Screening-level Sensitivity Analyses of Water Storage in the Everglades Agricultural Area (EAA)

South Florida Water Management District
January 20, 2009

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1. Introduction

This report summarizes the preliminary findings of a hydrologic analysis that was performed during the summer of 2008 to evaluate the capability of increased water storage and treatment areas in the Everglades Agricultural Area (EAA). This analysis was performed as part of a "due diligence" effort to provide information to assist with the pending decision on acquisition of U.S. Sugar land within the EAA.

Due primarily to lack of sufficient regional storage to capture excess water during very wet periods, south Florida's water management system has periodically required large discharges to the Caloosahatchee and St. Lucie Estuaries. These large discharges damage the estuary ecosystems. The 2008 regulation schedule for Lake O further reduced the storage capacity of Lake Okeechobee in order to decrease the risk of failure of the aging Herbert Hoover Dike.

One idea to solve this limited storage problem has been to buy land in the EAA to build above-ground impoundments to store and treat excess Lake O water to lessen the discharges to the estuaries. The idea includes using the stored and treated water to revitalize and restore the hydrology of the Everglades.

There are many issues related to evaluating the feasibility of this idea, and a feasibility study is necessary. However the analysis summarized in this report should not be construed as a traditional feasibility analysis. Rather, the scope of this report is limited to the hydrologic evaluation of multiple combinations of storage and operational parameters to assess whether the idea of more storage and treatment in the EAA has the potential to provide significant benefits to Lake Okeechobee, the Caloosahatchee and St. Lucie Estuaries and the Everglades.

This report is formatted in 5 sections. Section 2 provides a brief description of the methodology used for the analysis; Section 3 presents the preliminary findings; Section 4 provides a more-detailed description of the analysis of two specific south storage configurations known as Option 6 and Option 7; and Section 5 provides a short summary and conclusions.

2. Analysis Methodology

To assist with the preliminary analyses and testing of alternative storage configurations that consider the interconnectivity of Lake Okeechobee, the Lake O Service Area, and estuary watershed systems, a spreadsheet-based screening model was developed. The REservoir Sizing and OPerations Screening (RESOPS) Model is a coarse-scale water management simulation model that was developed to quickly test alternative reservoir sizes and system operating rules for the region surrounding and including Lake Okeechobee.

The following provides a brief overview of the RESOPS Model and is not a user's guide. More detailed documentation of the features and usability of the RESOPS Model is to be prepared as a separate document.

The graphical user interface (GUI) for the RESOPS Model is shown in Figure 1. The RESOPS Model provides rapid testing of the integrated effects of alternative reservoir sizes and proposed operating rules for both Lake Okeechobee and the proposed reservoirs. RESOPS performs monthly time-step, 41-year (1965-2005) continuous simulations of the hydrology and operations of the regional water management system including Lake Okeechobee, the Lake O. Service Area, the Caloosahatchee and St. Lucie Estuaries, and flows to the Everglades WCAs. These major physiographic regions and the primary connections are illustrated in the map-based GUI.

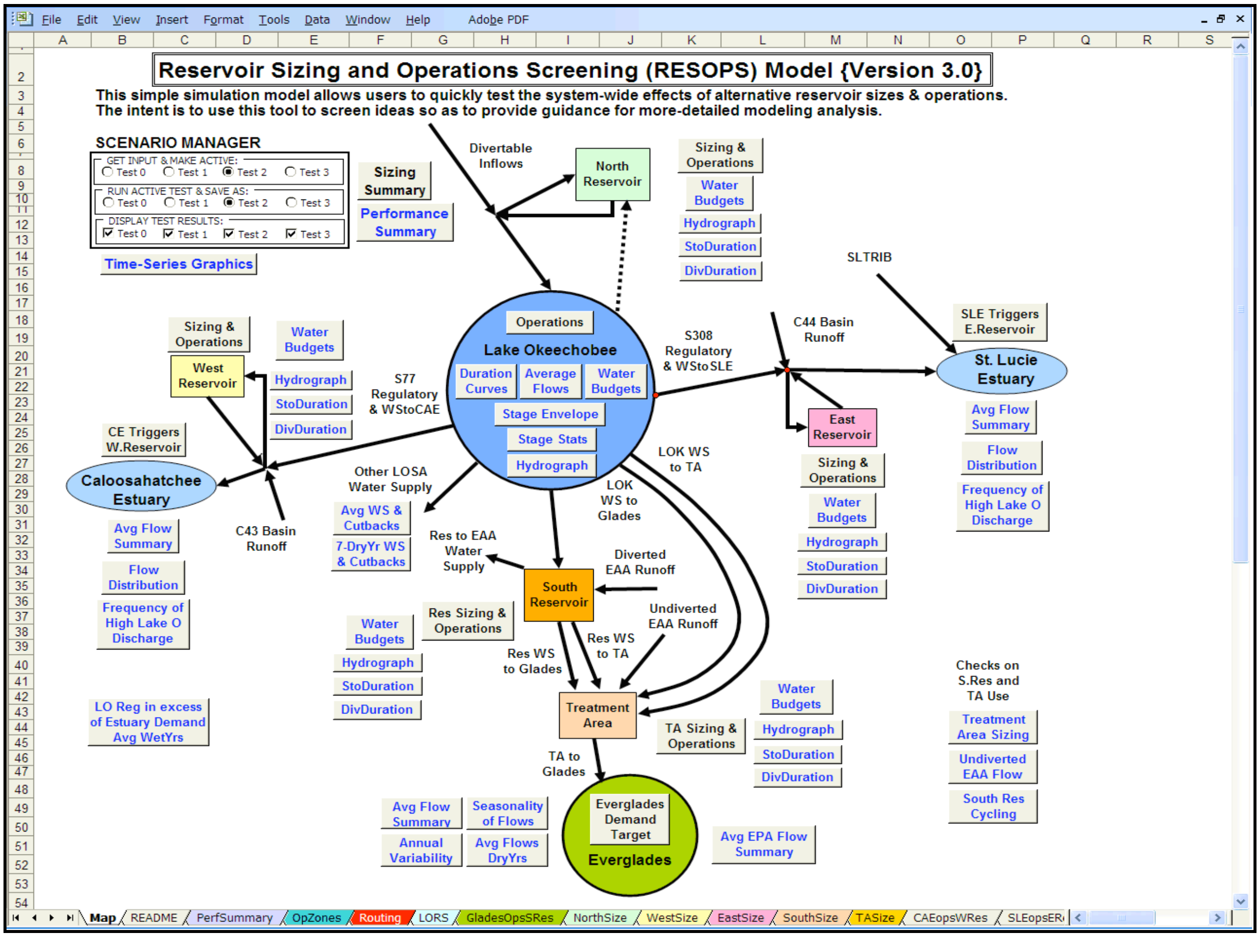

Figure 1. Map GUI for the RESOPS Model

The RESOPS Model is, as its name states, a screening-level model. The RESOPS Model has a limited scope and is not a replacement for the detailed regional hydrologic simulation models that have traditionally been used for the analysis and planning of south Florida's water resources. Those detailed models, the South Florida Water Management Model (SFWMM) and the South Florida Regional Simulation Model (SFRSM), are necessary for the comprehensive in-depth analysis of the existing and future components of the water management system. Although the detailed regional models are the best available tools for performing the finer-scale evaluation, they are not as appropriate for quickly testing a broad range of alternative reservoir sizes and Lake Okeechobee operation configurations. The strength of the RESOPS Model is with its ability to quickly test the performance of alternative configurations which can provide guidance for more-detailed modeling. Such a hierarchical process can allow the detailed models to focus on a smaller number of more-promising alternative plans.
RESOPS Model input requirements include: (1) capacities and operations for reservoirs and treatment areas, (2) Lake O operations; (3) monthly time-series (1965-2005) of rainfall,

evaporation, tributary basin runoff, service area demands, estuary water needs, and (4) Everglades water demands (flow time-series). The source of most of these time-series data inputs is the SFWMM. The exception is the Everglades water demands which are highly uncertain and historically controversial.

