Preliminary Investigation of Supplementing the City of Apopka Reuse System with Water Withdrawn from Lake Apopka

TO: Don Brandes/SJRWMD
Bob Elmquist/City of Apopka
Barbara Vergara/SJRWMD
Elizabeth Thomas/SJRWMD
Jerry Salsano/TAURANT

FROM: Ron Wycoff/CH2M HILL /GNV
Mandy Parks/CH2M HILL/GNV
Randy Boe/GNV

DATE: May 30, 2001

INTRODUCTION

The City of Apopka owns and operates an extensive reclaimed water reuse system. Currently, all wastewater treated at the City's wastewater treatment plant is reused. Approximately 70% of the reclaimed water is used to irrigate public access areas, and the remaining 30% is applied to the City's restricted access spray field. It is the City's intent to maximize future reuse, including development of as much public access irrigation as practical.

In 1999, the City completed a Reclaimed Water System Master Plan to establish reuse water needs and facilities requirements though service area buildout, (Boyle, 1999). This master plan estimates that the potential maximum demand for reclaimed water, at service area buildout, will be nearly 17 million gallons per day (mgd).

Several important issues were addressed in the 1999 Master Plan. These include existing and future treatment and transmission facilities, future options for alternative disposal or storage facilities, and options for supplemental water supplies. One of the major challenges in development of a viable reclaimed water reuse system is matching variable demands to a rather constant supply. Wastewater is produced at a nearly constant rate, whereas irrigation demands can be highly variable both daily and seasonally. Therefore, alternative disposal method and/or large storage facilities are needed to manage effluent quantities in excess of immediate demands, and supplemental sources are needed to meet demands when available reclaimned water is insufficient.

The 1999 Master Plan demonstrates the benefits of providing a supplemental supply. If a supplemental supply is not provided then the peak reuse demand satisfied will be limited to the average reclaimed water production rate, and a significant portion of the available reclaimed water could not be used for irrigation. That is, providing some supplemental supply, during peak irrigation demand periods, will result in a greater overall beneficial use of reclaimed water.

Supplemental sources considered in the 1999 Master Plan include surface water, stormwater, groundwater, and potable drinking water.

DRAFT REPORT COMMENTS AND NEW ISSUES

This letter report was distributed, in draft form, for review and comment, on December 15, 2000. The City of Apopka responded in writing on January 25, 2001 and a copy of the City's comments are included in this final report as Appendix A. The City's comments were the only written review comments received.

In February 2001, a significant new water resource management issue was identified that could impact the ability to withdrawal water from any water body within the Ocklawaha River basin above the Moss Bluff Lock and Dam, including Lake Apopka. This new issue is the ongoing development of the Sunnyhill Restoration Area Reservation of Water From Use Rule. The proposed rule will reserve a significant portion of the upper Ocklawaha River basin watershed yield for the Sunnyhill Restoration Project, located in southern Marion County. The impact of this proposed water reservation rule cannot be fully evaluated in this preliminary investigation. However, potential implications are discussed to the extent possible.

PURPOSE AND SCOPE

The purpose of this preliminary investigation is to further identify, examine, and evaluate issues involved in development of Lake Apopka as a supplemental supply for the City of Apopka reuse system.

Like all surface water systems, the Lake Apopka basin is subject to floods and droughts and the ability to withdraw water for supplemental reuse supply will likely depend upon lake outflow or level. Supplemental irrigation needs will likely be required when lake level and outflow are at or near seasonal lows. That is, irrigation needs are typically the greatest when available surface water supplies are at a minimum. Therefore, development of Lake Apopka as a supplemental reuse water supply source may require development of storage facilities as well as treatment facilities.

Issues addressed in this preliminary investigation include.

- Lake Apopka water quality and treatability
- Minimum Flows and Levels (MFLs)
- Potential supplemental water supply yield
- Compatibility of proposed withdrawal with SJRWMD Lake Apopka restoration projects
- Water withdrawal schedule and storage needs

Addressing these issues requires investigation of the hydrology and water quality of Lake Apopka as well as an evaluation of future supplemental public access reclaimed water needs and required quality characteristics.

LAKE APOPKA HYDROLOGY

General Characteristics

Lake Apopka, located within Orange and Lake Counties Florida, is the headwater lake for the Ocklawaha chain of lakes. Nearby towns and cities include Apopka, Ocoee, Winter Garden, and Oakland (Figure 1).

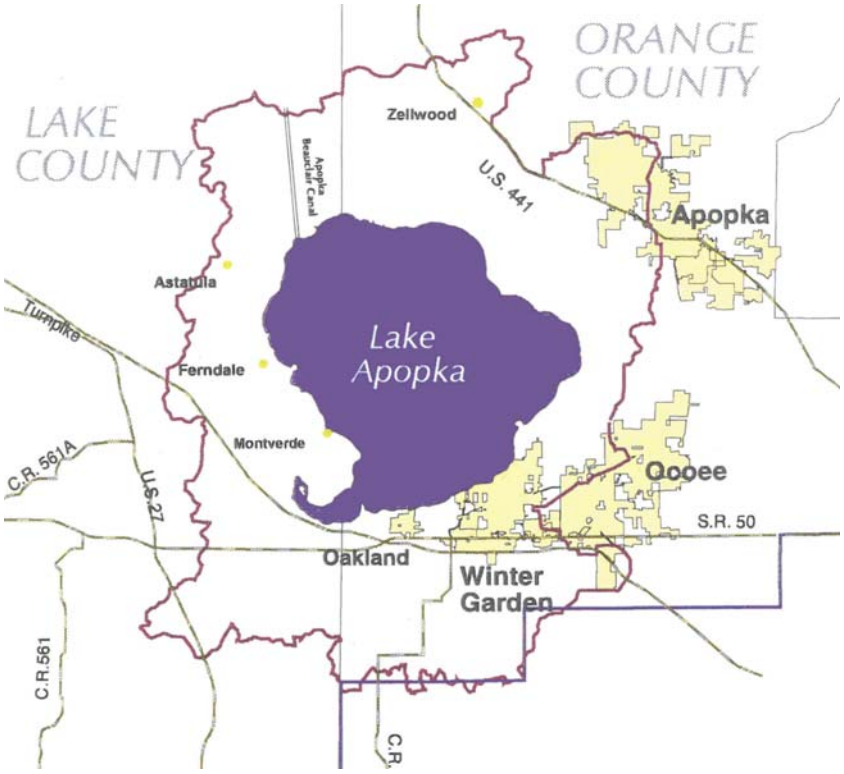


Figure 1 Lake Apopka Basin and environs (adapted from Hoge, et. al., 1998)

Lake Apopka is located in the Central Valley physiographic province of central Florida which includes the Ocklawaha River drainage system. It is bordered on three sides by significant upland or ridge features, including the Mount Dora Ridge to the east, the Lake Wales Ridge to the south, and the Lake Upland physiographic province to the west (Locker, et. al., 1988).

