) temperature of the receiving body of water (RBW) shall not be discharged into coastal waters in any zone during the months of June, July, August, and September. During the remainder of the year, heated water with a temperature at the POD more than 4° F higher than the ambient (natural) temperature of the RBW shall not be discharged into coastal waters in any zone. In addition, during June, July, August, and September, no heated water with a temperature above 92° F shall be discharged into coastal waters. Further, no heated water with a temperature above 90° F shall be discharged into coastal waters during the period October thru May.

Broward County Water Quality Standards Sec. 27-195
Temperature shall not exceed 90°F (32.2°C)

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7.0 Conclusions and Recommendations

- Depending on the level of water quality protection that is required, the City may implement a combination of storm drain filtration devices or high efficiency street sweeping to achieve pollutant removal.

- Computer model results indicated that the use of storm water filtration devices such as a CDS™ or Stormceptor® at the proposed storm water outfalls would reduce most storm water pollutant loads to levels that are comparable to the current loads to West Coral Lake. The PLOAD model simulations indicated small increases in soluble nutrients with filtration devices alone.

- Model results indicated reductions in pollutant loads could be obtained through the use of high-efficiency street sweeping technology. Pollutant loads reductions ranged from 15 to 65 percent. Soluble phosphorus (SP) loads were comparable (± 5%) to current loadings.

- It is recommended that a combination of street sweeping and storm drain filtration devices be implemented for maximum pollutant removal efficiency and protection of water quality in West Coral Lake.

- Based on a review of available water quality data for West Coral Lake, it is evident that the tidal influences result in density stratification within the lake. The isocline typically develops between 7 and 10 feet from the surface. Lower dissolved oxygen (DO) concentrations are generally observed below the isocline. It is recommended that the storm water outfalls to West Coral Lake be designed to discharge into the upper water layer and that outfall design specifications minimize disturbances to the isocline and mixing of the low DO water.

- Additional treatment and pollutant removal will be accomplished by exfiltration trenches and grassed swales. It is recommended that the City and homeowners associations (HOAs) participate in the FDEP "Save the Swales" program. Many local civic organizations are active in promoting swales including the South Middle River Civic Association, which promotes the City of Fort Lauderdale's "Save Our Swales" (S.O.S.) program. A similar program may be developed for Oakland Park with educational materials distributed on the City web page, the City's quarterly newsletter, The Oakleaf or local HOA newsletters.

- Probable sources of soluble nutrients are commercial fertilizers applied to urban landscapes (i.e., residential lawns). It is recommended that the City participate with homeowners associations in the area to promote proper lawn management practices. Educational programs concerning proper fertilizer application methods, application rates and timing are available from federal, state and local agencies. The Florida Yards & Neighborhoods program coordinated by the University of Florida County Extension Service is an excellent source of educational materials and provides training workshops and guidance materials.

- It is recommended that the City monitor temperature and pollutant concentrations at the proposed storm water outfalls to West Coral Lake and implement additional BMPs if exceedences of water quality standards are observed.

- It is recommended that the City pursue potential grant funding for implementation of water quality monitoring within West Coral Lake. In addition to water quality monitoring by the

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City and Broward County, Oakland Park citizens may want to participate in the Florida Lakewatch program, which is a statewide volunteer water quality monitoring program coordinated through the University of Florida's Institute of Food and Agricultural Sciences Department of Fisheries and Aquatic Sciences. Training, equipment, educational materials and test kits are available through the Florida Lakewatch program for citizen's volunteer monitoring programs. Data collected by area residents could supplement data collected by the City to assess water quality and ecosystem health in West Coral Lake.

8.0 References

Allison, R.A., T.A. Walker, F.H.S Chiew, I.C. O'Neill, and T.A. McMahon, 1998. *From Roads to Rivers: Gross Pollutant Removal from Urban Waterways.* Report 98/6. Cooperative Research Centre for Catchment Hydrology, May 1998.

ASCE, 2002. *Urban Stormwater BMP Performance Monitoring:A Guidance Manual for Meeting the National Stormwater BMP Database Requirement,* April 25, 2002.

Broward County, 2000. *Draft—An Investigation of Complaints of Water Quality Problems in the North, West and East Coral Lakes, Oakland Park, Florida.* Broward County Department of Planning and Environmental Protection, Water Resources Division, May 2000.

CH2M HILL, 2000. Technical Memorandum 1, *Urban Stormwater Pollution Assessment, prepared for North Carolina Department of Environment and Natural Resources*, Division of Water Quality, August, 2000.

