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Ecological Evaluation – North, West and East Lake Coral Lakes, Oakland Park, Florida; Sections 14 & 23, Township 49E, Range 42S

Prepared For:

City of Oakland Park
Public Works Department
250 North East 33rd Street
Oakland Park, Florida 33431

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Introduction

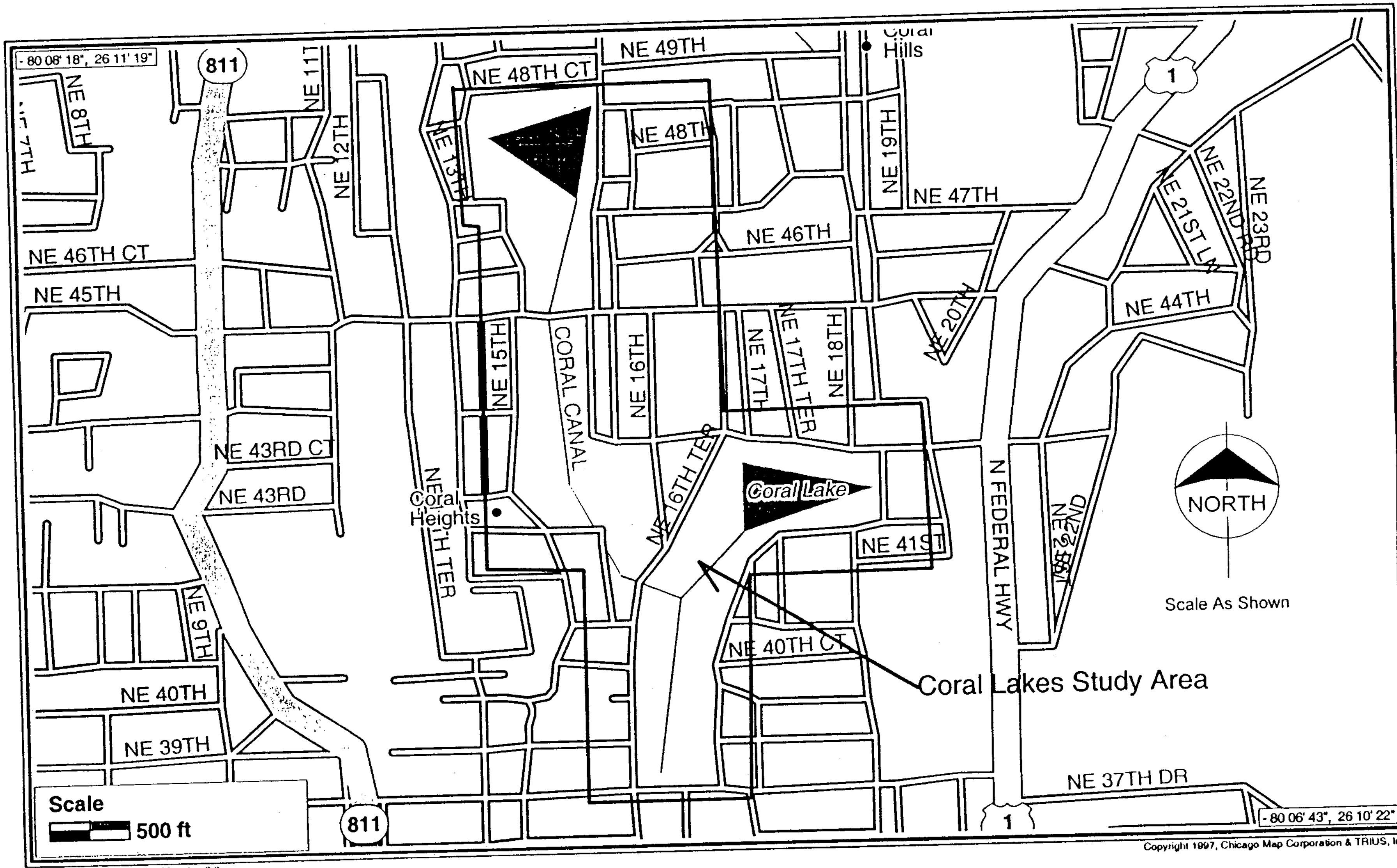
General Site Description

The areas evaluated consist of a series of artificially created lakes that are interconnected by a series of excavated linear waterways. The lakes and associated interconnecting waterways were excavated to produce fill for the adjacent residential development and to provide drainage and conveyance for the adjacent developed lands. The interconnecting waterway was excavated within the limits of an existing tidal stream / canal throughout the southern end of the system. It appears that the northern end of the interconnecting waterway was excavated from uplands. The lakes were excavated primarily from the uplands. The study area is situated in Sections 14 and 23, Township 49, Range 42, City of Oakland Park, Broward County, Florida, see **Sheet 1 of 5** for the location of the study area and **Sheet 2 of 5** for an overall aerial photograph of the study area.

Site Analysis Protocol, Methods and Procedures

Local residents, the City of Oakland Park and Craig A. Smith and Associates, Incorporated, defied the study area. The initial design of the study was to conduct a single field analysis of water from the surface of each of the three lakes at one station in each lake. The parameters to be analyzed pursuant to the initial study design included dissolved oxygen (DO), pH, salinity, turbidity, specific conductance (conductivity), water temperature and depth at each sampling location. However, subsequent to a plenary meeting with local residents, the City of Oakland Park and Craig A. Smith and Associates, Incorporated engineers the survey was modified. The modifications included the expansion to two separate field surveys with a total of seven discrete sampling stations at surface, mid – depth and approximately one foot above the bottom of the lake. Each lake was to be sampled at two separate locations and the interconnecting waterway was to be sampled at the outflow / inflow point at NE 38th Street during both of the surveys. **Sheet 3 of 3** through **Sheet 5 of 5** show each of the lakes and the approximate location of each of the seven sampling stations. In addition, each of the lakes was sampled for sediment quality pursuant to physical characteristics such as color, obvious odors, approximate grain size and benthic organism activity. The sediment samples were collected from each of the lakes at the approximate center of the individual waterway so that shoreline interferences would be eliminated to the greatest extent practicable.

The survey parameters were selected since each provides an important insight to the health of the lakes and interconnecting waterways with respect to the biological and chemical integrity of the aquatic and marine system. Further, previous water quality surveys have included an analysis of surface waters for nutrients, heavy metals and bacterial (total and fecal coliform) constituents. Additional analysis of these parameters was deemed costly and unnecessary as the previous analysis provided a valuable understanding of the system based upon the reported concentrations of each of the analytes.