The total drainage basin is approximately 187 square miles in size, including the lake. The lake water surface area is approximately 48 square miles, and therefore occupies approximately 25 percent of the total basin area (Figure 1).

Overall Water Budget

Lake outflow, or net basin discharge, is through the Apopka-Beauclair Canal, and is controlled by the Apopka-Beauclair Lock and Dam (Hoge, et. al., 1998). Average discharge at the control structure is approximately 79.1 cubic feet per second (cfs), based on analysis of historic flow records for the period 1958 through 1998. Outflow rates have ranged from zero, with the gates closed, to a maximum of 754 cfs.

The lake is relatively shallow, with a mean depth of about 5.4 feet. Lake water surface elevation has ranged from a minimum of 64.2 feet National Geodetic Vertical Datum (NGVD) to a maximum of 68.5 feet NGVD under controlled conditions. A total range of only 4.3 feet. Average water surface elevation is 66.6 feet NGVD, based on analysis of historic stage records for the period 1958 through 1998.

Lake Apopka receives inflow from direct rainfall, and from surface runoff from tributary lands. It also receives inflow from the Floridan aquifer through Gourdneck Spring located on the floor of the lake. In May 1971 the United States Geological Survey (USGS) conducted flow measurements at Gourdneck Spring. The measured spring discharge was 27.8 cfs on May 4th, and 28.4 cfs on May 13th (Kimrey, 1971). More recently, Karst Environmental Services, Inc., conducted detailed flow measurements within the spring conduit for SJRWMD. The measured spring discharge was 30.0 cfs on November 13th 1997 (Karst Environmental Services, 1997). These individual spring discharge measurements are in substantial agreement and indicate a significant groundwater contribution to lake inflow, with little if any change over the 26 year interval between flow measurements.

Given that total average annual rainfall is about 50 inches per year, and that lake evaporation will average about 46 inches per year (Hoge, et. al., 1998), an approximate water budget for Lake Apopka can be estimated based on the general basin and lake characteristics, and available historic flow records. Inflow to Lake Apopka includes direct rainfall, surface runoff, and springflow. Outflow includes lake evaporation and discharge through the Apopka-Beauclair Lock and Dam. The estimated average annual water budget is summarized in Table 1.

Table 1 Approximate water budget for Lake Apopka

Inflow	Average Annual Flow , in cfs	Percentage of Total
Direct rainfall (50 inches per year)	177.3	73.2%
Springflow	30.0	12.4%
Surface runoff	34.9	14.4%
TOTAL	242.2	100.0%
Outflow		
Lake evaporation (46 inches per year)	163.1	67.3%
Control structure discharge	79.1	32.7%
TOTAL	242.2	100.0%

As can be seen by inspection of Table 1, direct rainfall and lake evaporation are the largest individual components of the water budget. However, these components largely offset each other. The net inflow for these components (direct rainfall minus lake evaporation) is equal to about 14.2 cfs, or about half of the springflow (groundwater inflow) component.

The total annual discharge, or basin yield, is equal to the 79.1 cfs (51.1 million gallons per day (mgd)) average annual flow released through the Apopka-Beauclair Lock and Dam. A portion of this basin yield could be used to supplement the City of Apopka reuse system if withdrawals from the lake do not result in significant harm or a violation of established minimum flows and levels (MFLs).

Stage and Outflow Characteristics

Figure 2 is the stage duration curve, for Lake Apopka, for the 41 year period 1958 through 1998. Figure 3 is the outlet canal flow duration curve for the same period. The stage duration curve is fairly symmetrical, indicating a normal distribution about the mean. The flow duration curve on the other hand is obviously skewed, with long durations of moderate to low flow and shorter durations of high flow. These are typical characteristics of a controlled hydrologic system where flood flows are released relatively infrequently, and normal or base flows are released much more frequently.

Figure 2 Stage Duration Curve for Lake Apopka (1958 - 1998)