To account for the uncertainty in the Everglades water demands, the RESOPS Model allows the user to choose among several alternative flow-based demand target time-series (Figure 2). The RESOPS Model simulates flows to the Everglades by attempting to meet the flow target time-series at the northern boundary of WCA-3A. Users can experiment with the alternative time-series targets, or use a multiplier to simulate what-if scenarios. The impacts to the Everglades hydropatterns from additional flows cannot be estimated from RESOPS and requires more detailed models such as the SFWMM or SFRSM to evaluate.

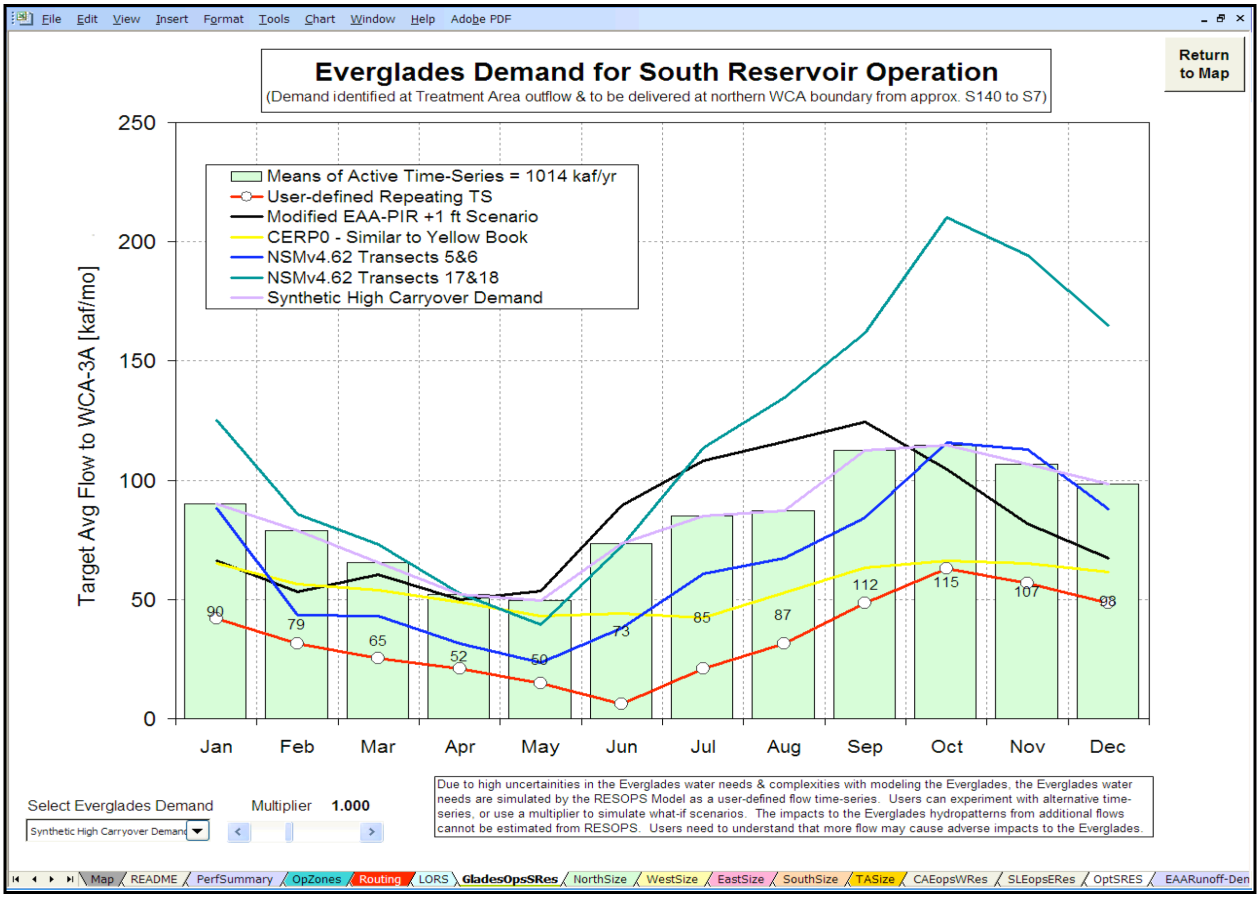

Figure 2. Everglades Water Needs GUI for the RESOPS Model

RESOPS Model outputs include: (1) water budgets, stage hydrographs, stage and flow duration curves for Lake Okeechobee and the reservoirs; (2) typical planning-level hydrologic performance measures including Lake O stage envelope scores, estuary flow distributions, water deliveries to the Everglades, water shortage indicators; (3) detailed monthly hydrographs for each storage area to facilitate detailed comparative analyses; and (4) performance curves which enable systematic evaluation of multiple storage facility capacity configurations.

3. Preliminary Findings

a. Introduction

The “due diligence” hydrologic assessment required a relatively simple tool for rapidly screening a large number of facilities and operations. The development of the RESOPS Model provided this tool and the means for testing thousands of scenarios. Preliminary findings from these tests are summarized in this section.

The primary objective of this hydrologic assessment was to determine if additional storage and treatment capacities can provide significant benefits to Lake Okeechobee, the Caloosahatchee and St. Lucie estuaries and the Everglades. The analysis was performed via multiple sensitivity analyses which addressed the primary objective and also led to other important findings. Sensitivity analyses were chosen as the best way to test ideas since there are many variables that can influence performance. The findings from these sensitivity analyses should be helpful for the next level of analysis.

Rather than structure the presentation of the results to follow the specific sensitivity analyses details, the format of this section is more concisely structured to summarize the primary findings and abridge the details of the supporting analyses. General findings are presented first, followed by findings pertaining to the northern estuaries, the Everglades, Lake Okeechobee, and water quality. Section 4 of this report provides a more-detailed description of the analysis of two specific south storage configurations known as Option 6 and Option 7.

b. General Findings

The analysis demonstrated that increasing the storage size in the EAA generally improves system performance for most of the key performance measures. However there is generally a range of diminishing returns where further increases in EAA storage capacity does not result in large performance improvements.

Operating rules for the system can significantly influence performance, particularly for the interrelated components including the EAA storage (aka South Reservoir) and treatment areas, Lake Okeechobee, and North-of-Lake Okeechobee storage (aka North Reservoir). Since the North Reservoir can release to Lake Okeechobee, its operation is important for improving low Lake O stages. Diversions of excess Lake O water to the South Reservoir provide increased discharge capability from the Lake and reduce the need for discharges to the northern estuaries. This increased discharge capacity more rapidly lowers the Lake stage, which is also a benefit to the protection of the Herbert Hoover Dike. However the adverse effects from subsequent extended dry periods are exacerbated if there is not sufficient supply in the North Reservoir to supplement low Lake stages. Thus, the operating rules for diversion of excess Lake O water to the South Reservoir and for the release of Lake O water to meet Everglades water needs, must both be carefully tuned to minimize the adverse consequences to Lake ecology and water supply capability.

c. Northern Estuaries

Flow patterns that are highly altered from historical conditions exist in both the Caloosahatchee and St Lucie estuaries in the current condition. In addition to impacts from local basin runoff, damaging high discharges of Lake Okeechobee water are currently necessary to balance the competing objectives of Lake Okeechobee and northern estuary management. During periods of high Lake stage when discharges to the estuaries may be prescribed by the regulation schedule, the presence of additional storage either north of the Lake (to divert additional inflow volume) or south of the Lake (to receive discharge in place of releases to the estuaries) can provide a means to reduce the need to make damaging discharges to the estuaries. Additionally, operationally proactive use of additional storage features even at lower Lake stages provides a means to help manage the Lake in a more desirable range such that estuary performance can be further improved. As available storage is increased, the number of Lake-triggered high discharge events to the estuaries is reduced. This can be observed in Figure 3 which illustrates dramatic reductions in the number of events for both the Caloosahatchee and St Lucie Estuaries as South storage size is increased with 600 kac-ft of North storage size assumed.