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City of Oakland Park

Study Area and Lake Location Map
City of Oakland Park Water Quality Evaluation
North, West and East Coral Lakes
Sections 14 & 23, Township 49, Range 42

Date	Revision	Sheet
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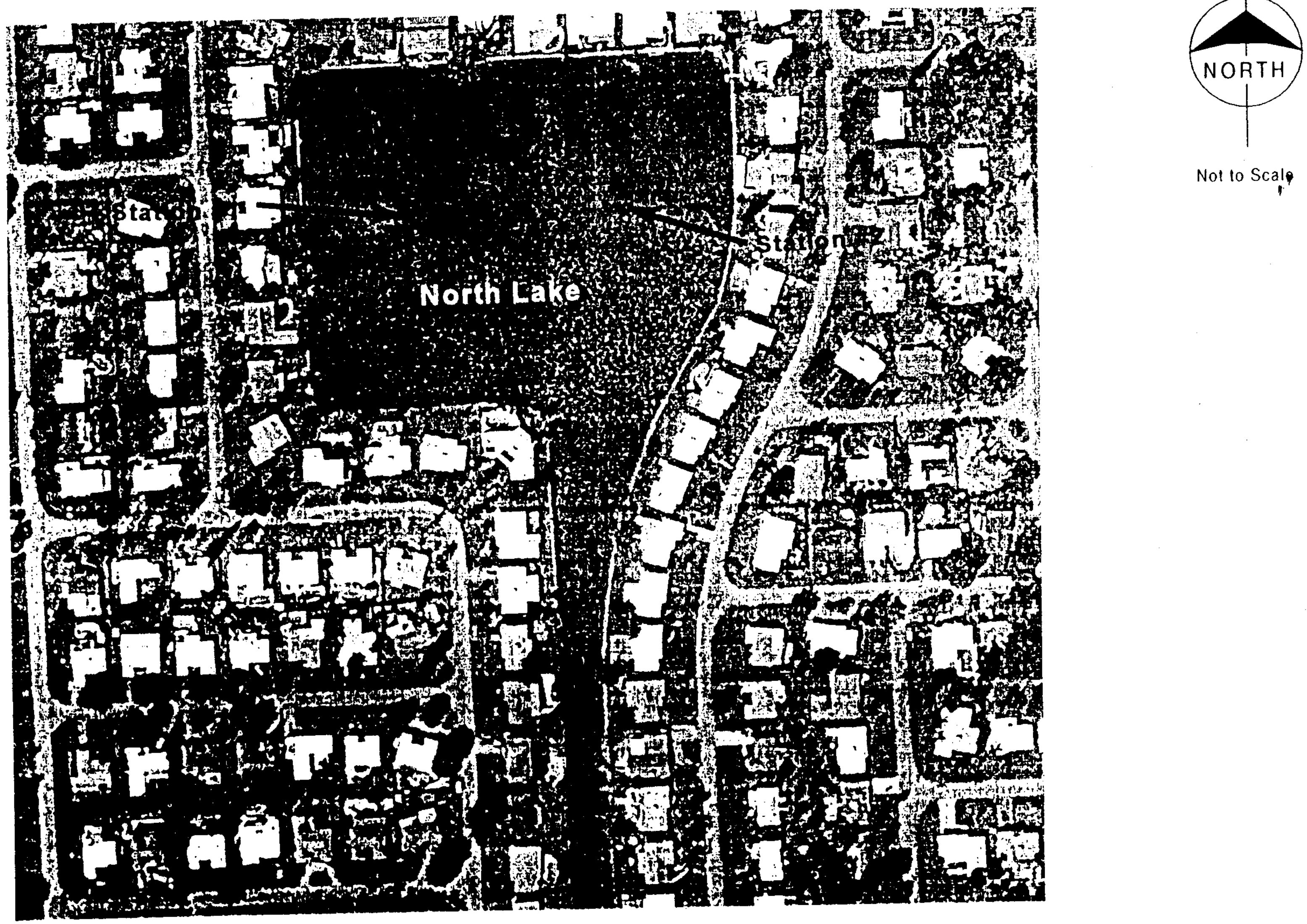

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North Lake Aerial Photograph
City of Oakland Park Water Quality Evaluation
North, West and East Coral Lakes
Sections 14 & 23, Township 49, Range 42

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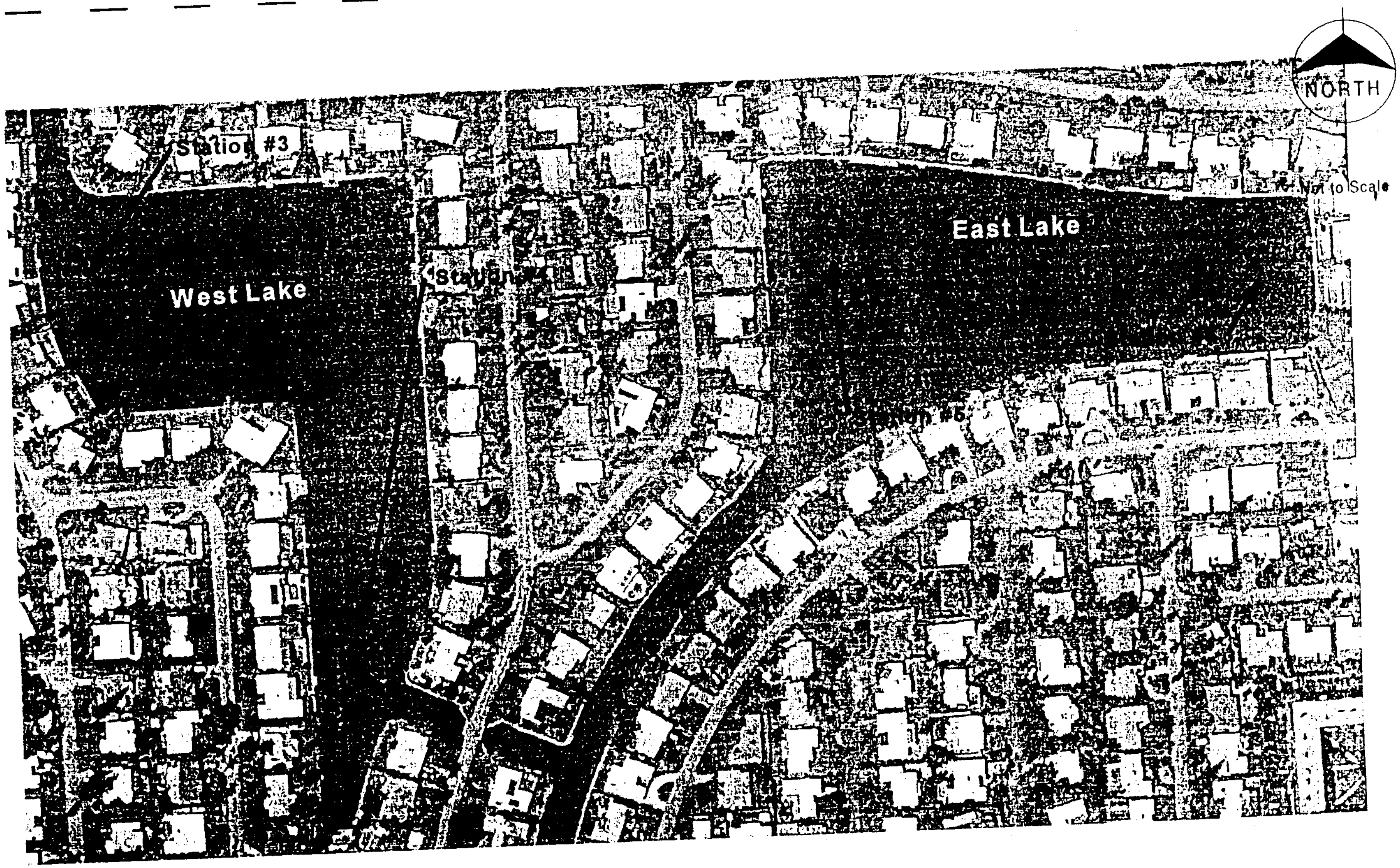

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East & West Lake Aerial Photograph
City of Oakland Park Water Quality Evaluation
North, West and East Coral Lakes
Sections 14 & 23, Township 49, Range 42

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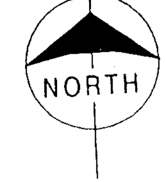

Not to Scale

Note: After Digital Ortho Photograph, Broward County 2000

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City of Oakland Park

Interconnecting Waterway Tidal Inflow Site Aerial Photograph
City of Oakland Park Water Quality Evaluation
North, West and East Coral Lakes
Sections 14 & 23, Township 49, Range 42

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Specifically each of the selected analytes provides information on the following elements of the water quality.