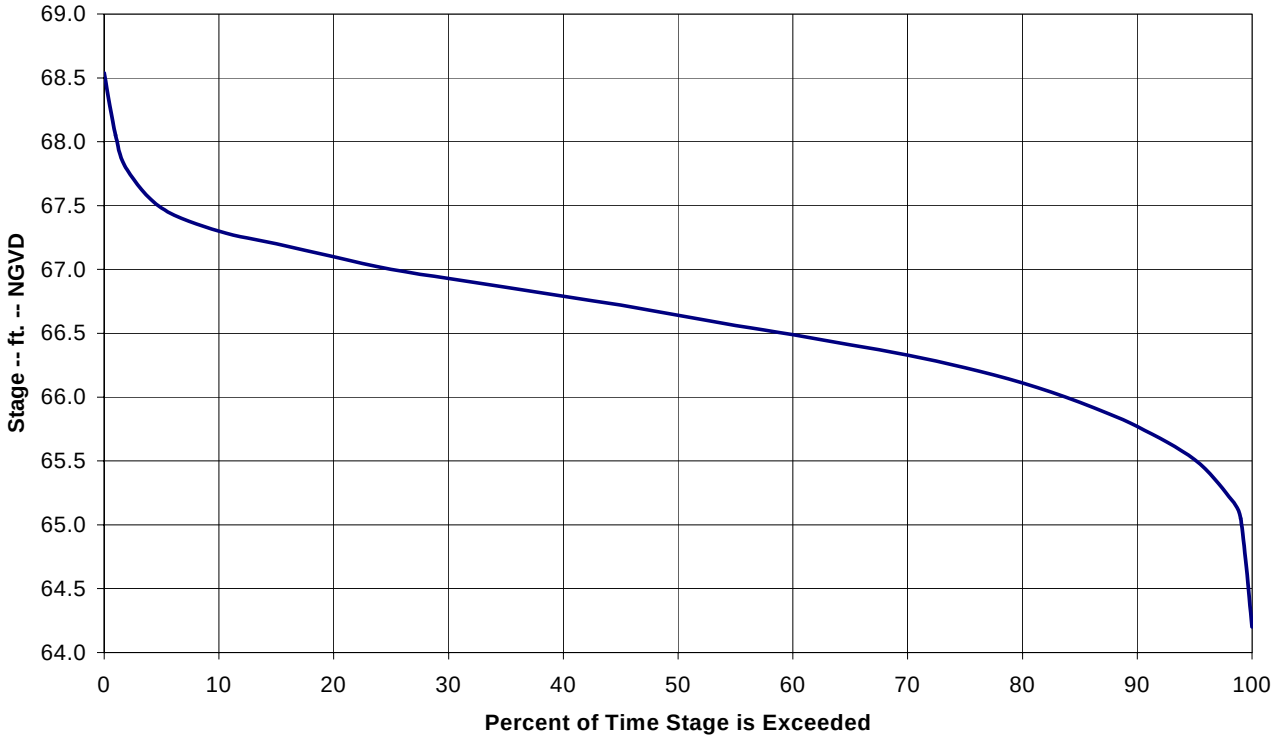
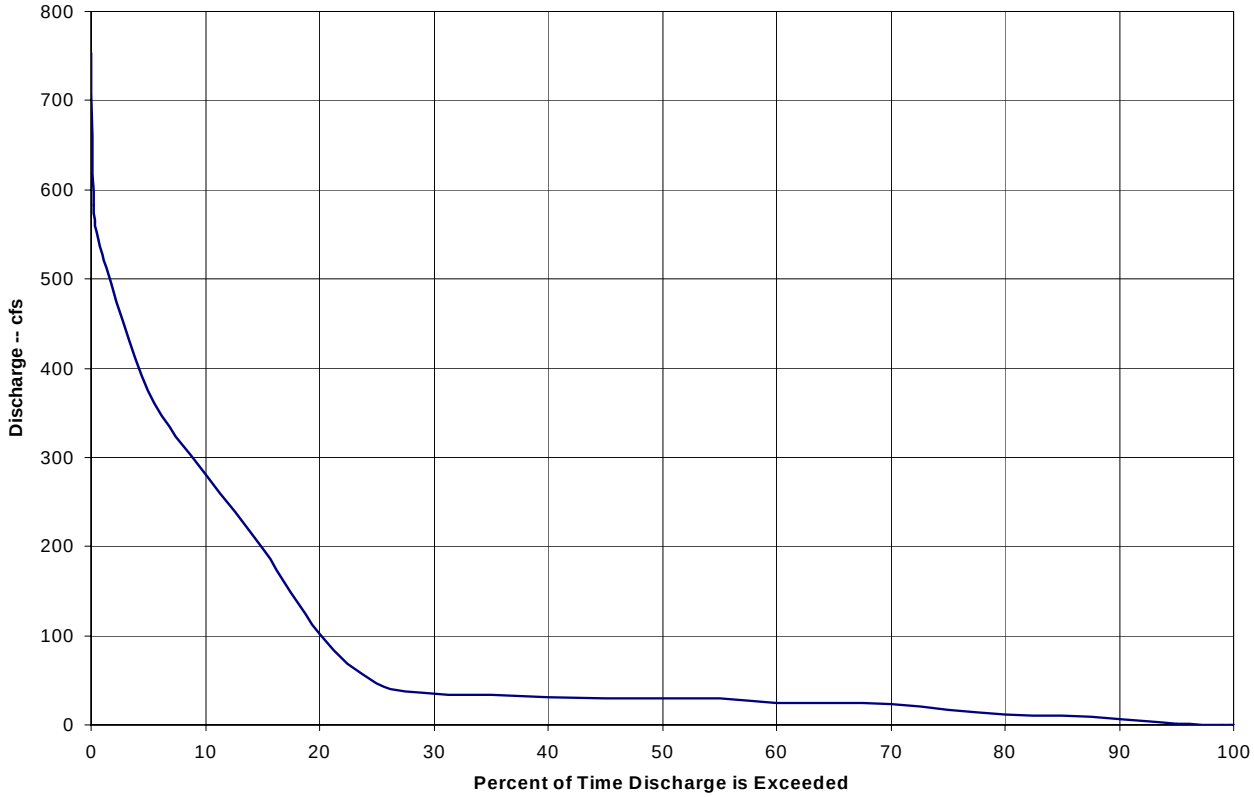


Figure 3 Flow Duration Curve for Apopka-Beauclair Lock and Dam (1958 - 1998)



The distribution of monthly flow is also of interest to this preliminary feasibility analysis and these are summarized in Table 2. This table reports the 10th percentile flow, the mean flow, and the 90th percentile flow for each month of the year based on analysis of flow records for the 41 year period, 1958 through 1998. The mean value is the expected value for any given month of the year. The 10 percentile value would be exceeded 9 years out of 10 on the average, and the 90 percentile value would be exceeded on the average once every 10 years. That is, the range in monthly flows represented by the 10 percentile flow and the 90 percentile flow is the range to be expected 80 percent of the time. Ten percent of the monthly flow values will be less than the 10 percentile flow and, 10 percent of the monthly flow values will be greater than the 90 percentile flow.