England, Gordon, 2001. "The use of ponds for BMPs". *Stormwater*, 2(5).

Goldasich and Associates, Inc. 2001. *Ecological Evaluation – North, West and East Lake Coral Lakes, Oakland Park, Florida; Sections 14 & 23, Township 49E, Range 42S.* Prepared by the J.J. Goldasich and Associates, Inc. for the City of Oakland Park, Public Works Department, January 2001.

Kurahashi & Associates, Inc., 1997. *Port of Seattle – Stormwater Treatment BMP Evaluation.* Prepared for Port or Seattle, Pier66. Prepared by Kurahashi & Associates, in association with AGI Technologies.

Kurahashi & Associates, Inc., 1995. *Street Sweeper Pick-up Performance.* Prepared by Kurahashi & Associates, http://www.americansweeper.com/topics/kurahashi_study_1/kura_study_1.html.

McConnell, Robert G., Elie G. Araj and David T. Jones, 1999. *Developing Nonpoint Source Water Quality Levels of Service for Hillsborough County, Florida.* Proceedings of the Sixth Biennial Stormwater Research & Watershed Management Conference, September 14-17, 1999, pages 145 –154.

Northeast Florida Water Management District, 1994. *St. Marks and Wakulla Rivers Resource Assessment and Greenway Protection Plan*, September 1994. Appendix 4.

Novotny, Vladimir and Harvey Olem, 1994. *Water Quality: Prevention, Identification, and Management of Diffuse Pollution*, Van Nostrand Reinhold, New York, 1994.

Polls, Irwin and Richard Lanyon, 1980. *Pollutant Concentrations from Homogeneous Land Uses.* Journal of the Environmental Engineering Division, February 1980.

Raird, Charles, Marshall Jennings, David Ockerman, and Tim Dybale, 1996. *Characterization of Nonpoint Sources and Loadings to Corpus Christi Bay National Estuary Program Study Area,* Corpus Christi Bay National Estuary Program/USGS/NRCS, CCBNEP-05, January 1996, Table IV.9. http://tarpon.tamucc.edu/Library/FinalReports/pdf/CCB05.pdf.pdf

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Schueler, Thomas R., 1997. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs.* Metropolitan Washington Council of Governments, July 1997.

Strynchuk, Justin, John Royal and Gordon England, P.E. 2001. *The Use of a CDS™ Unit for Sediment Control in Brevard County.* Brevard County Surface Water Improvement, Viera, FL, 1/16/2001.

Sutherland, Roger and Gary Minton. 2001. "How Do We Judge the Equivalency of New Treatment BMPs?" *Stormwater Treatment Northwest* 4(4). http://www.americansweeper.com/topics/mintonvol4No4.html

Terrene Institute, 1998. "A Clean Sweep Now Possible". *Runoff Report*, 6(4), Alexandria, VA, July/August 1998.

U.S. EPA, 1983. *Results of the Nationwide Urban Runoff Program, Violume 1 - Final Report.* U.S. Environmental Protection Agency, PB84-185552, December 1983.

U.S. EPA, 2001. *PLOAD Version 3.0 An ArcView GIS Tool to Calculate Nonpoint Sources of Pollution in Watershed and Stormwater Projects, User's Manual.*

USEPA, 2002. Pollution Prevention/Good Housekeeping for Municipal Operations. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/poll_10.cfm.

Walker, T.A. and T.H.F. Wong. 1999. *Effectiveness of Street Sweeping For Stormwater Pollution Control.* Technical Report 99/8, Cooperative Research Centre for Catchment Hydrology, December 1999.

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Appendix 1: Exhibits

6/16/04

Aquagenix
Managing Your Liquid Assets

City of Oakland Park
Public Works Dept.
3650 NE 12th Ave
Oakland Park, FL 33334

CC: Dave Womacks
Via Fax # 954-561-6296

CC: Chris Eoherty
Via Fax # 954-561-6109

City of Oakland Park
Water Test Results

	Test Date: 06/16/04	
	Phosphates*	pH**
NE 15t Ave & Floranada	0.50 ppm	7.00
NE 15th Way & NE 43rd St	0.25 ppm	7.00
NE 15th Ave & NE 48th Ct	0.50 ppm	7.50
NE 16th Terr & NE 43rd St	0.50 ppm	7.00
NE 16th Terr & NE 38th St	0.50 ppm	7.50

*Optimal pH level is between 6 and 9

**For Class II Public Access Waters, The Florida Administrative Code (FAC) Chapter 62, Section 302.530 states that total Elemental Phosphorous (Phosphate) count shall not exceed .1 micrograms per litre, or 50.0 parts per million (ppm)

Tests performed using the following Test Kits;

Ph Test	-	LaMotte Wide Range P-3100 / Code 2117
Phosphorous (Sulfide) Test	-	LaMotte Phosphate Model PAA / Code 3114-01

1460 SW 3rd Street, Suite B2, Pompano Beach, FL 33069
(954) 943-5118 — Fax (954) 943-2994

Aquagenix is a division of DeAngelo Brothers, Inc.