Dissolved oxygen is an important measure of the ability of surface water to support aquatic and marine organisms. Dissolved oxygen concentration in surface waters is influences by such features as winds, surface agitation (waves), flowing or non – flowing conditions, water temperature, organic content, turbidity, plant associations (both rooted macrophytes as well as phytoplankton), water depth, water temperature, water color and water transparency. Clear flowing or agitated shallow water should have high dissolved oxygen concentration at or near the saturation value for the temperature and pressure of the sample location. As the water becomes more quiescent, deeper, more turbid or with higher concentrations of suspended or deposited organic materials the dissolved oxygen concentration will become lower. The lower the dissolved oxygen concentration, the less the system is capable of supporting a diverse association of aquatic organisms. As the dissolved oxygen concentration of the surface waters falls 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. Poor quality fish and lowered benthic diversity will result as the dissolved oxygen falls below 3.0 mg/l.

The measurement of the **pH** of the water provides information on the hydrogen ion activity of the sampled waterway, which in turn often points to potential areas of industrial or domestic contamination. The range of pH values is between a hypothetical 0 – 14 scale with 7 being neutral, values below 7.0 represent an acid condition and values above 7.0 represent a basic condition. The normal pH of natural surface waters should fall between 6.5 and 8.5 pH units. As the pH value extends outside of the stated "normal" values, biologic activity and taxonomic diversity of the biota is reduced. This results in a poor quality system that is less capable of responding to natural or human induced stresses in a favorable manner.

Salinity measurements were included in the water quality survey to aid in the identification of potential stagnant areas or areas that experience poor flushing. In addition, salinity was measured to help identify the areas that received higher levels of storm water discharges during or immediately after storm events. Although not envisioned prior to the surveys, salinity was also valuable in identifying the mixing character of the lakes during flood and ebb tide events.

Turbidity was targeted as a monitoring parameter in order to identify the mixing characteristics of the lakes as well as to identify potential illicit discharges of storm water or surface waters from individual point sources. Turbidity is a measure of the clarity of the water and the water clarity is a major determinant of the condition and productivity of the system. Suspended matter, such a clay, silt, finely divided organic matter cause turbidity in natural surface water, soluble colored organic compounds including phytoplankton and zooplankton also contribute to increased turbidity. Turbidity is an expression of the optical properties of the water that causes light to scatter and be absorbed rather than be transmitted through the water column in straight lines. Higher turbidity in a lake results in increased sedimentation and lower light transmission through the water column. This causes the photic zone to be higher in the lake, which reduces the ability of the system to support plant life at deeper depths. This usually results in a lower abundance and diversity of planktonic and rooted plants and a lowered productivity of the system. Natural surface waters in Broward County usually have a low turbidity, with typical values between 2 and 7 Nephelometric Turbidity Units (NTU's).

Specific conductance (conductivity) was selected as an indicator of poor quality water and illicit industrial, domestic or storm water discharges. Conductivity is a numerical value of the ability of an aqueous solution to carry an electric current. This ability is dependant upon the total concentration, valence and relative concentration of ions in the solution being measured. The ions that provide the highest conductivity include most inorganic acids, bases and salts. Therefore, even if such levels of ions are too low to be pinpointed by other parameters measures, the measure of minute differences in conductivity will often point to water contaminated by prohibited discharges. Organic compounds that do not disassociate in aqueous solutions are not measured by conductivity, as they conduct an electric current very poorly.

The study area was evaluated by reviewing the historic aerial photographs, a previous Broward County Department of Planning and Environmental Protection (DPEP) preliminary report on the water quality of the lake system and soils maps of the site in the office. In addition, the local neighborhood and adjacent uplands were reviewed for potential impacts to the lake system. Analysis of the upland areas included an evaluation of potential erosion and sedimentation points as well as illicit discharges of surface or storm waters. This initial site scopeing was conducted so that potentially important water quality impacts could be identified and targeted for later review in the field from the waterway. In addition, maps supplied by local residents were evaluated and considered in the subsequent design of field sampling locations.

The water quality surveys were conducted from a canoe that was launched at the NE 38th Street Bridge over the interconnecting waterway at the southern terminus of the study area. Each survey consisted of a series of samples analyzed in the lake system while traveling from south to north in the lakes. Survey one was conducted during high and flood tide and Survey Two was conducted during low and ebb tide. The two different tidal stages were included in the study design to identify potential onsite or offsite inputs that may be contributing to the water quality of the lake system. **Exhibit 1, Sheets 1 of 2 and 2 of 2** show the tidal stages during the two water quality surveys. Based upon National Oceanic and Atmospheric Administration (NOAA) tide station data (see **Appendix 2**), the average vertical tidal fluctuation (Mean Range) for the nearfield area is approximately 2.1 feet.

The sampling locations were sampled by *insitu* analysis of the targeted parameters with two instruments inserted at each sampling location simultaneously. A Horiba Water Quality Monitor was used to measure turbidity, pH and water temperature, while a Yellow Springs Instruments (YSI) Model 84 Meter was used to measure dissolved oxygen, salinity and conductivity (specific conductance). Further, all areas that were previously targeted as potentially containing potential impacts to the waterway were evaluated with surface measurements. The water quality survey included an ecological evaluation of the system and adjacent lands to provide additional supporting data and information relative to the quality of the surface water system. The field evaluations were conducted during the daylight hours and were designed to record incidental faunal observations through direct and indirect means. Indirect faunal identification may be confirmed by such measures as surface swirls, tracks, scat, characteristic dens or burrows, feeding stations or locations or identifiable vocalizations. No faunal trapping or nighttime work was included in this effort.

Field Evaluation

The lake system and interconnecting waterways were evaluated in the field during wet and dry weather conditions on October 27, 2000 and January 16, 2001 respectively. Each of the surveys included an initial reconnaissance level survey of the area and a water quality analysis at surface, mid – depth and approximately one foot above the substrate in each lake. Antecedent and survey period weather was recorded during each of the sampling events.