Table 2 Monthly flow characteristics for Apopka-Beauclair Lock and Dam

Month	10 percentile flow – cfs	Mean flow -- cfs	90 percentile flow – cfs
January	5.0	89	281
February	3.0	90	321
March	10.0	114	373
April	13.0	113	375
May	8.0	45	100
June	5.0	59	208
July	6.0	62	224
August	6.0	92	320
September	8.7	104	353
October	9.4	69	248
November	9.1	51	120
December	8.8	57	174

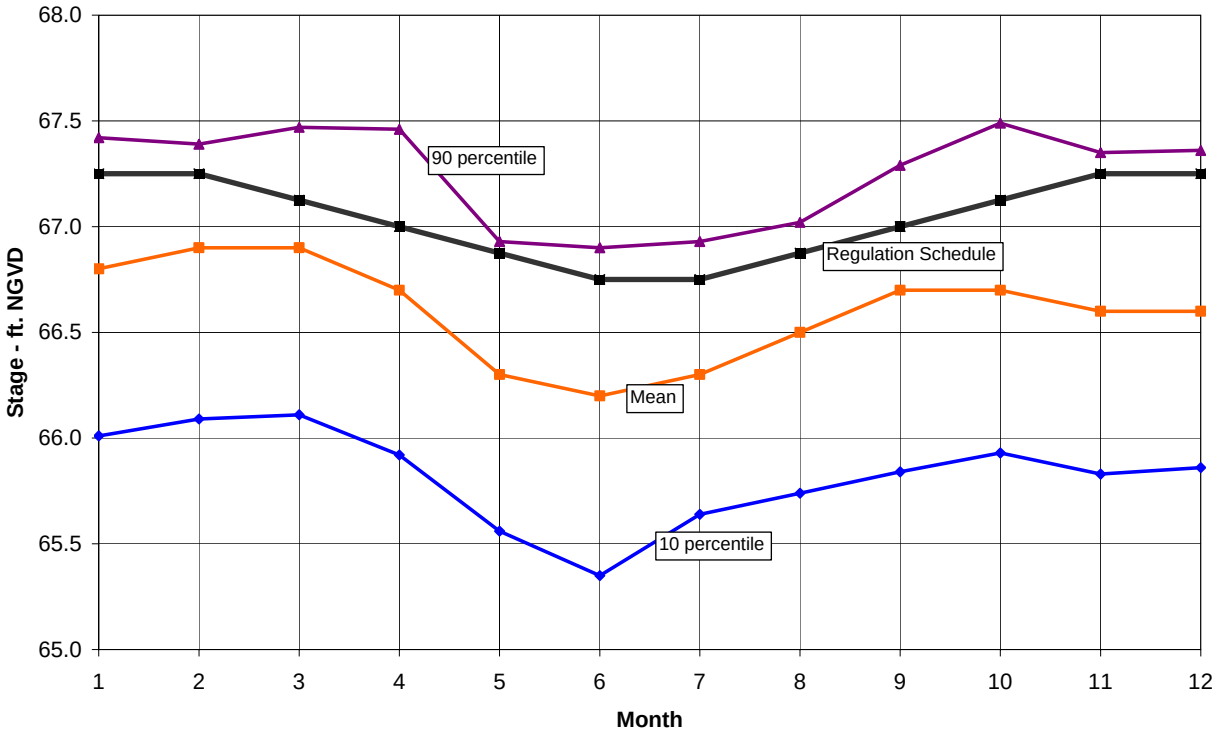
There are no established or adopted MFLs for Lake Apopka. However, lake levels are currently controlled by SJRWMD primarily to maintain available flood storage and to induce some seasonal water level variation. The target water levels range from a low of 66.75 feet NGVD in June and July, to 67.25 feet NGVD from November

through February. The outlet canal control structure is operated to attempt to come as close to the target levels as possible without exceeding the levels.

It is noted that the operational objective is to maintain lower water levels, and thus maximize available flood storage, during the wet season. Therefore, water is often released, at relatively high rates, during the spring dry season. This is reflected in the monthly flow characteristics reported in Table 2. For example, the months of March and April have the highest lake outflow rates. The existing operations schedule appears to be relatively compatible with supplemental reuse water needs which are at a maximum during the spring dry season.

Figure 4 illustrates monthly variation in Lake Apopka water levels for the 1958 through 1998 period of record.

Figure 4 Lake Apopka monthly stage record (1958 - 1998)



This figure illustrates the 10th percentile stage, the mean stage, and the 90th percentile stage, as well as the regulation schedule. In general mean monthly water levels are about 0.4 feet below the corresponding target elevation as defined by the regulation schedule. The 90th percentile stage is greater than the target stages, indicating that the regulation schedule is exceeded from time to time. However, for the most part water levels are maintain at or below the regulation schedule. Also, the month of

April, May, and June are months when the water levels are generally lowered to provide the desired wet season flood storage.

IMPACT OF PROPOSED SUNNYHILL RESTORATION AREA RESERVATION OF WATER FROM USE RULE ON WATER SUPPLY AVAILABILITY

As noted previously the current operation of Lake Apopka, to establish lower water levels at the onset of the wet-season for flood control, appears to be generally compatible with withdrawal of a moderate quantity of Lake Apopka water for supplemental reuse. However, the upper Ocklawaha River basin is a complex water resources system with many existing, proposed and somewhat competing uses, including recreational navigation, flood control, environmental restoration, and water supply. Multiuse objectives may generate conflicts that must be resolved before final allocation of limited water resources.

Currently, SJRWMD is developing a water reservation rule for the Sunnyhill Restoration Area located in southern Marion County, downstream from Lake Griffin and upstream from the Moss Bluff Lock and Dam which controls discharge from Lake Griffin. This proposed water reservation rule could impact the ability to develop viable water supplies from all upstream Ocklawaha River basin water bodies, including Lake Apopka.

Upper Ocklawaha River Basin Water Resources Management Issues

Water resource management within the upper Ocklawaha River basin is a critical concern for SJRWMD as well as Lake, Marion and Orange counties. Major water management issues facing this watershed system include the following:

- Regulation of lake levels
- Restoration of previously impacted wetland systems, including Sunnyhill Farms, and
- Development of alternative water supplies

Each of these issues are interrelated and should not be considered in isolation.