DRINKING WATER BACTERIOLOGICAL SAMPLE COLLECTION AND LABORATORY REPORTING FORMAT

Broward Testing Laboratory
4416 NE 11th Avenue
Ft. Lauderdale, Fl. 33334
FL Certification # E-86035

Lab Receipt Date & Time: 6/14/04 13:45
Analysis Date & Time: 6/14/04 17:50
Sample Acceptance Criteria:
Sample Preservation ☐ On Ice x Not On Ice ☐ ______ °C
Disinfectant Check ☐ Not Detected ☐ ______ mg/L
This sample does not meet the following NELAC requirements:

Report Number: ______________ Sub-Contract Lab ID: ______________

Analysis Requested: (please check all that apply)
X Standard Coliform Test
☐ HPC
☐ Other:

System Name: City of Oakland Park
System Address: 5100 NE 12 th Terrace
System or Owner's Phone #: 954-561-6271
Collector: David Pfeiffer

PWS I.D.
City: Oakland Park, Fl. 33334
Fax #: 954-561-6109
Collector's Phone #: 954-561-6271

Type of Supply: (check only one)
Community Water System   Non-Transient Non-community Water System   Transient Non-community Water System
Limited Use System   Bottled Water   Private Well   Swimming Pool   X Other - Waterway

Reason for Sampling: (check only one) Routine Compliance   Repeat   Replacement   Main Clearance   Well Survey   X Other

Sample Collection Date: 6/14/04

To be completed by collector of sample							To be completed by lab				
							Total Coliform Analysis Method: SM 9222B				
							Fecal or E.coli Analysis Method: SM 9221E				
Sample Number	Sample Point (Location or Specific Address)	Collection Time	Sample Type[1]	Disinfect Res'd (mg/L)	pH		Non Coliform	Total Coliform	Fecal or E. coli	Data Qualifier[2]	Lab Sample Number
1	NE 45th St. - Bridge	11:30					2200	300	A		79110
2	NE 15th Terrace & 43rd Street - Canal	11:30					2300	400	A		79111
3	NE 43rd Street & 16th Terrace - Lake	11:30					19000	3000	P		79112
4	15th Terrace & 48th Court - N. Lake	11:30					32000	700	P		79112

Average of disinfectant residuals for routine and repeat samples. (Complete for community and non-transient non-community systems serving populations up to and including 4,900. Do not include raw or plant samples in the average.)

[2]Defined in Florida Administrative Code Rule 62-160, Table 1
All tests are performed in accordance with NELAC standards.

Disinfectant Residual Analysis Method: ☐DPD Colorimetric ☐Other: ______
Person performing analysis is (Please see instructions on reverse):
☐A certified operator (# ____________) ☐Employed by a certified lab
☐Supervised by a cert operator (# ____________) ☐Employed by DEP or DOH

Date PWS notified by lab of positive results:
Date State notified by lab of positive results:

Lab Signature: [signature]
Title: Lab Director

Name and Mailing Address of Person to Receive Report

City of Oakland Park
David Pfeiffer
5100 NE 12th Terrace
Oakland Park, Fl. 33334

DEP/DOH USE ONLY
☐ Satisfactory
☐ Incomplete Collection Information
☐ Repeat Samples Required
☐ Replacement Samples Required
Date Reviewed by DEP/DOH: ______________
DEP/DOH Reviewing Official:

[1]DEP Sample Type Codes: D = Distribution (Routine Compliance); C = Repeat or Check; R = Raw; N = Entry to Distribution; P = Plant Tap; S = Special (clearance, etc.)
Analysis Methods: MF = SM9222B & D; MTF = 9221B & EC/MUG; MMO/MUG = SM9223B; HPC = SM9215B
Results: A = coliforms are absent; P = coliforms are present; C = confluent growth; TNTC = too numerous to count

#17d
11.19.03

CITY OF OAKLAND PARK
PUBLIC WORKS DEPARTMENT
MEMORANDUM

DATE:	November 7, 2003	**03- 029 PW Ops.**
TO:	David Womacks, Public Works Director D.W.	
FROM:	Christopher Doherty, Assistant PW Director/Operations	
REF:	Water Quality Tests – Coral Lakes	

As per your direction, I had our aquatic maintenance contractor take water samples from various locations in the Coral Lakes. These basic water quality tests were performed to address repeated concerns regarding water quality. The basic elements tested for which usually indicate or have an influence on a healthy water body were, total coliform, copper, phosphorous, and dissolved oxygen. Past water test samples had indicated above average levels of copper and phosphorous, so these elements were included in these test samples. We will continue to perform these tests on a bi-annual basis and other testing parameters may be added.