Results

Survey One (October 27, 2000)

The October 27, 2000 survey was conducted on a high tide that was ebbing throughout the sampling sequence. The antecedent weather was rainy and windy although the period was generally dry. Air temperatures were in the high 70's to low 80's throughout the survey and the sky was partly cloudy. No measurable rain fell during the survey although isolated showers were experienced during collection of samples from East Lake and North Lake and during the sediment collection in East Lake.

Reconnaissance Field Evaluation and Survey

The lakes and interconnecting waterways are entirely protected by seawalls except in a small area adjacent to NE 38th Street. The seawalls are in generally good condition although some seepage was noted in small numbers of the walls. This could contribute water with high nutrient concentrations following fertilization of lawns, trees or shrubs. Aquatic plants will respond to fertilizer if it reaches the water column the same as upland grasses, trees and shrubs.

The general condition of the shoreline was good throughout all areas evaluated except in isolated locations on the southern bank of East Lake, the southeastern corner of the interconnecting waterway between East Lake and West Lake on NE 16th Avenue and at each of the bridge crossings of the interconnecting waterway at Floranada Road and NE 38th Street. In each of these locations bare and erodable earth was exposed to the waterway and the slopes are steep enough to suggest that direct discharges of sediment and turbid water would occur during storm events. This condition would result in increased turbidity in the water column and increased sedimentation in relatively shallow areas adjacent to the two bridges, further reducing transport of water during normal tidal cycles. Further, in one case, construction activities on the adjacent upland property resulted in unprotected bare earth piles directly adjacent to the lake and direct discharge of construction water into the lake. While this water was low in turbidity, as no construction was actually underway at the time of the study, turbidly water would probable be discharged into the waterway when construction was underway.

Slopes and grassed areas that extend directly to the vertical seawalls also represent another probable negative impact to the waterway. Such conditions are present on the majority of the upland adjacent properties and represent a significant potential impact to the system. Direct discharges of storm water that has sheet flowed across the lawns often carry high levels of nutrients that have been applied to the lawn but runoff into the lakes and interconnecting waterways. Further, most seawalls contain scuppers that allow water to drain from the upland properties. These waters often contain high levels of sediment and nutrients, which unnecessarily speeds the eutrophication (aging) of the surface water system. Lesser, but important, additional contributors of contaminants to the surface water system that were identified during the study area reconnaissance review include numerous large trees and shrubs that supply large quantities of leaf litter directly to the water and pet waste and grass clippings thrown or blown into the water. While none of the mentioned features could be documented as producing an impact on the lake or interconnecting waterways, each will produce a negative impact on the system and collectively such an impact will be measurable.

Water Quality Concentrations – October 2000

The results of the October 27, 2000 water quality determinations are provided in **Appendix 1**, and specifically discussed below. The physio – chemical parameters evaluated indicated that the lakes and interconnecting waterways are generally in good health and are generally well mixed throughout.

Dissolved Oxygen

The initial water quality survey showed that the dissolved oxygen was sufficient for a diverse aquatic community in all surface samples and in the interconnecting waterway. Stratification of the water column was apparent and a fairly strong isocline was present between one (1) and ten (10) feet deep in all lake samples except in southern end of West Lake. This sample showed a well-mixed system to depths below ten (10) feet deep. This is probable due to the water flows from the interconnecting waterway mixing thoroughly with the lake in the areas adjacent to the confluence of the lakes and the interconnecting waters. The dissolved oxygen concentrations observed during the October sampling event are considered to be within the normal range for surface waters in Broward County and point to a relatively healthy lake and interconnecting waterway. Only in the deeper limits of the lakes were dissolved oxygen concentrations limiting to a well-balanced biotic assemblage. Low dissolved oxygen concentrations in the deeper portions of water bodies is a normal condition caused by isolation of this part of the water column from atmospheric oxygen and poor mixing below temperature and chemical induced stratification layers. Even though the dissolved oxygen was low in the deep lake areas, the concentration was still high enough to provide sufficient oxygen for a wide range of fish and invertebrates.

Specific Conductance (Conductivity)

The Specific conductance showed a stratified layer of higher conductivity water at mid – depths in both East Lake and West Lake, while the highest conductivity noted in North Lake was in the bottom reading. While these levels of conductivity are not considered high, the stratification does suggest that discharges of waters containing contaminants are entering the waterways during sporadic events and that differential settling of the constituents is occurring. Some of the higher conductivity values are directly attributable to the salinity of the water, particularly at station number 5 at mid – depth (Western end of East Lake), but this condition does not account for elevated readings at mid - depth in West Lake or the bottom of North Lake.

Salinity

Salinity readings during the October analyses show higher readings at the deeper limits of all of the lakes with some stratification of water at the mid – depth region of the east end of East Lake and the South end of West Lake. It is possible that the southern end of West Lake does have some freshwater spring discharges that would account for the lower salinity at depth. However, the relatively high salinity at mid – depth in the western end of East Lake suggests an area of stagnation with very poor mixing. The configuration of the lake would contribute to this condition and poorer water quality and increased sedimentation in this area will result. The generally lower salinity readings in all stations and at all sampling depths is a result of the increased rain events during the "rainy season" and points to the fact that some limitation on the degree of flushing is imposed by the shallow areas near the NE 38th Street and Floranada Road Bridge. While these shallow areas reduce the normal tidal flushing of this lake system, no significant negative impact on the water quality of the lake system was noted during the conduct of the October survey.

Temperature

Temperatuce readings showed that the lake system is generally holomictic and typically un-stratified with respect to thermal differences. This is a characteristic condition for sub – tropical lakes where air temperatures typically do not allow for the formation of thermal clines. This condition further aids in the transport of surface waters to the bottom of the lake system and the utilization of the entire water column by important faunal components including fish, ichtyoplankton, zooplankton and other free swimming and benthic organisms. Where strong thermal clines are formed there is little mixing below the metalimnion and the hypolimnetic areas are often barren of faunal use. Given the relatively constant temperatures throughout the water column normal mixing from wind and current (tidal) induced actions should occur on a routine basis. The majority of the water quality parameters monitored during this survey confirmed this condition.

Turbidity

Turbidity was well within the normal ranges during the October survey event although some elevated readings were observed at the surface in North Lake and at the surface in the west end of East Lake. These higher readings are still in the low range but do suggest a poorly flushed or stagnant condition or isolated point sources of contaminants entering the waterway at these locations. As this sampling event was performed following rain events it is probable that some of the increased turbidity at the surface in these locations was contributable to storm water discharges. However, East Lake did have at least one unauthorized discharge of construction water in the vicinity of the sampling station. This discharge probable contributed some increased turbidity to the water column. Improvements in the construction and maintenance of grassed swales in the vicinity of seawall and storm drains will reduce the discharge of turbid waters into the lake system. All unauthorized discharges into the lake and interconnecting waterways should be stopped in order to eliminate this unnecessary input of low quality water. The high reading at the bottom of the west end of West Lake is attributable to substrate disturbance with the analytical meter probes and should not be considered a true representation of the water column condition.

pH

The pH values observed in the October survey all fell within the normal range and were slightly basic in all areas and all depths. Stratification was not noted with respect to the pH values and a generally holomictic condition was evident throughout each lake.