Regulation Schedules

The current lake regulation schedules focus on flood control and navigation. Under current practice, a low base flow (water released from the Moss Bluff control structure) of 30 cfs, is maintained most of the time with infrequent releases of high flow during high inflow or flood flow conditions. The goal is to maintain lake levels within a narrow range to accommodate recreational navigation and lake access and to provide flood protection. These goals are largely achieved. While water-level stabilization has provided the benefits of flood protection and year-round navigation, it has contributed to poor water quality, erratic out-of-season downstream flows, loss of wetland and aquatic vegetation and habitats, and

deteriorated fisheries. In order to restore and maintain a healthy lake and river ecosystem, more natural lake levels and seasonal flow patterns need to be restored.

New lake level regulation schedules have been proposed which will reintroduce a more natural streamflow and lake stage regime. The new regulation schedule would have positive impacts on lake water quality and the overall health of the lake system. However, the new schedules would also increase the frequency and duration of both higher and lower lake levels which would have adverse impacts on recreational navigation, lake access, and peak flood levels.

Restoration

Restoration of impacted flood plain wetlands is also an important water management issue for the upper Ocklawaha River basin. The proposed water reservation rule for the Sunnyhill Restoration Area is designed to provide the water necessary to achieve the wetland restoration goals for the approximately 4,500 acre Sunnyhill Restoration Area located along the Ocklawaha River flood plain between Moss Bluff and Lake Griffin.

Water Supply

Public water supply is also a very important water management issue facing the upper Ocklawaha basin. The *District Water Supply Plan* (DWSP) (Vergara, 2000) concludes that additional groundwater resource development alone will not be sufficient to supply all future needs in east-central Florida, including the upper Ocklawaha River basin. The DWSP also estimates that the upper Ocklawaha River basin could potentially supply as much as 14 mgd of new surface water to supplement existing groundwater sources.

Proposed Reservation Rule

The proposed reservation rule would reserve surface water from the upper Ocklawaha River basin sufficient for the purpose of providing environmental restoration for the Sunnyhill Restoration Area. The proposed reservation rule is structured similarly to minimum flows and levels (MFLs) established for other District streams, in that a minimum streamflow regime, rather than a single flow value, is identified. This streamflow regime, if established and maintained, should provide the desired environmental restoration.

The exact impact of the proposed water reservation rule on surface water supply availability is somewhat uncertain. However, it is likely to depend in part on whether the existing or the new regulation schedules are in effect, given that the regulation schedules will have a dramatic effect of the upper Ocklawaha River streamflow regime.

Potential impact of proposed water reservation rule with new regulation schedule

In February 2000, CH2M HILL reviewed the draft *Water Management Plan for the Sunnyhill Restoration Area*. This review focused on the potential impact of the proposed MFL's on the development of a moderate (14 mgd) public water supply. It was concluded that development of a moderate surface water supply and the goals of the Sunnyhill Restoration project were compatible, given implementation of the new regulation schedule, which would return the streamflow regime to a more natural condition. That is, the new lake level regulation schedule, the Sunnyhill restoration project goals, and the development of additional surface water supply, all appear to be compatible goals. However, it is likely that some trade offs will need to be addressed in the final decision process.

Because the numeric flow limits included in the proposed water reservation rule are very similar to the flow limits presented in the January 2000 draft water management plan, it is likely that the multi-objective goals included in the new regulation schedule, the Sunnyhill Restoration Project, and the development of some additional public supply are all mutually compatible goals. The key will be implementation of the new lake level regulation schedule(s).

Potential impact of proposed water reservation rule with existing regulation schedule

Under the current regulation schedule the proposed reservation rule cannot be fully met. In this case, the proposed minimum infrequent low and the minimum frequent low flow criteria will not be met even if no additional water is withdrawn from the basin upstream from Moss Bluff.

Under the current regulation schedule a low flow discharge of 30 cfs is maintained at Moss Bluff. The proposed minimum infrequent low flow and minimum frequent low flow are 40 and 65 to 85 cfs respectively (Fulton, R. S., et. al., 2001). However, because these flow regimes cannot be met under current operating conditions, application of the proposed water reservation rule to the consumptive use permitting process is uncertain and subject to interpretation.

One possible interpretation is that because the reservation rule is not met under the current regulation schedule no additional water supply development should be allowed. However, because outflow from this system is controlled, by SJRWMD, it is possible to withdraw water without decreasing the current 30 cfs minimum flow at Moss Bluff. In this case, during low flow periods, water would be obtained from upstream lake storage, rather than from lake outlet discharge. Lake storage would then be replenished during high flow periods. Lake stage would be affected but the outlet low flow magnitude would not be changed. Therefore, another possible interpretation is that water supply withdrawal should be allowed if it can be demonstrated that such withdrawal will not have a significant impact on the

upstream lakes stage/duration relationships and that the existing 30 cfs low flow release can be maintained.

It is noted that the upper Ocklawaha basin lakes contains significant quantities of water in temporary storage. For example, Lake Apopka alone, at normal pool, contains about 10 billion gallons of water per foot of stage. This natural storage provides a significant opportunity to develop a viable surface water supply while still maintaining the existing 30 cfs minimum discharge, at Moss Bluff.

LAKE APOPKA WATER QUALITY

Lake Apopka is one of the most eutrophic lakes in Florida. Lake Apopka water quality issues are related to hydrologic modifications and historic land use within the basin. Over the last century, and particularly over the last half century, lake Apopka was partially drained, lowering normal water levels, and the surrounding highly productive lands were developed as muck farms. These activities have resulted in excessive nutrient enrichment of the lake. The hydrologic modifications and nutrient enrichment have in turn resulted in a general degradation of lake water quality and fish and wildlife habitat. Algae content is very high, light penetration is limited, and biological species diversity is poor.

Currently, Lake Apopka is the focus of significant SJRWMD restoration efforts, including efforts to reduce nutrient concentrations and improve biological diversity. Although SJRWMD water quality investigations and monitoring efforts have centered on development of a full understanding of nutrient budgets and interactions, several water quality parameters important to reclaimed water reuse have also been measured.