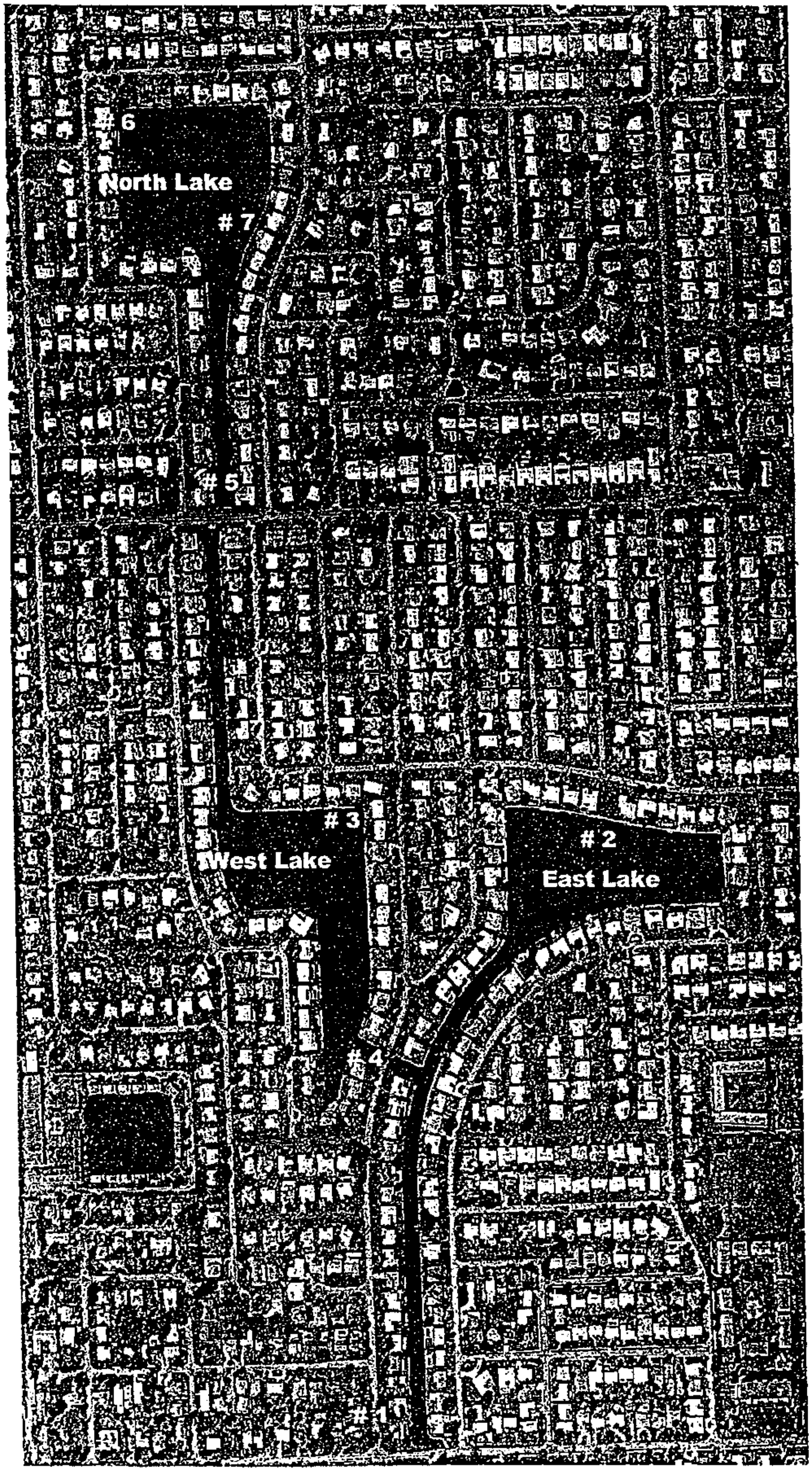
The following paragraphs define these elements:

DISSOLVED OXYGEN: The ability of the surface water to support aquatic and marine organisms. As the dissolved oxygen concentration of the surface water falls drastically below 5.0 milligrams per liter (mg/l), good quality aquatic organisms, sport fish, and the associated fish larvae and benthos are eliminated from the system. If the dissolved oxygen falls below 3.0 mg/l, poor fish quality and lowered benthos diversity will be the result. The dissolved oxygen concentration in surface waters is influenced by winds, waves, water temperature, organic content, turbidity, water depth, water color, and water transparency.