Sediment

The sediments in each of the three lakes were similar in color and consistency with a very fine organic component being most noticeable. No strong odor or oily texture was observed in any of the samples. The sediment in North Lake had a matrix color of 7.5 Y/R 6/1. West Lake sediment had a matrix color of 7.5 Y/R 7/1. East Lake sediment had a matrix color of 7.5 Y/R 2.5/1. None of the samples contained noticeable mottles or concretions. The sediment in the interconnecting waterway was dominated by course to fine sand and shell fragments and had a color of 7.5 Y/R 7/3.

Tidal Prism Flushing

The calculated estimate of tidal action flushing during the October 27, 2000 field survey date was calculated based upon the mean tidal fluctuation of 2.7 feet and an average flow rate of 2.0 feet per second through the NE 38th Street Bridge. Given the cross sectional area and the approximate influent flow time of 6.45 hours, approximately 3.6 million cubic feet (~26.9 million gallons) entered the study area as a result of tidal action.

Survey Two (January 16, 2001)

The January 16, 2001 survey was conducted on a low tide that was in flood stage throughout the sampling sequence. The antecedent weather was dry and windy although a small of rain fell the morning of the sampling event and continued during the collection of water samples from East Lake. Air temperatures were in the high 60's to low 70's throughout the survey and the sky was mostly cloudy early and partly cloudy at the end of the sampling sequence. While some isolated showers fell early in the sampling event, no measurable rain fell during the survey.

Reconnaissance Field Evaluation and Survey

The seawalls remain in generally good condition and no seepage was noted during the January sampling event, this probable being due to the reduced rain during this period.

The general condition of the shoreline was good throughout all areas evaluated. As in the October survey, the areas adjacent to the waterway at the southeastern corner of the interconnecting waterway between East Lake and West Lake on NE 16th Avenue and at each of the bridge crossings of the interconnecting waterway at Floranada Road and NE 38th Street represent areas that probable contribute poor quality waters to the system during storm events. In each of these locations bare and erodable earth was exposed to the waterway and the slopes are steep enough to suggest that direct discharges of sediment and turbid water would occur during storm events. This condition would result in increased turbidity in the water column and increased sedimentation in relatively shallow areas adjacent to the two bridges, further reducing transport of water during normal tidal cycles. The construction activities on the adjacent upland property on East Lake was completed and the erodable earth was covered, thereby eliminating this potential source of poor quality water.

Water Quality Concentrations – January 2001

The results of the January 16, 2001 water quality determinations are provided in **Appendix 1**, and specifically discussed below. The physio – chemical parameters evaluated during the dry season sampling event indicated that the lakes and interconnecting waterways are generally in very good health and are well mixed at all depths and all locations.

Dissolved Oxygen

The second water quality survey showed that the dissolved oxygen was sufficient for a diverse aquatic community in all surface samples and in the interconnecting waterway with values exceeding standards throughout the water column. Stratification of the water column was apparent between the one (1) and ten (10) foot depth readings in all lakes but little changes were observed throughout the water column to the substrate. This is supported by the October analyses and is due to the strong water flows from the interconnecting waterway, which thoroughly mix the lake at the confluence of the lakes and the interconnecting waters. The dissolved oxygen concentrations observed during the January sampling event are considered to be within the high normal range for surface waters in Broward County and point to a very healthy lake and interconnecting waterway. Based upon the readings generated during the January survey event, dissolved oxygen concentrations are not limiting to a well-balanced biotic assemblage throughout the entire water column. While it is typical to observe lower dissolved oxygen concentrations in the deeper portions of water bodies as a result of isolation of this part of the water column from atmospheric oxygen and poor mixing below temperature and chemical induced stratification layers, the subject lakes showed very high values even at the deeper reaches of the water bodies. This condition points to a well-mixed lake system with adequate tidal flushing. Even though the shallow areas at NE 38th Street and Floranada Road do reduce the tidal interchange, this limitation is not producing a measurable reduction in water quality based upon the parameters measured during the subject water quality survey.

Specific Conductance (Conductivity)

The Specific conductance results from January showed a well mixed system throughout the water column with a slightly stratified layer of higher conductivity water at the bottom of each lake and at mid

– depth in the east end of East Lake. The higher conductivity values measured during the January sampling event are directly attributable to the salinity of the water, particularly due to the lower rain inputs and reduced mixing with storm water discharged into the system via storm water structures, seawall scuppers and sheet flows.

Salinity

Salinity readings during the January survey period showed high values throughout the lake system with increasing values evident at the southern end of the system. The tidal water entering the system during the January survey has a value of 15.0 for salinity, which was lower than all waters below East Lake. The lower salinity readings in West and North Lake suggest that East Lake intercepts much of the tidal prism water during normal tidal flushing and waters in West and North Lake are exchanges at much lower rates than the water in East Lake. This condition is contributed to by the configuration of the lake system primarily as adequate water depths are present at NE 16 Street Bridge to pass tidal flows. Increased salinity at the deeper reaches of the lakes is a result of the increased density of the higher salinity water.

Water Temperature

Temperature readings showed that the lake system is generally holomictic with little stratification noted with respect to thermal differences. This situation was also observed during the October survey event and is a typical condition for sub – tropical lakes where air temperatures typically do not permit the formation of thermal clines. This condition further aids in the transport of surface waters to the bottom of the lake system and the utilization of the entire water column by important faunal components including fish, ichtyoplankton, zooplankton and other free swimming and benthic organisms. Given the relatively constant temperatures throughout the water column normal mixing from wind and current (tidal) induced actions should occur on a routine basis. The majority of the water quality parameters monitored during this survey confirmed this condition during both the October and January survey events.

Turbidity

Turbidity was well within the normal ranges during the January survey event with slightly elevated readings observed at the surface of each of the lakes. These higher readings are still in the low range but do suggest recent discharges of turbid waters. As this sampling event was performed during the dry season some rain did fall on the morning of the sampling event. While this rain was not measurable, some storm water discharge probable contributed turbid water to the lake system. This discharge probably contributed some increased turbidity to the surface of the water column. As previously stated, improvements in the construction and maintenance of grassed swales in the vicinity of seawall and storm drains will reduce the discharge of turbid waters into the lake system. All unauthorized discharges into the lake and interconnecting waterways should be stopped in order to eliminate this unnecessary input of low quality water.

pH

The pH values observed in the January survey all are within the normal range and were slightly basic in all areas and all depths. Stratification was not noted with respect to the pH values and a generally holomictic condition was evident throughout each lake.

Tidal Prism Flushing

The calculated estimate of tidal action flushing during the January 16, 2001 field survey date was calculated based upon the mean tidal fluctuation of 2.1 feet and an average flow rate of 2.0 feet per second through the NE 38th Street Bridge. Given the cross sectional area and the approximate influent flow time of 5.9 hours, approximately 2.5 million cubic feet (~18.7 million gallons) entered the study area as a result of tidal action.