Table 3 presents a summary of public access reuse standards as well as Lake Apopka constituent concentrations. As can be seen, from inspection of Table 3 many constituents addressed in the public access reuse standards have been measured while many others have not. It appears however that the most significant water quality challenge, associated with using lake Apopka for supplemental reuse, will be meeting the total suspended solids (TSS) standard of 5 mg/L. Average lake water TSS is about 86 mg/L with a standard deviation of about 32 mg/L. This suggests a required TSS removal of at least 95% or greater. In addition, most of this suspended material will be made up of algae and/or other very low density organic material.

The water quality data also suggest a need for some pH adjustment, because observed pH is slightly higher than required to meet the reuse standards.

Nutrients, which are of great concern to the lake restoration efforts, are not of direct concern to reuse applications because lake water nutrient concentrations are well within acceptable reuse limits. However, reduction in nutrients will eventually improve the general condition of the lake resulting in reduced algae content and therefore a reduction in the organic TSS content.

SJRWMD restoration efforts will help improve lake water quality and will tend to reduce treatment requirements for supplemental reuse. There are no apparent major conflicts between the restoration goals and use of a small portion of the lake outflow for supplementing reclaimed water for irrigation. However, at this time, treatment requirements should be provided based on existing lake water characteristics.

Table 3 Summary of Lake Apopka water quality data and reuse standards

Constituent	Public Access Reuse Maximum Average Concentration -- mg/L	Lake Apopka Concentrations			Source
		Mean	Minimum	Maximum	
Alkalinity	--	123	109	149	1
		113	std dev = 14.4		2
Arsenic	0.1				
Beryllium	0.10				
Bicarbonate (Alkalinity)	200				
Barium	1.0				
Boron	1.0				
Cadmium	0.01				
Chromium	0.01				
Calcium	200	35	26	47	1
Chloride	100	37	25	45	1
		42	std dev = 4.3		2
Chlorine	10.0				
Chlorophyll a (micro g/L)	--	99.1	std dev = 32.8		2
Cobalt	0.05				
Color (Pt-Co units)	--	65	15	240	1
		32.3	std dev = 17.3		2
Copper	0.20				
Dissolved Oxygen	--	6.7	1.9	12.2	1
Hardness (as CaCO3)	--	159	135	187	1
Iron	5.0				
Lead	0.1				
Lithium	0.01				
Magnesium	25	17	15	20	1
Manganese	0.20				
Mercury	0.01				
Nickel	0.20				
Nitrogen	30	4.5	2.4	10.7	1
		5.4	std dev =1.18		2
Phosphorus	10	0.26	0.04	0.91	1
		0.21	std dev =0.05		2
Potassium	30	11	7.4	13	1
Selenium	0.02				
Silver	0.05				
Sodium	70	17	11	33	1
Sulfate	100	24	10	34	1
Temperature (degrees C)	--	23.5	11	31	1
Total Organic Carbon	--	26	13	57	1
Turbidity (NTU)	--	12	0.6	29	1
		31.3	std dev = 10.7		2
Zinc	1.0				
BOD5 (Biological Oxygen Demand)	30				
Chemical Oxygen Demand	120				
Total Suspended Solids	**5**	**85.8**	**std dev =32.4**		**2**
Ecw	1100 umhos				
pH	**6.5-8.4**	**8.6**	**7.5**	**9.4**	**1**
		9.2	**std dev = 0.31**		**2**

Data Sources:

1. Schiffer, 1994
2. Sites, et. al., 1997

EXISTING WASTEWATER MANAGEMENT AND REUSE SYSTEM

The existing wastewater treatment facility includes two treatment trains each with a 2.0 mgd rated capacity. One treatment train, the EIMCO Carrousel system with filtration, produces a high quality treated effluent suitable for public access irrigation. The second treatment train, an older Walker Process Package plant with no filtration, produces treated water suitable for restricted access sprayfield application only. Currently, the treatment plant is being upgraded such that all treated water will be suitable for application to public access areas.

The existing reclaimed water facilities and reuse system are fully described in the 1999 Master Plan (Boyle, 1999) and includes reclaimed water storage and pumping facilities, post storage filtration, and a reuse distribution system. Also included is a spray field for management of excess reclaimed water and groundwater wells to provide supplemental reuse water. It is likely that all of the existing components will play a role in future reclaimed water management. However, as previously stated, the purpose of this preliminary investigation is to evaluate the role water withdrawn from Lake Apopka could play in providing supplemental reuse water to help maximize the beneficial use of available reclaimed water, and thereby reduce the need for use of high quality groundwater.

SUPPLEMENTAL WATER NEEDS

Recent supplemental water needs are minimal, but are expected to increase as public access irrigation needs increase. An analysis of reuse availability and demand data for the period November 1997 through October 1998 was presented in the 1999 Master Plan. This analysis indicates a maximum reuse demand, occurring in April 1998, of 2.24 mgd, as compared to a reclaimed water supply availability of 1.90 mgd, resulting in a maximum monthly supplemental need of 0.34 mgd. Only April and May required supplemental reuse supply, and totaled only about 16 million gallons (MG) for the two month period. Annually, this represents a very small flow rate (0.044 mgd). However, the entire volume of supplemental water is needed during a 2 month period.

The 1997/1998 public access reuse was 1.52 mgd, or about 80% of the available supply of 1.90 mgd. If public access area irrigation demands were increased to effectively use all available reclaimed water, then some supplemental water would be required in the months of March, April, May and June, and in September, October and November (Boyle, 1999). That is, to effectively use all available reuse water, some supplemental water would be needed 7 months of the year. Using the 1999 Master Plan data as a basis of estimation, total maximum supplemental water needs will equal about 12.7 percent of the total volume of reuse water. The maximum supplemental water demand will occur in April and would equal about 47% of the reclaimed water supply.

These supplemental reuse values apply to maximizing the beneficial use of available reclaimed water, which is a goal of SJRWMD. If irrigation demand exceeds the amount needed to fully use the available reclaimed water then additional irrigation supply would be needed. However, this additional irrigation supply should not be considered supplemental reuse water because its use would not increase the beneficial use of reclaimed water.

The 1999 Master Plan estimates total future reuse demand at approximately 16.92 mgd. Using the ratios discussed above, supplemental water needs required to fully develop the 16.92 mgd resource would be 2.27 mgd long term, and 7.95 mgd during the peak demand month.