As previously stated, both North and South storage can be used to achieve estuary objectives effectively. As a result, a range of feasible combinations of North and South storage can be used to meet estuary needs as shown in Figure 4. In this figure, any combination of storage that falls within the shaded region would serve to reduce the number of Lake-triggered high discharge events by at least 80% relative to the current condition while preventing the Lake from experiencing additional prolonged high or low stage conditions.

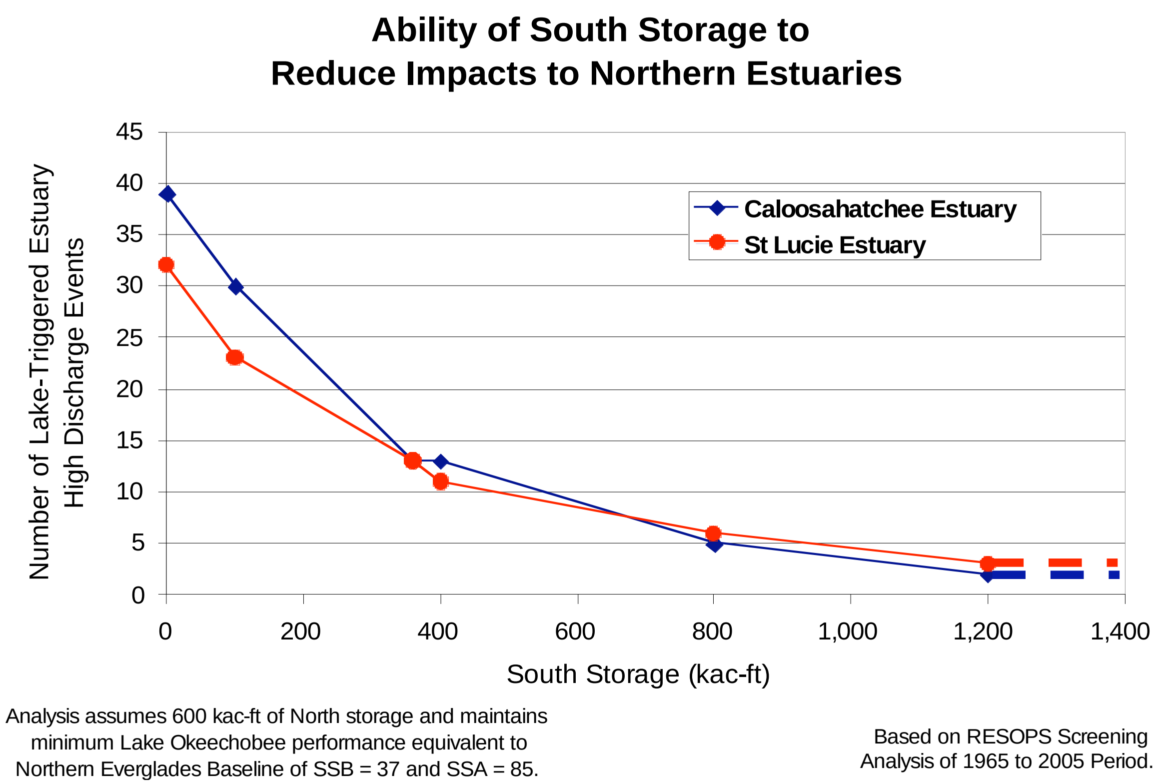

Figure 3. Ability of South Storage to Reduce Impacts to Northern Estuaries

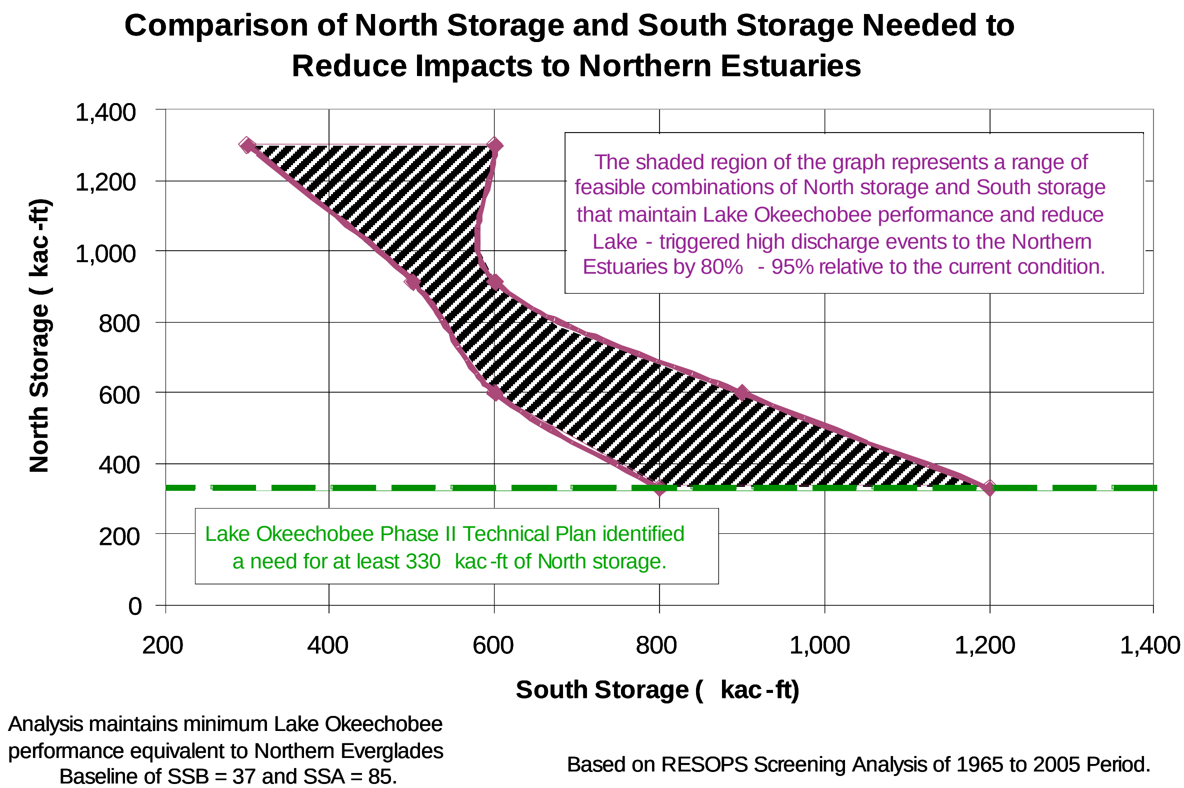

Figure 4. Comparison of North and South Storage Needed to Reduce Estuary Impacts

Two primary factors that significantly impact the ability of South storage to meet estuary objectives have been identified as part of the sensitivity testing. The first is the physical conveyance capacity of the infrastructure to the south including Lake Okeechobee outflow, conveyance through the EAA and discharge into the Water Conservation Areas. In order to relieve impacts to the northern estuaries, a monthly capacity to the south of approximately 350,000 ac-ft (or approximately 6,000 cfs/d) is required if operations of Lake Okeechobee are modified to effectively utilize such a conveyance route. If no Lake operational changes are made, however, and the desire is simply to divert existing discharges from the estuaries to the south, a monthly capacity of up to 900,000 ac-ft (or approximately 15,000 cfs/d) could be required.