Conclusions and Recommendations

Based upon the results of the subject water quality survey, the Coral Lake system of relatively deep lakes and shallow interconnecting waters is a marine system with high quality water. Although flushing is somewhat reduced, all of the parameters measures suggest that the lake system is fairly well flushed by normal tidal action. The reduction in tidal flushing is the result of two factors, 1) the configuration of the lake and canal system and 2) the very shallow areas below the bridges at NE 38th Street and Floranada Road. The shallow areas at these two bridges further limit water flows with lush submergent rooted aquatic growth primarily dominated by eel grass (*Vallisneria americana*). The growth of this submerged rooted aquatic was more pronounced during the October survey, but was still evident during the January survey. While this rooted plant does reduce the flows into and out of the lake system, it should be noted that it also provides a very valuable resource for a diverse faunal association. Eel grass beds are used as a food source, hiding and foraging grounds and nursery areas for fish and invertebrates. Eelgrass beds also produce large quantities of dissolved oxygen for the aquatic and marine system, which promotes a well-balanced indigenous faunal association. Complete elimination of the eelgrass beds is not recommended as this would result in a negative overall impact on the biota of the system. Further, the reduction in tidal flushing does not appear to significantly negatively affect the water quality of the lakes and interconnecting waterways and complete elimination of the rooted aquatics would produce more negative impacts to the aquatic and marine system than realized benefits to the system. Dredging of the shallow areas adjacent to the NE 38th Street and Floranada Road Bridges would result in increased tidal interchanges between the lakes but probably would not account for measurable improvements in the water quality of the system. Based upon the parameters measured, the water quality does not appear to be limited by the tidal interchange between the lakes and interconnecting waterways. Similar water quality readings were observed in all lakes and in the interconnecting waterway during all sampling events and at all depths, suggesting that adequate flushing and mixing does occur throughout the system. Further, the configuration of the interconnecting waterways and lake system (particularly East Lake) will still contribute to a reduced flushing action in West Lake and, to a greater extent, North Lake. Important benthic macroinvertebrate associations that are an important food web component for young fish are found throughout the shallow areas and this community would be lost or severely damaged if these areas are dredged. Regulatory agency review of such a proposal would be very lengthy and may not be authorized due to the potential for negative impacts to he benthic macroinvertebrate community and associated icthyo – faunal resource. Permits for such a proposal would be required from the US Army Corps of Engineers (ACOE pursuant to Section 10 of the Rivers and Harbors Act of 1899, from the State of Florida pursuant to the Environmental Resource Permit (ERP) rule (1994) and from Broward County pursuant to Section 27 – Broward County Code of Ordinances. In each case, the regulatory agency would balance the benefits of the dredging operation with the negative impacts, including environmental, aesthetic, economic, social, etc. If the perceived benefit outweighs the negative impacts then a favorable permit decision would result. Based upon initial discussions with agency staff, the benefits of such a dredging proposal do not outweigh the negative impacts to the system.

Recommended Actions

1. Grassed swales and grassed slope areas adjacent to rights of way should be maintained by the entity responsible for these areas.

2. All areas adjacent to seawalls should be constructed with a shallow swale or slightly elevated berm to eliminate sheet flow of storm water into the lakes and interconnecting waterways. Conversely, mulch buffers should be installed adjacent to the upland edges of all seawalls to eliminate direct overland flows of nutrient laden waters.

3. Grassed swales should be installed and maintained adjacent to all storm water catch basins in the drainage basin.

4. Where possible, native aquatic and marine emergent vegetation should be installed at the waterward face of seawalls and in shallow areas of the aquatic system.

5. Where possible, remove the vertical seawalls and install rip – rap with planted emergent aquatic and marine vegetation. Where water depths make this impossible, investigate the possibility of installing aquatic vegetation planters at the waterward edge of seawalls. Such native vegetation will not require fertilization and will intercept much of the nutrient laden water that enters the system by overland flows.

6. Remove or rehabilitate the scuppers that discharge water through the seawalls. Rehabilitation would necessarily include excavation of the upland edges and installation of appropriate filtering media and the isolation of the inflows from lawns or other areas that are routinely fertilized.

7. Conduct a complete tidal survey to identify the specific limitations of tidal flows in each of the lakes. Such a survey would require survey crews collecting water elevation data throughout three tidal cycles on each of the lakes and at the NE 38th Street at a minimum.

8. Conduct a synoptic survey of the sediment in each lake and in the interconnecting waterway. Analysis of organic and heavy metals should be conducted at three locations in each lake and at two locations in the interconnecting waterway (see Exhibit 3, Sheet 3 of 3).

Appendix 1 – Water Quality Results, City of Oakland Park, Coral Lakes Water Quality and Ecological Evaluation; October 27, 2000 and January 16, 2001

City of Oakland Park – Water Quality Survey

2/2/01

 October 27, 2000 Survey

Lake	Station	DO (mg/l)	Conductivity (Mm/S)	Salinity (ppt)	Temperature (° C)	Turbidity (NTU)	PH (units)	Depth (feet)
North Lake	1(surface)	5.6	5.66	3.1	24.7	9	8.1	1
North Lake	1 (mid-depth)	2.3	7.30	3.9	25.0	5	7.8	11
North Lake	1 (bottom)[1]	2.1	9.10	6.1	25.5	3	7.65	23
North Lake	2(surface)	5.5	5.65	3.1	24.9	12	8.27	1
North Lake	2 (mid-depth)	2.5	7.54	4.2	24.9	5	7.94	11
North Lake	2 (bottom)	2.5	8.85	6.7	25.4	5	7.55	22
West Lake	3(surface)	4.4	9.30	5.2	25.5	8	7.95	1
West Lake	3 (mid-depth)	4.5	10.76	5.9	25.4	7	7.92	11
West Lake	3 (bottom)	2.5	12.6	7.5	25.2	18	7.67	22.5
West Lake	4(surface)	5.15	7.59	4.2	25.4	5	7.85	1
West Lake	4 (mid-depth)	2.68	8.12	6.6	25.0	5	8.12	8
West Lake	4 (bottom)	2.1	8.55	5.6	25.1	3	7.73	15.9
East Lake	5(surface)	5.6	11.38	6.7	25.5	6	7.86	1
East Lake	5 (mid-depth)	3.4	17.24	10.1	25.3	3	7.67	10
East Lake	5 (bottom)	2.7	18.0	9.5	25.5	3	7.67	22
East Lake	6(surface)	4.4	9.77	5.4	24.4	4	7.93	1
East Lake	6 (mid-depth)	3.8	10.13	5.8	24.9	4	7.64	10
East Lake	6 (bottom)	2.1	17.1	7.9	25.1	3	7.53	21
NE 38th St.	7(surface)	5.9	12.17	7.0	25.5	3	7.95	1
NE 38th St.	7 (mid-depth)	N/A	N/A	N/A	N/A	N/A	N/A	
NE 38th St.	7 (bottom)	N/A	N/A	N/A	N/A	N/A	N/A	2.0

[1] Bottom samples taken approximately 1 to 3 feet above substrate.