FECAL COLIFORM: The Florida Administrative Code, Chapter 62, Section 302.530, states that the total coliform bacteria shall not exceed a count of 1,000 organisms per 100 milliliters of water in 20% or more of the samples examined during any month nor exceed 2,400 ORG/100ml at any individual station. High levels of fecal coliform increase algae blooms. Low levels below 500 organisms per 100 milliliters are more desirable and usually indicate a healthier water body.

PHOSPHOROUS: High phosphorous levels are most likely due to above recommended label rate applications of fertilizers in residential lawns. Subsequent storm events then cause runoff containing dissolved phosphorous into the lakes and waterways. Phosphorus is essential to the growth of organisms and can be the nutrient that limits the primary use of a body of water.

CORAL LAKES
Water Samples



The numbers indicate the sample locations

Memo #03-PW-029 Ops, *cont.*

In the case of non-point source runoff of phosphates to a body of water may result in the stimulation of growth of photosynthetic aquatic macro-and micro-organisms in nuisance quantities. As a result, there is a continuing effort to control the amount of P compounds that enter surface waters from non-point source runoff. According to Broward County Code, Section 27-195, the maximum level of phosphorous in a waterway should not exceed 20.0 micrograms per liter (mg/l).

COPPER: Copper is usually found in the lakes and waterways as a result of herbicides being used to treat and control aquatic plants. High levels of copper reduce the nutrient level, in turn reducing plant and aquatic life. Our aquatic contractor does not use any herbicide containing copper. According to Broward County Code, Section 27-195, the maximum level of copper in a waterway should not exceed 3.0 micrograms per liter (mg/l).

The Coral Lakes have been tested 5 times since 1999, most recently on October 23, 2003. Samples were taken (see attached test locations) from the east, west, and north lakes and the connecting waterways. The exact location was different each time a test was performed. Listed below is a table of the most recent results:

	Location	Total Coliform	Copper	Phosphorous	Dissolved Oxygen
1	NE 16th Ave & NE 38th St	130 ORG/100 ml	0.00 mg/l	0.00 mg/l	5.50 ppm
2	NE 43 St & NE 17 Terr	80 ORG/100 ml	0.00 mg/l	0.80 mg/l	5.50 ppm
3	NE 15 Way & NE 43 Pl	110 ORG/100 ml	0.00 mg/l	0.32 mg/l	5.50 ppm
4	NE 16 Ave & NE 40 Pl	90 ORG/100 ml	0.00 mg/l	0.00 mg/l	5.50 ppm
5	NE 45 St & NE 15 Terr	150 ORG/100 ml	0.00 mg/l	0.32 mg/l	5.50 ppm
6	NE 48 Ct & NE 13 Terr	100 ORG/100 ml	0.00 mg/l	0.16 mg/l	5.50 ppm
7	NE 15 Terr & NE 47 Ct	150 ORG/100 ml	0.00 mg/l	0.32 mg/l	5.50 ppm

After reviewing the previous test results, which contained high levels of copper, as you can see the most recent test results indicate no presence of copper. This may be attributed to our current aquatic maintenance contractor not using any aquatic herbicide containing copper. A more balanced approach in the treatment of aquatic vegetation has been performed for the last 3 years, allowing desirable aquatic vegetation to survive. Phosphorous levels were found to be slightly higher in some test locations, but still well below the maximum threshold established by County Code. The phosphorous levels are probably due to over application of fertilizers on lawns in the area and subsequent stormwater non-point source runoff. The total coliform levels have dropped since the 1999 testing and all 7 test stations recorded levels well below the acceptable thresholds established in the Florida Administrative Code. The dissolved oxygen varies from the time of year and the air and water temperature at the time when the samples were taken. At the time of this test the Dissolved Oxygen levels were in a good range for supporting aquatic life.

According to the test results and conversations with professionals in the aquatic maintenance field, these basic indicators are the basis of a healthy water body capable of sustaining aquatic life.