The focus of this analysis is supplementing the reclaimed water supply with water withdrawn from Lake Apopka such that the available reclaimed water is used to its maximum feasible extent. Withdrawal of water form Lake Apopka beyond the amount needed to fully utilize available reclaimed water is of interest to the City but is not specifically addressed in this preliminary investigation.

The City of Apopka reclaimed water supply for the year 2000 is estimated to be 2.15 mgd in the year 2000, and 2.94 mgd in the year 2005, according to recent projections. This represents an annual growth rate of 6.46 percent. Using this growth rate, reclaimed water availability is projected to be about 4.02 mgd in 2010, and 7.52 mgd in 2020.

Based on these projections of reclaimed water availability and the monthly distribution of reuse water irrigation demands reported in the 1999 Master Plan, monthly supplemental reuse water needs were estimated (Table 4).

Table 4 Estimated monthly supplemental reuse water needs

Month	Supplemental Needs -- % of Available Reclaimed Water [1.]	Supplemental Water Needs		
		Year 2010	Year 2020	Buildout
January	0%	0.00	0.00	0.00
February	0%	0.00	0.00	0.00
March	15%	0.60	1.13	2.54
April	47%	**1.89**	**3.53**	7.95
May	45%	1.81	3.38	7.61
June	18%	0.72	1.35	3.05
July	0%	0.00	0.00	0.00
August	0%	0.00	0.00	0.00
September	5%	0.20	0.38	0.85
October	9%	0.36	0.68	1.52
November	22%	0.88	1.65	3.72
December	0%	0.00	0.00	0.00
Mean	13%	0.54	1.01	2.27

[1.] Monthly distribution based on data reported in Boyle Engineering Inc., 1999. These supplemental water needs will maximize the beneficial use of available reclaimed water.

Total annual supplemental water needs in 2010 equals about 0.5 mgd with a peak need, occurring in April, of about 1.9 mgd. By 2020 average annual need increases to 1.0 mgd and the peak monthly need increases to about 3.5 mgd. These values provide a basis for assessment of supplemental water facilities needs and costs, as well as compatibility with Lake Apopka hydrology and current operations.

The analysis of supplemental water needs presented in the 1999 Master Plan, and used as a basis for development of Table 4, is based on providing enough supplemental water to maximize the use of available reclaimed water, which is the focus of this preliminary investigation. If irrigation demands exceed the available reclaimed water supply then additional irrigation demands could be met by additional supplemental water supply. However, these potential additional supplemental water requirements are beyond the scope of this preliminary investigation and are not considered here.

TREATMENT NEEDS

Florida regulations (Rule 62-610.472) require that surface water supplies used to supplement reclaimed water supply be treated to fecal coliform and TSS limits established for high level disinfection of wastewater. These limits are non-detect of fecal coliform and 5 mg/l TSS. These limits must be met before combining with reclaimed water. Typically, fecal coliform concentrations in Florida lakes will range from less than 10 per 100 ml, to several hundred per 100 ml (Friedemann, and Hand, 1989). Therefore, it can be reasonably assumed, that water withdrawn from Lake Apopka will contain less than 1,000 fecal coliforms per 100 ml. Based on this maximum fecal coliform concentration, the assumed minimum required product of total chlorine residual and contact time is 25.

A preliminary treatment scenario to meet these treated water quality requirements consists of coarse screening, an enhanced ballasted flocculation treatment process to provide pre-treatment, filtration for final solids removal, pH adjustment, and chlorination. Pilot testing must be performed to confirm the treatment process requirements and establish final acceptable loading rates. Dissolved air flotation may be a viable alternative pre-treatment option as well. However, the advanced ballasted flocculation treatment process is likely to be the best pre-treatment option based on experience with other surface waters in Florida where algae is a major contributor to the measured TSS concentration. Screening would be performed at the intake structure. Sulfuric acid may be used for pH adjustment. It is assumed that the existing WWTP chlorination facilities have capacity to chlorinate the supplemental lake water as well as the reclaimed water from the wastewater treatment plant (WWTP). However, chlorination of the lake water would be accomplished in a contact chamber separate from the WWTP's. It is assumed that

the treatment facilities will likely be co-located with the existing WWTP's and other reclaimed water facilities to make maximum use of the existing infrastructure and to centralize and consolidate reclaimed water operations.

The quantity of sludge generated by the treatment process would be significant when compared to the quantity of sludge generated by the existing WWTP. It is possible that sludge produced from the enhanced ballasted flocculation treatment process may be dewatered with the wastewater treatment plant sludge on a belt filter press or sent to existing sludge drying beds. However, the need for upgrade of the existing WWTP solids handling facilities must be determined through a capacity evaluation and study of the dewaterability of the combined sludges. It is assumed that filter backwash water may be sent to the wastewater treatment plant for processing. Sludge characteristics will need to be confirmed as part of the treatability study.

STORAGE NEEDS

It is possible that the Lake Apopka source could be developed without providing additional storage, at least in the near term. As previously discussed, maximum supplemental water needs tend to coincide with the spring period of lake drawdown and therefore significant discharge. Lake discharge in April averages 113 cfs (73 mgd) and exceeds 13 cfs (8.4 mgd) 90% of the time. Therefore, the 1.9 mgd (2010) and 3.5 mgd (2020) supplemental needs can be met well in excess of 90 percent of the time without additional storage and without impacting lake stage.

Actually, the month of May is somewhat more critical than the peak demand month of April. Supplemental water needs decrease only slightly from April to May, but the 90 percentile lake outflow decreases to 8.0 cfs (5.2 mgd). However, this flow rate is still sufficient to meet the supplemental irrigation need.

Like all surface water sources, Lake Apopka will be subject to extreme droughts from time to time. Under these conditions lake withdrawals are likely to be restricted. In this case, short term use of the existing supplemental groundwater wells would likely provide the needed supplemental reuse water.

TRANSMISSION NEEDS

Raw water withdrawn from the lake would need to be transported to the City of Apopka water reclamation facility site for treatment, blending with reclaimed water and distribution and use. Exact distance will depend on detailed routing and it is possible that some existing city owned lines could be used in place. However, for the purpose of this preliminary evaluation a 4.2 mile transport system designed to accommodate the 3.5 mgd 2020 supplemental need is assumed.