The second consideration that influences the effectiveness of South storage related to estuary performance is the fact that estuary performance is highly sensitive to Everglades needs. In general, the larger the Everglades prescribed need, the better the estuary performance. This is due to the fact that larger Everglades needs lead to more storage facility releases from the EAA to the Everglades. As a result of these releases, storage in the EAA has larger available capacity to receive Lake discharges and fewer Lake Okeechobee regulatory releases to estuaries are needed.

Assuming that sufficient storage and conveyance capacity exists in a combination of North and South storage and that an operational protocol can be developed that makes efficient use of such storage, the due diligence effort has concluded that significant reduction in Lake-triggered high discharge events are observed, reducing the return period of years with damaging discharges from occurring every two to three years (as in the current condition) to fewer than once in a decade while simultaneously limiting the magnitude and duration on events that do occur.

d. Everglades

One of the key elements for achieving restoration objectives for the Everglades is the addition of storage to the south of Lake Okeechobee. The presence of this storage, coupled with other system infrastructure and operational changes (e.g. decompartmentalization, etc…), has historically been recognized as being capable of providing enhanced flow volumes and improved flow timing aimed at achieving both flow and hydropattern improvements throughout the Everglades Protection Area. Unfortunately, specific environmental water needs for the Everglades are uncertain, contentious or even conflicting from a scientific perspective. Despite this fact, the magnitude and temporal distribution of desired flow can heavily influence the need for storage capacity.

As a means of addressing some of this uncertainty, the RESOPS Model allows users to specify a number of alternative flow-demand target time-series as previously discussed. These target series were derived from sources encompassing a wide range of data utilized in previous planning and modeling efforts. This included information taken from the Natural System Model v4.6.2 (defining targets both in WCA3A and in Everglades National Park) and from SFWMM output sets representing the anticipated future Comprehensive Everglades Restoration Plan (CERP) and the future with Everglades Agricultural Area Phase 1 Reservoir conditions.

As a first step, sensitivity analysis was performed that examined the relative impact of assuming different time-series in conjunction with specified storage alternatives. This analysis indicated that the most sensitive characteristic of the desired flow time-series on reservoir sizing was the ability of that time-series to represent the need for carryover storage from wet or normal periods into drier conditions (both seasonally and inter-annually). This conclusion, in combination with an informal review of information presented at the 2008 Greater Everglades Ecosystem Restoration (GEER) conference, led to the development of the “synthetic high carryover demand” time-series that contained characteristics based on the consideration of the following parameters: 1) excess water in Lake Okeechobee and discharges to the northern estuaries, 2) volume of observed EAA runoff, 3) desired flows across Tamiami Trail into Everglades National Park, 4) type of year (extremely wet, above normal, normal, below normal or extremely dry) and 5) calendar month (captures seasonality). This time-series was then utilized for subsequent sensitivity analysis. As previously stated, the impacts to the Everglades hydropatterns from additional flows cannot be estimated using RESOPS and require a more complete and detailed modeling tool.

Sensitivity testing utilizing the synthetic high carryover demand time-series has led to a number of conclusions about the likely outcomes to Everglades inflows associated with the addition of South storage. Primarily, it is clear that flows to the Everglades can be substantially increased with the addition of EAA storage and treatment. As can be seen in Figure 5, the average annual flows through South storage features approaches one million ac-ft / yr with the addition of 840,000 ac-ft of storage and 35,000 acres of treatment area (Option 6 scenario). Additional RESOPS outputs not displayed in this write-up further indicate that the timing of flows to the Everglades improves with additional storage and that the year-to-year (Inter-annual) variability of flows to the Everglades is likely to increase with additional storage, with peak flows more than doubling over those currently observed with values in excess of two million ac-ft / yr.

Meeting dry period needs of the Everglades increases the need for storage as can be observed in Figures 6 and 7. In the case of seasonal carryover (within a single year), a point of diminishing returns is evident in the increase in dry season flows. However, assuming the desired objective is to increase flows during dry years (multi-year storage carryover) the relationship indicates that large increases in storage continue to provide large improvements in carryover ability.