	Station	DO (mg/l)	Conductivity (Mm/S)	Salinity (ppt)	Temperature (° C)	Turbidity (NTU)	PH (units)	Depth (feet)
North Lake	1 (surface)	8.7	18.2	10.8	19.7	6	7.79	1
North Lake	1 (mid-depth)	6.4	19.6	11.7	19.0	3	7.61	10
North Lake	1 (bottom)[1]	5.5	20.2	12.0	19.0	3	7.56	20
North Lake	2 (surface)	7.9	18.6	11.0	19.5	4	7.72	1
North Lake	2 (mid-depth)	6.3	19.7	11.7	19.0	3	7.60	10
North Lake	2 (bottom)	5.7	20.3	12.2	19.3	3	7.55	20
West Lake	3 (surface)	9.3	23.4	14.2	19.6	5	7.76	1
West Lake	3 (mid-depth)	5.3	24.5	14.9	19.2	2	7.50	10
West Lake	3 (bottom)	4.6	25.2	15.4	19.5	2	7.48	19
West Lake	4 (surface)	7.7	20.4	12.4	19.6	5	7.71	1
West Lake	4 (mid-depth)	5.4	24.5	14.9	19.2	2	7.51	10
West Lake	4 (bottom)	5.6	25.3	15.4	19.5	2	7.51	19
East Lake	5 (surface)	8.6	25.0	15.2	20.2	4	7.82	1
East Lake	5 (mid-depth)	6.7	29.0	18.0	19.5	2	7.59	10
East Lake	5 (bottom)	5.9	28.9	17.9	19.3	2	7.57	19
East Lake	6 (surface)	9.7	25.2	15.5	20.0	5	7.76	
East Lake	6 (mid-depth)	6.1	28.4	17.6	18.9	3	7.55	
East Lake	6 (bottom)	4.6	29.2	18.1	19.2	4	7.50	19
NE 38th St.	7 (surface)	8.6	24.8	15.0	20.3	3	7.80	0.5
NE 38th St.	7 (mid-depth)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NE 38th St.	7 (bottom)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[1] Bottom samples taken approximately 1 to 3 feet above substrate.

Appendix 2 – Nearfield Tidal Range, City of Oakland Park, Coral Lakes Water Quality and Ecological Evaluation; October 27, 2000 and January 16, 2001

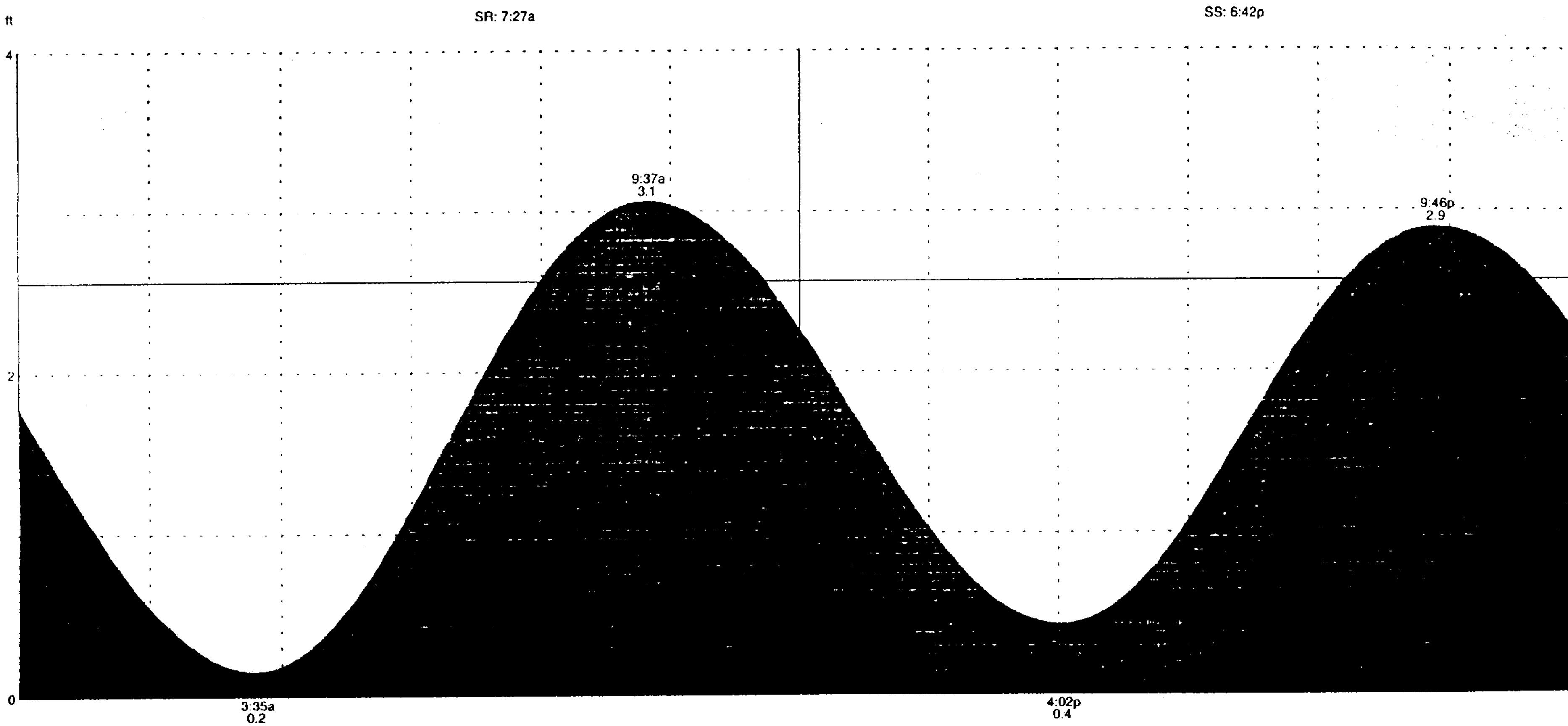
Tides-Fort Lauderdale, Andrews Avenue bridge, New River

based on Miami Harbor Entrance, Florida (NOAA)
26° 7.10 N 80° 8.70 W

Friday, October 27, 2000

Average Tides	
Mean Range:	2.1 ft
MHWS	2.6 ft
Mean Tide:	1.2 ft

Daily Highs & Lows		
3:35a	0.2 ft	Low
9:37a	3.1 ft	High
4:02p	0.4 ft	Low
9:46p	2.9 ft	High



(EDT)	Tide
12:00a	1.8 ft
12:30a	1.4 ft
1:00a	1.1 ft
1:30a	0.8 ft
2:00a	0.5 ft
2:30a	0.3 ft
3:00a	0.2 ft
3:30a	0.2 ft
4:00a	0.2 ft
4:30a	0.3 ft
5:00a	0.5 ft
5:30a	0.8 ft
6:00a	1.2 ft
6:30a	1.5 ft
7:00a	1.9 ft
7:30a	2.3 ft
8:00a	2.6 ft
8:30a	2.8 ft
9:00a	3.0 ft
9:30a	3.1 ft
10:00a	3.0 ft
10:30a	2.9 ft
11:00a	2.8 ft
11:30a	2.5 ft
12:00p	2.3 ft
12:30p	2.0 ft
1:00p	1.6 ft
1:30p	1.3 ft
2:00p	1.0 ft
2:30p	0.8 ft
3:00p	0.6 ft
3:30p	0.5 ft
4:00p	0.4 ft
4:30p	0.5 ft
5:00p	0.6 ft
5:30p	0.8 ft
6:00p	1.1 ft
6:30p	1.4 ft
7:00p	1.7 ft
7:30p	2.1 ft
8:00p	2.4 ft
8:30p	2.6 ft
9:00p	2.8 ft
9:30p	2.9 ft
10:00p	2.9 ft
10:30p	2.8 ft
11:00p	2.7 ft
11:30p	2.5 ft
12:00a	2.2 ft

Exhibit 1, Sheet 1 of 2

Notes For
Tides - Fort Lauderdale, Andrews Avenue bridge, New River

NOAA Notes
None defined.