COST ESTIMATE

Facilities required to develop the Lake Apopka supplemental supply include a lake water intake structure and pumping station, a raw water transmission line, and a lake water treatment plant. For the purpose of this cost estimate, treatment requirements are based on an enhanced ballasted flocculation process, filtration, chlorination, pH adjustment, and a sludge thickener/holding tank.

Cost estimates are developed at the preliminary planning, or order of magnitude level of accuracy. These cost estimates use procedures developed in the SJRWMD Water 2020 process where applicable (Law Engineering, 1997). Estimated construction, capital, and annual operation and maintenance costs, are summarized in Table 5.

This system would provide an average of about 1.0 mgd with a maximum delivery rate of 3.5 mgd. Assuming that the average economic life of these facilities is about 30 years and that the time value of money is 7 percent per year, the equivalent annual cost of the system is approximately $696,500 per year. The overall supplemental water production cost would be about $1.91 per 1,000 gallons.

Table 5 Estimated Costs for Lake Apopka supplemental reclaimed water facilities

Major System Component	Estimated Construction Cost (with contingency)	Estimated Capital Cost	Estimated Operation and Maintenance Cost - - $/year.
Lake water intake structure and pumping station	$862,000	$1,041,000	$23,700
Raw water transmission line	$1,559,000	$1,884,000	none
Water treatment plant	$3,739,000	$4,518,000	$73,000
Total	$6,160,000	$7,443,000	$96,700

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Lake Apopka appears to be a reasonably viable source option for supplemental reuse water for the City of Apopka. Lake outflow averages about 51 mgd and supplemental reuse needs, in 2020, are estimated to average about 1.0 mgd, with a maximum of 3.5 mgd occurring in April, the maximum irrigation demand month.

The effect of withdrawals of this magnitude on the overall water budget from the lake should be negligible. In addition, peak supplemental reuse water requirements occur in the late spring, when the lake levels are normally being lowered to provide flood storage for the approaching wet season. Therefore lake outflow tends to be highest when irrigation, and therefore supplemental water needs, are greatest. This fortunate hydrologic compatibility means that excess water should be available when needed and that supplemental storage should not be required to develop a useful and fairly reliable system.

Although the existing hydrologic characteristics and lake operations appear to be consistent with the development of Lake Apopka as a supplemental water supply for the City of Apopka reuse system, considerable uncertainty is introduced as a result of the recently proposed Sunnyhill Restoration Area Reservation From Use Rule. The water supply impacts of this rule are subject to considerable interrpitation. One interpretation is that no additional surface water withdrawal could be allowed above Moss Bluff Dam for any purpose, at least until a new water level regulation scheduled is adopted for Lake Griffin and possibly other upper Ocklawaha basin lakes.

If withdrawals are permitted, required facilities would include a lake water intake structure and pumping station, a raw water transmission line, and a water treatment plant, co-located with the City's existing wastewater treatment and reuse facilities. Because of poor source water quality, treatment requirements are likely to be rather extensive. Lake water is very high in algae content which accounts for the high observed TSS concentration. Treatment requirement will include a pre-treatment process to remove most of the algae and other suspended solids, filtration to achieve the required finished water TSS (5 mg/L), chlorination to meet reuse disinfection standards, and pH adjustment. Treatability studies will be required to identify the most efficient processes and design loading rates.

The system would be rather expensive. Estimated capital costs total $7.4 million with an estimated O&M cost of about $97,000 per year. Overall this system will deliver an average of 1.0 mgd of supplemental reuse water at an overall unit cost of about $1.91 per 1,000 gallons. These costs are preliminary planning level estimates and no doubt final costs will vary from these estimates.

Recommendations

If after review of this supplemental reuse concept both the City of Apopka and SJRWMD have a mutual interest in furthering the investigation, the next logical steps would be to; 1) fully assess the impacts of the Sunnyhill Restoration Area Reservation From Use Rule on water availability from Lake Apopka, and 2) design and conduct a treatability analysis.

The water availability analysis should be conducted first. It would include a SJRWMD policy level decision related to the interpretation of the water reservation

rule and hydrologic modeling to determine acceptable withdrawals including both quantity and timing. Based of the results of this analysis then the need for a treatability analysis can be determined.

The objective of the treatability analysis would be to test available water treatment processes to determine the most appropriate treatment technologies for this water source and to further refine design criteria, estimated costs, and economic feasibility.

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APPENDIX A
City of Apopka Draft Report Review Comments

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CITY OF
APOPKA
FLORIDA

P.O. BOX 1229 • APOPKA, FLORIDA 32704-1229
PHONE (407) 703-1700

January 25, 2001

Mr. Ron Wycoff, PE
CH2M Hill
3011 Southwest Williston Rd.
Gainesville, FL 32608

Subj: Lake Apopka Supplemental Reuse

Dear Mr. Wycoff,

We would like to thank you for the opportunity to review the first draft of the subject report. Upon examination we would like to offer the following comments:

- The average daily demand for reclaimed water is estimated to be 17 MGD at build out. The wastewater influent flow at build out is predicted to be 10.3 MGD. Therefore, a 6.7 MGD assumed deficit will need to be satisfied by supplemental sources such as surface water, untreated groundwater or stormwater.

- A build out year of 2020 was calculated in the Boyle Engineering Reuse Master Plan.

- Since the Reuse Master Plan design incorporates a booster pump station in the vicinity of Lake Apopka we assumed the surface water treatment facility would be constructed there as well. What were your thoughts in providing surface water treatment at the existing wastewater treatment facility?

- Please provide us with a description of the items included in the Estimated Capital Cost and Estimated Operation and Maintenance Cost - $/ year figures on Page 15.

Your memorandum mentioned the possibility of a meeting. We would be very interested in attending. Please advise us of the schedule. In the meantime, do not hesitate to contact us at (407) 703-1731 for any questions or comments.

Sincerely,

Bob Elmquist
Public Services Project Coordinator

cc) John Jreij, PE
Vic Godlewski, Jr., PE