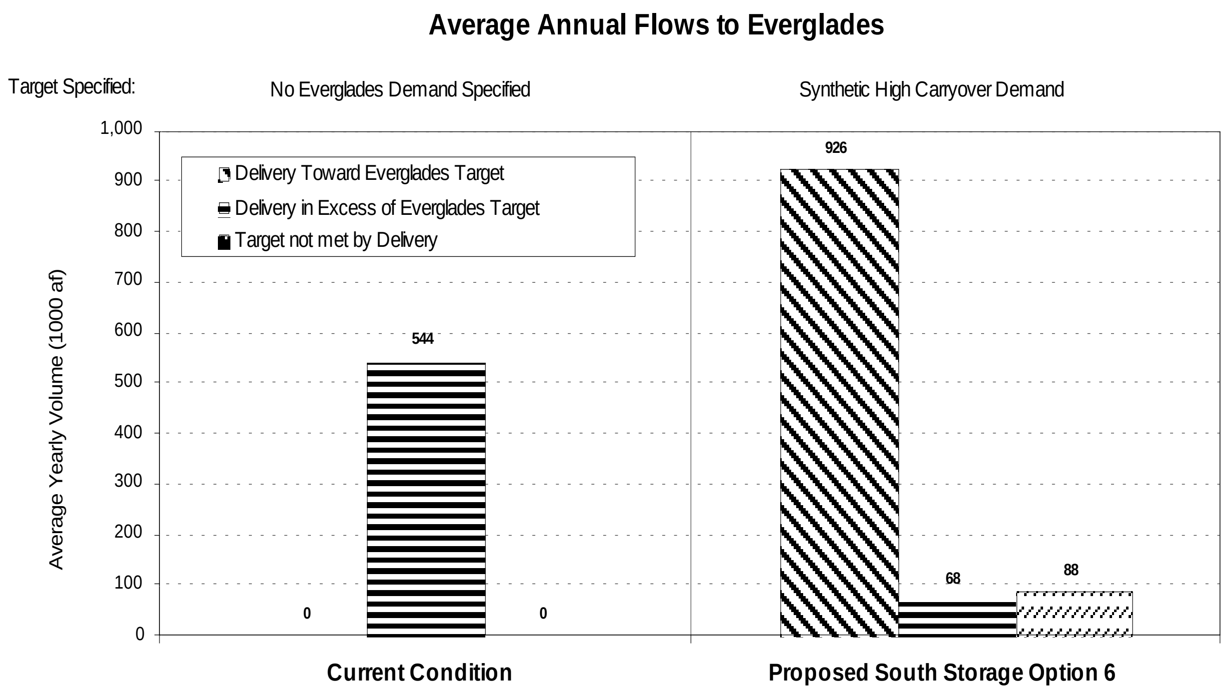

Figure 5. Comparison of Simulated Mean Annual Flows to the Everglades

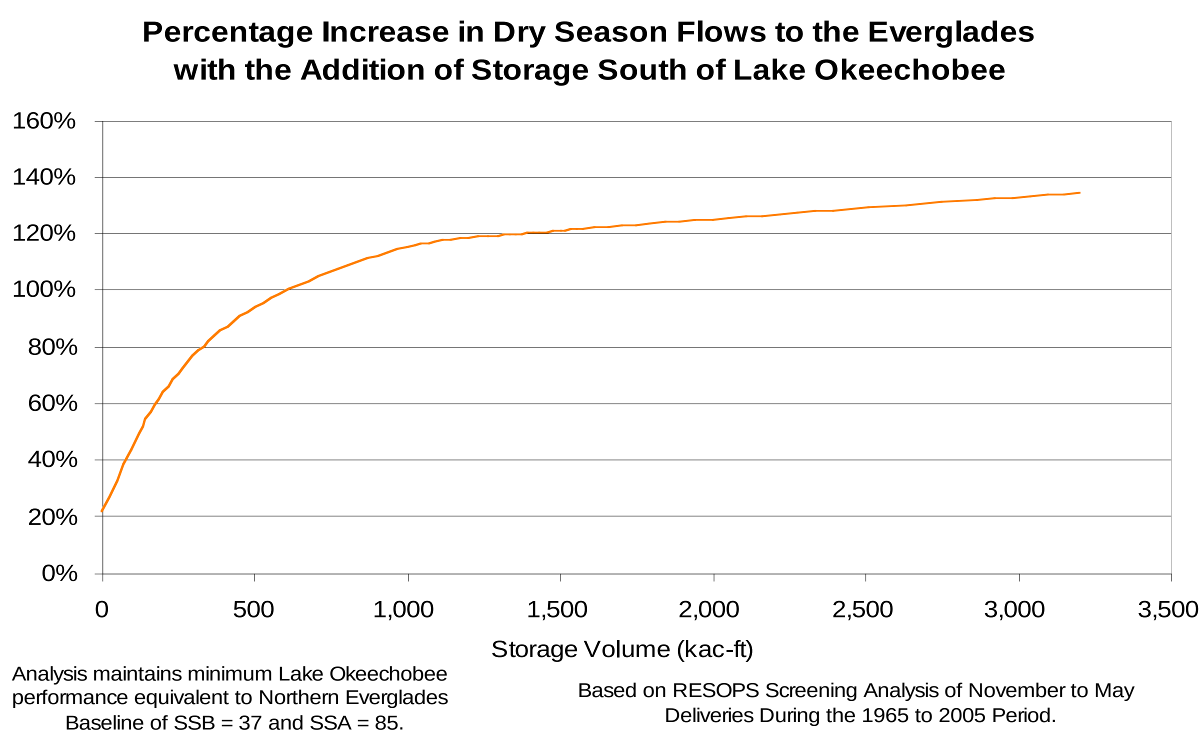

Figure 6. Increase in dry season flow (within-year carryover) with South Storage – Analysis assumes 914 kac-ft of North Storage

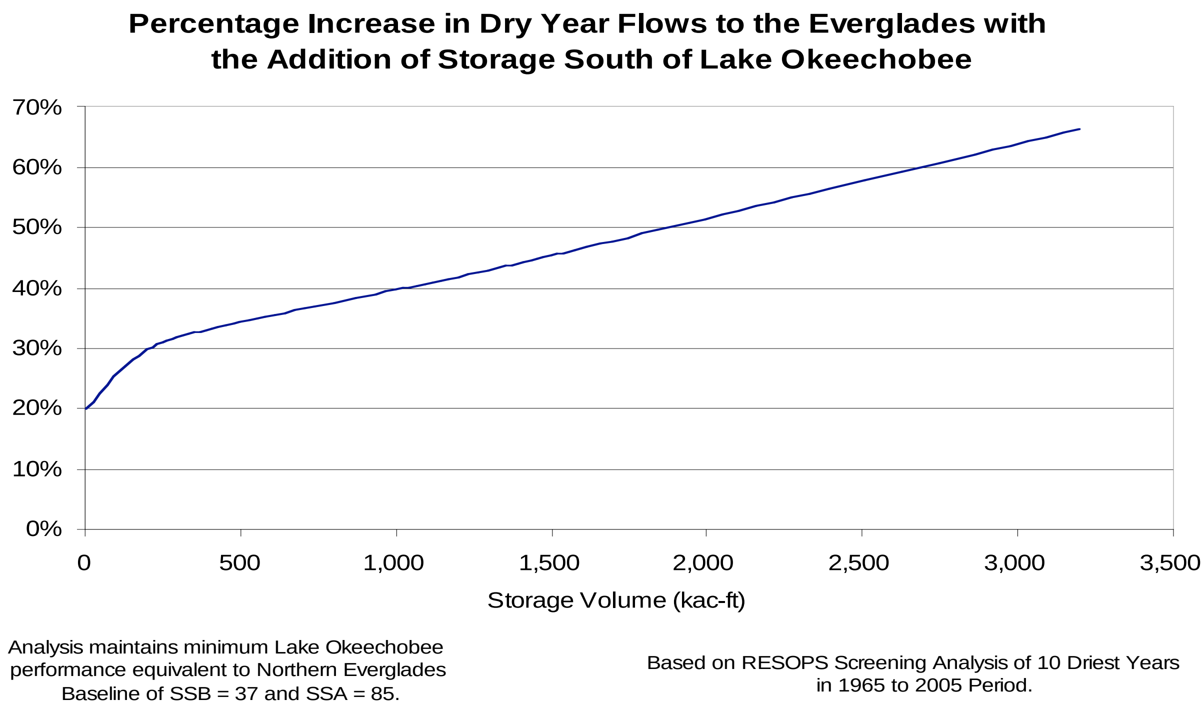

Figure 7. Variation of dry year flows (multi-year storage carryover) with South Storage – Analysis assumes 914 kac-ft of North Storage

e. Lake Okeechobee

The largest single storage area in the system is Lake Okeechobee. However, the current storage capacity of Lake O is not sufficient to store inflows during very wet periods. Thus large discharges to the Caloosahatchee and St. Lucie Estuaries are periodically required to protect the integrity of the Herbert Hoover Dike (HHD). These large discharges damage the estuary ecosystems. The 2008 regulation schedule for Lake O further reduced the storage capacity of Lake Okeechobee in order to decrease the risk of failure of the aging HHD. Additional storage north and/or south of Lake O has the potential to reduce the frequency of damaging high discharges to the northern estuaries, increase the volume and improve the timing of flow to the Everglades, and achieve more ecologically-desirable water levels in Lake O. Operating rules for these interrelated components can significantly influence performance and must be tuned to maximize and balance system performance.

This section describes the interconnected relationships of the future system and illustrates the importance of Lake Okeechobee operating rules for achieving improved and balanced system-wide performance.

i. Release Types & System Interconnectivity

There are three primary classes of Lake O releases to the south: (1) Discharges of excess Lake water are triggered when the Lake O stage rises above prescribed thresholds; (2) Environmental Water Supply (EWS) releases are made to meet the needs of the Everglades when insufficient supplies are available in the South Reservoir; and (3) Water Supply releases are made to meet agricultural irrigation and municipal demands in the Lake O Service Area (LOSA).

Now consider a future interconnected system comprised of the North Reservoir, Lake Okeechobee, and the South Reservoir. Diversions of Lake O inflow into the North and South Reservoirs occur when the Lake stage rises above prescribed levels which are related to the upper limit of the ecologically-desired Lake O stages (see the dashed lines representing the stage envelope in Figure 8). Releases from the North Reservoir to Lake Okeechobee are made when the Lake O stage falls below prescribed levels which are related to the lower limit of the Lake O stage envelope. This capability of the North Reservoir is important for improving low Lake O stages. Due to water quality concerns, it is assumed that the South Reservoir does not have this capability to discharge back to Lake Okeechobee.

Diversions of excess Lake O water to the North and/or South Reservoirs provide increased discharge capability from the Lake and reduce the need for discharges to the northern estuaries. This increased discharge capacity more rapidly lowers the Lake stage, which is also a benefit to the protection of the HHD. However the adverse effects from subsequent extended dry periods are exacerbated if there is not sufficient supply in the North Reservoir to supplement low Lake stages. Thus, the operating rules for diversion of excess Lake O water to new storage areas and for the release of Lake O water to meet Everglades water needs, must both be carefully tuned to minimize the adverse consequences to Lake ecology and water supply capability.