General Notes
General Notes for: Fort Lauderdale, Andrews Avenue bridge, New River

General vicinity: FLORIDA, East Coast
Reference station: Miami Harbor Entrance, Florida
Reference station ID: 2498
Subordinate station ID: 3845
Time meridian: 75.00° W

All readings are True North (not magnetic).
Source of Data: National Oceanic and Atmospheric Administration (NOAA)

User Notes
None defined

NORTH

Not to Scale

'ote: After Digital Ortho Photograph, Broward County 2000

Oakland1.cad January 28, 2001

Professional Wetland Scientists
Environmental Consultation & Permitting

City of Oakland Park

Study Area Aerial Photograph
City of Oakland Park Water Quality Evaluation
North, West and East Coral Lakes
Sections 14 & 23, Township 49, Range 42
Broward County, Florida

Date	Revision	Sheet
January 20, 2001		2 OF 5

J. J. Goldasich & Associates, Incorporated
(561) 883-9555 FAX (561) 883-0054

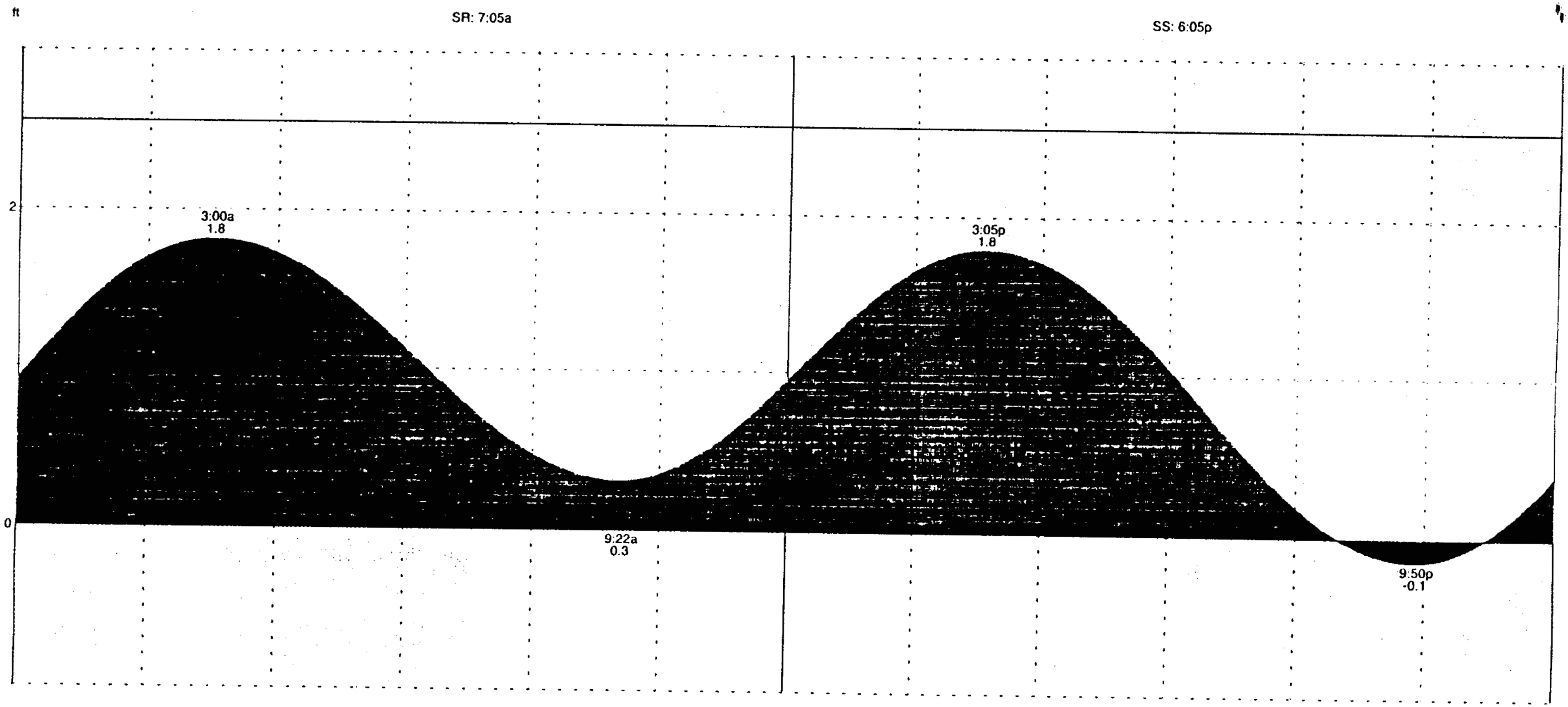
Tides-Fort Lauderdale, Andrews Avenue bridge, New River

based on Miami Harbor Entrance, Florida (NOAA)
26° 7.10 N 80° 8.70 W

Friday, February 2, 2001

Average Tides
Mean Range: 2.1 ft
MHWS 2.6 ft
Mean Tide: 1.2 ft

Daily Highs & Lows
3:00a 1.8 ft High
9:22a 0.3 ft Low
3:05p 1.8 ft High
9:50p -0.1 ft Low



(EST)	Tide
12:00a	0.9 ft
12:30a	1.2 ft
1:00a	1.4 ft
1:30a	1.6 ft
2:00a	1.7 ft
2:30a	1.8 ft
3:00a	1.8 ft
3:30a	1.8 ft
4:00a	1.7 ft
4:30a	1.6 ft
5:00a	1.5 ft
5:30a	1.3 ft
6:00a	1.1 ft
6:30a	0.9 ft
7:00a	0.8 ft
7:30a	0.6 ft
8:00a	0.5 ft
8:30a	0.4 ft
9:00a	0.3 ft
9:30a	0.3 ft
10:00a	0.4 ft
10:30a	0.5 ft
11:00a	0.6 ft
11:30a	0.8 ft
12:00p	1.0 ft
12:30p	1.2 ft
1:00p	1.4 ft
1:30p	1.5 ft
2:00p	1.7 ft
2:30p	1.8 ft
3:00p	1.8 ft
3:30p	1.8 ft
4:00p	1.7 ft
4:30p	1.6 ft
5:00p	1.4 ft
5:30p	1.3 ft
6:00p	1.0 ft
6:30p	0.8 ft
7:00p	0.6 ft
7:30p	0.4 ft
8:00p	0.2 ft
8:30p	0.0 ft
9:00p	-0.1 ft
9:30p	-0.1 ft
10:00p	-0.1 ft
10:30p	-0.1 ft
11:00p	0.0 ft
11:30p	0.2 ft
12:00a	0.4 ft

Exhibit 1, Sheet 2 of 2