Figure 8 shows one of the potential Lake O operation scenarios that was derived based on the coarse optimization capability of the RESOPS Model. Note that the only zone of the regulation schedule that pertains to discharges to the estuaries is the upper bound (Zone A). The intermediate and low zones/bands of the current schedule (LORS2008) will not be needed if large-scale storage reservoirs north and/or south of the Lake are constructed.

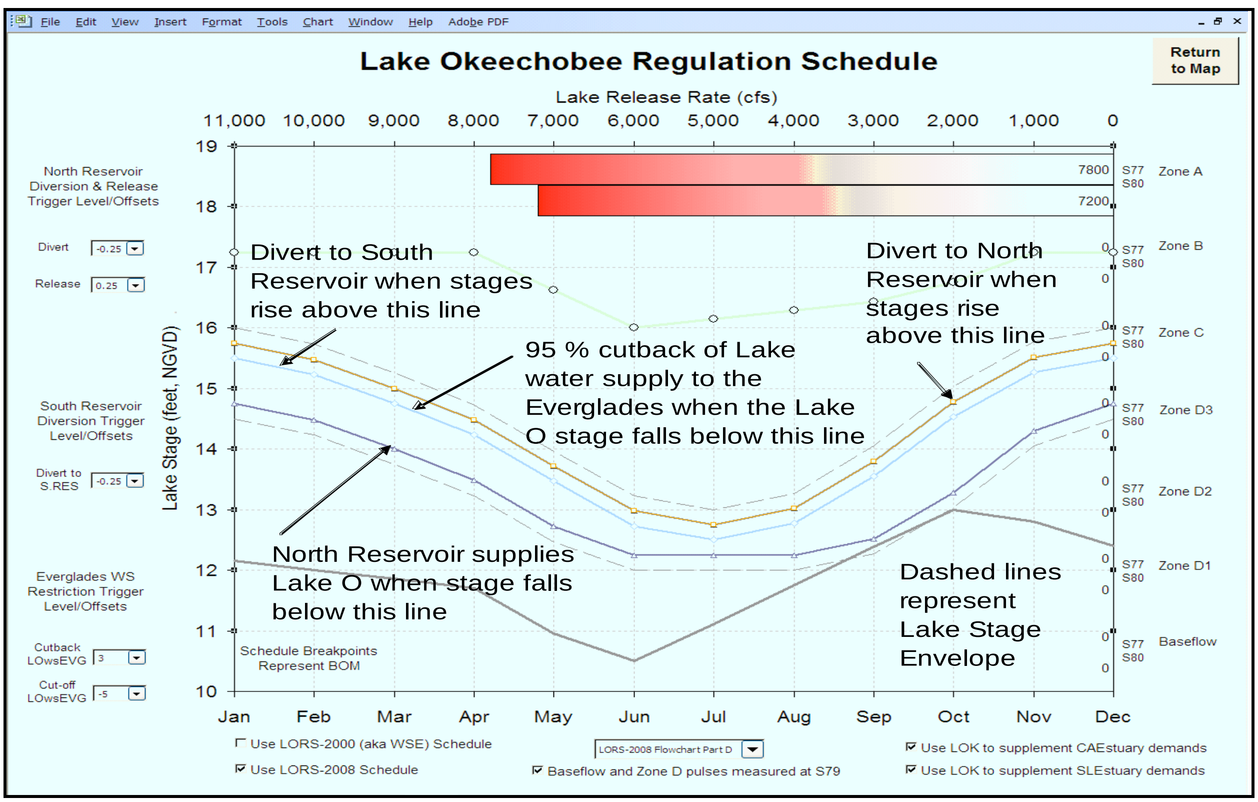

Figure 8. Potential Operating Rules for Lake Okeechobee

ii. What if Lake O releases to meet Everglades water needs are unconstrained?

The analyses described above in the sections pertaining to the northern estuaries and the Everglades assumed the environmental water supply (EWS) from Lake O to the Everglades was cut-back or cut-off when Lake O stages fell below prescribed EWS trigger lines. This was necessary to achieve solutions that improved performance without causing adverse impacts to the Lake O ecology and water supply capability. The extent of the EWS cutback and the position of the EWS trigger lines were tuned to prevent the releases to the Everglades from causing excessive lowering of the Lake O stage. To illustrate the importance of the EWS operational parameters on Lake O performance, the following sensitivity analysis was performed.

Figure 9 illustrates the Lake O stage envelope performance measure which has been traditionally used for various planning studies. The measure has 2 components: a lower stage envelope measure, and an upper stage envelope measure. Higher values of the standard scores indicate better performance and are related to how well the simulated Lake O stage falls inside the envelope. Three simulation tests are shown in Figure 9: (Test 0) is the current base; (Test 2) is the future base condition with a 330 kaf North Reservoir, 840 kaf South reservoir, and the EWS trigger lines and cutback levels as shown in Figure 8; and (Test 3) has the same features as Test 2, but with the EWS cutback level reduced from 95% to zero. The reader is referred to the Summary of Analysis in Section 4 for further details of the current and future base assumptions.

From Figure 9 it can be seen that the lower stage envelope score for Test 2 was 35.4, which is an improvement over current base (Test 1) value of 27.4. The Test 2 EWS cutback % was tuned to 95% to maximize the benefit of the EWS releases to the south, but without adverse impacts to the lower stage envelope.

To illustrate the importance of this EWS cutback operational parameter, recall that Test 3 relaxed the EWS cutback % to zero; thereby allowing Lake O to supply the Everglades water demands even when the Lake stage falls below elevation 8.0 ft, NGVD. Figure 10 shows that the Test 3 performance score for the low Lake stage envelope reduced substantially from 35.4 to 8.1. Figure 11 is the Lake O stage duration curve comparison which shows that for the lowest 20% of the time, the Lake stages are reduced by almost a foot; and the minimum stage is less than 7.0 ft, NGVD – about 1.5 feet lower than the Test 2 minimum. Such low Lake O stages would adversely impact the ecology of the Lake and also reduce its water supply capability.

This test shows that Lake O stages can be excessively lowered if releases to the Everglades are unconstrained. The results of this sensitivity test demonstrate just one example of the importance of the operational parameters and emphasize the need for modifications to the Lake O operating rules to best balance the multiple system objectives.

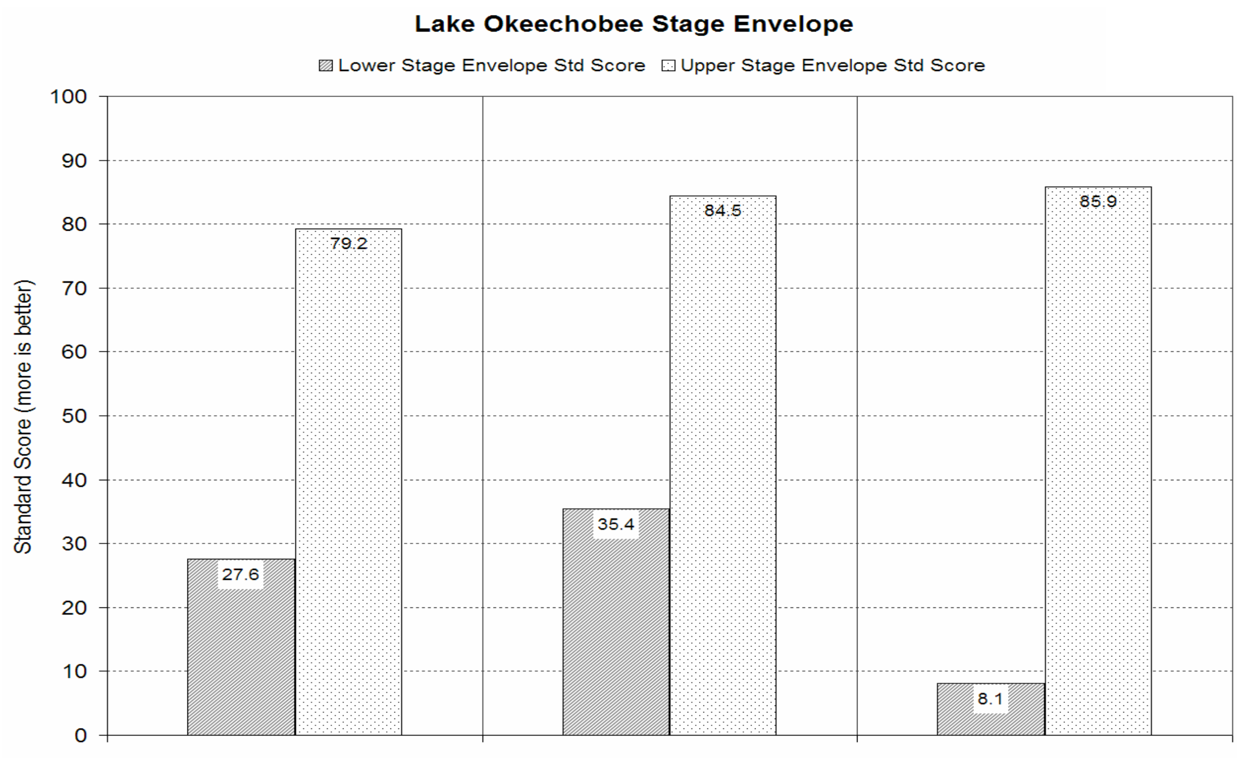

Figure 9. Lake Okeechobee Stage Envelope Performance Measure

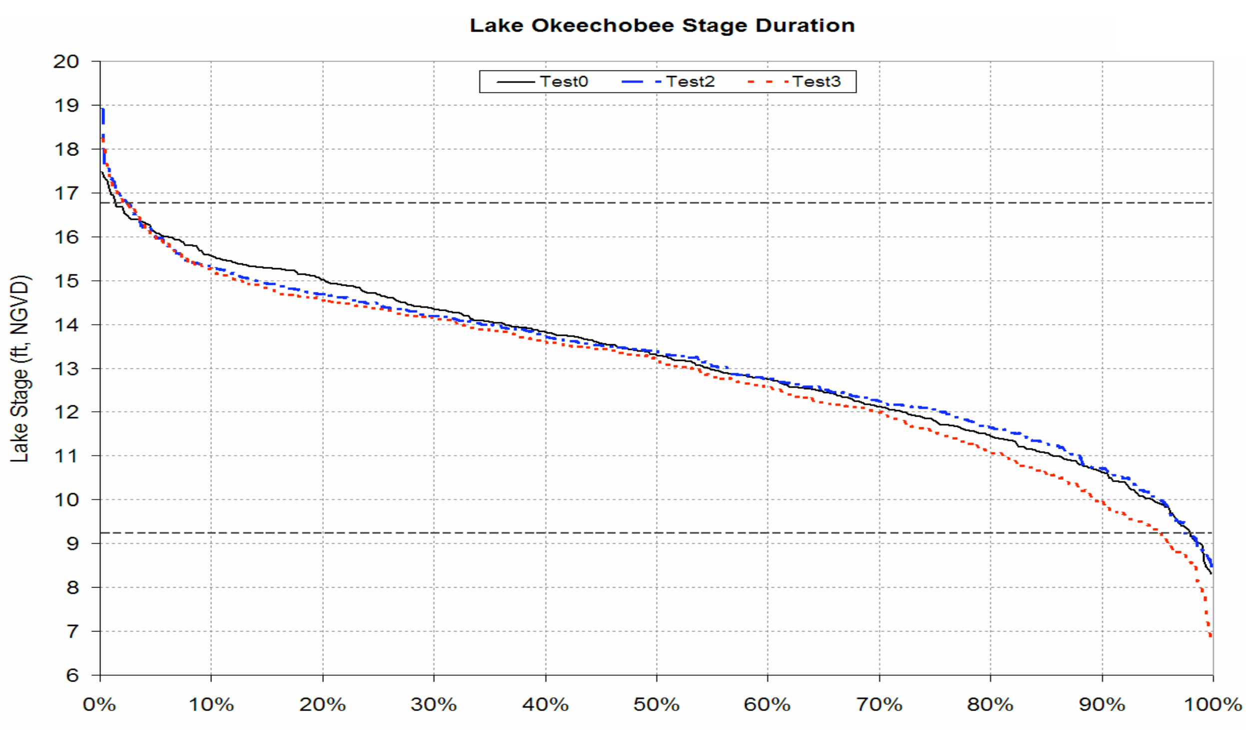

Figure 10. Lake Okeechobee Stage Duration Curve Comparison

f. Water Quality Treatment

In addition to providing the appropriate magnitude, timing and spatial distribution of flows, projects constructed to achieve restoration objectives in the Everglades must also include consideration of features to achieve desired water quality objectives. The RESOPS model simulates a lumped treatment area that receives inflow from the South storage feature as well as from EAA runoff and Lake Okeechobee, depending on the simulated operational protocols. Given the magnitude of flow to the Everglades simulated by many of the sensitivity analyses presented, it is clear that additional treatment area beyond currently planned Stormwater Treatment Area capacities is required when providing these increased flows. Utilizing relationships derived from the Dynamic Model for Stormwater Treatment Areas (DMSTA), in order to treat a flow volume of approximately 1 million acre-feet per year through the South storage and treatment area features, additional treatment area of between 12,000 and 45,000 acres may be required. This estimate is derived based on a range assuming 100 to 200 ppb phosphorous weighted inflow concentrations and 19 ppb outflow concentration.

It is also important to note that sensitivity analysis performed to assess the feasibility of large wetted treatment areas has indicated that evapotranspiration losses in larger footprint systems can significantly impact the ability to achieve system objectives by requiring additional water from Lake Okeechobee during dry periods to maintain minimum depths in the treatment area and also by reducing the available volume of water that could be sent to the Everglades (Figure 11). Due to this factor as well as uncertainties surrounding achievable outflow concentrations that meet water quality objectives, it is likely that new treatment area design and operational concepts may be needed to optimize water usage for facilities at this scale.

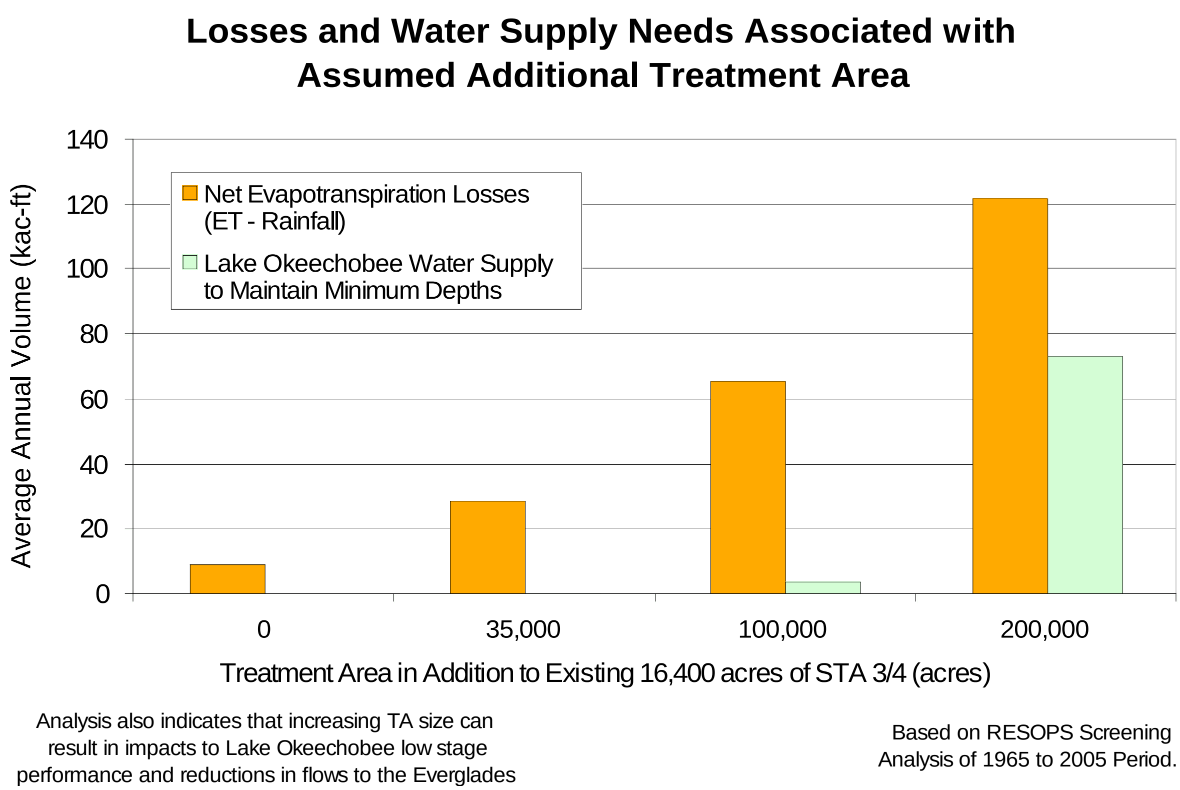

Figure 11. Losses and Water Supply Needs Increase with Additional Treatment Area

4. Summary of Analysis of Option 6 and Option 7

While the due diligence effort utilizing RESOPS primarily focused on sensitivity analyses as presented to this point, the model is also useful in analyzing what-if scenarios assuming specific configurations for system storage, treatment and operations. Specifically, two configurations possible with the acquisition of additional lands in the EAA were tested and compared to current and future base conditions. The following assumptions were used for the scenarios compared:

- 2008 Current Base - Current system infrastructure and operations with no reservoirs North, East, West or South of Lake Okeechobee. Includes the LORS2008 regulation schedule and existing STAs including STA3/4.
- Future Base – Similar to the Lake Okeechobee Phase II Technical Plan "Alternative 3" scenario. Assumes 330 kac-ft of North storage as well as the C43 and C44 reservoirs, but no South storage. Includes the LORS2008 regulation schedule and full planned STA build out including STA3/4 and Compartment B.
- Proposed Option 6 – Future Base with the addition of a South Reservoir specified as 840 kac-ft, 12 ft max depth, 4 compartments, inflow & outflow capacities = 420 kac-ft/mo and 35,000 acres of additional South Treatment. Includes modifications to system operations to work with proposed infrastructure.
- Proposed Option 7 – Future Base with the addition of a South Reservoir specified as 640 kac-ft, 12 ft max depth, 4 compartments, inflow & outflow capacities = 320 kac-ft/mo and 35,000 acres of additional South Treatment. Includes modifications to system operations to work with proposed infrastructure.

As can be observed by the summarized key output of the analysis as presented in Table 1, the addition of storage as proposed in Option 6 and Option 7 can provide substantial system benefits including reductions in damaging discharges to the northern estuaries, additional flow to the Everglades both as a long-term average and during drier conditions and improvements to low Lake stage conditions while maintaining similar high Lake stage performance.

Table 1. Key Performance Outcomes of Option 6 and Option 7 Analysis

Performance Objective or Criteria	**Scenario**			
	2008 Current Base	Future Base	Proposed Option 6	Proposed Option7
Lake-Triggered Caloosahatchee high discharge events	43	28	3	4
Lake-Triggered St Lucie high discharge events	40	27	3	4
Average Annual Flows to Everglades (to northern WCA3A in kac-ft)	544	544	994	980
Nov-May Dry Season Flows to Everglades (to northern WCA3A in kac-ft)	168	216	476	460
Average of 10 Driest Year Flows to Everglades (to northern WCA3A in kac-ft)	402	322	443	452
Lake Okeechobee High Stage Envelope (SSA)	79.2	85.7	84.5	81.2
Lake Okeechobee Low Stage Envelope (SSB)	27.6	25.5	35.4	35.4

5. Summary and Conclusions

As part of a “due diligence” effort to provide information to assist with the decision on acquisition of U.S. Sugar land within the EAA by the South Florida Water Management District, screening level analysis using the REservoir Sizing and OPerations Screening Model was performed during the summer of 2008. The nature of this analysis focused on examining a series of sensitivity tests aimed at achieving performance objectives for the Northern Estuaries, the Everglades and Lake Okeechobee using varying assumed sizes for storage both north and south of Lake Okeechobee as well as differing system operational schemes and treatment area configurations. Additionally, “what-if” scenarios using information on proposed uses of the acquired land were examined to determine the potential benefits possible from such plans.

Based on the analysis to-date, it can be concluded that the proposed land acquisition can facilitate additional storage and treatment capacities to provide significant benefits to Lake Okeechobee, the Caloosahatchee and St. Lucie estuaries and the Everglades. The analysis also identified some risks, indicating that careful future consideration must be given to potential issues of treatment area management, water depths in the Water Conservation Areas, and that modification to the Lake regulation schedule will be necessary to effectively utilize proposed storage. A summary of key findings of the analyses grouped by sub-region and performance objectives is provided in additional detail below. It is important to note, however, that these findings are preliminary in nature and that the optimal size, capacity, configuration and costs of facilities and the associated operations will be developed through a subsequent open, public planning process.

Summary of Key Findings:

Northern Estuaries

- Significant reduction in Lake-triggered high discharge events are observed with additional storage/treatment
- Both North and South storage can be used to effectively meet estuary objectives
- Estuary performance is highly sensitive to Everglades needs; in general, larger Everglades needs translate to better estuary performance

Everglades

- Specific environmental water needs are generally uncertain and can heavily influence storage capacity
- Flows to the Everglades can be substantially increased with the addition of EAA storage and treatment
- Timing of flows to the Everglades improves with additional storage
- Year-to-Year (Inter-annual) variability of flows to the Everglades is likely to increase with additional storage
- Meeting dry period needs of the Everglades increases the need for storage

Lake Okeechobee

- The regulation schedule for Lake Okeechobee will need to be revised to integrate the rules for triggering both diversions and deliveries to storage areas
- Increasing regional water flow to the south from Lake Okeechobee tends to increase the frequency and duration of low Lake stages
- Northern Everglades storage is effective in improving Lake Okeechobee lower stage envelope performance (Allows water to be released to Lake Okeechobee to offset low stages in dry periods)

Water Quality

- Additional treatment area beyond currently planned STA capacities is required when providing increased flows to the Everglades
- Based on a range of 100 to 200 ppb inflow concentrations and assuming a flow volume of approximately 1 million acre-feet per year, additional treatment area between 12,000 and 45,000 acres may be required
- Evapotranspiration losses in a wetted treatment area can significantly impact the ability to achieve system objectives.
- New treatment area design and operational concepts may be needed to optimize water usage for facilities at this scale