APPENDIX A

PERFORMANCE MEASURE FACT SHEETS

Performance Measure: Total surface phosphorus loading to Lake Okeechobee

Description – This performance measure addresses the total surface phosphorus inflow to Lake Okeechobee on an average annual basis. FDEP (2001) has established a total maximum daily load (TMDL) for phosphorus loading to Lake Okeechobee as 140 mt/yr. Attainment of the TMDL will be calculated using a 5-year rolling average based on monthly loads calculated from measured flows and phosphorus concentrations. This includes 35 mt/yr phosphorus loading from atmospheric deposition.

Rationale – Researchers have observed an increased rate of eutrophication in Lake Okeechobee from 1973 to the present. Symptoms of this eutrophication include the following:

- increases in algal bloom frequency since the mid-1980s (with an algal bloom being defined as chlorophyll a concentrations greater than 40 µg/L) (Maceina 1993, Carrick et al. 1994, Havens et al. 1995b),
- increases in the dominance of blue-green algae following a shift in the TN:TP ratio (Smith et al. 1995),
- increases in the lake water concentration of total phosphorus,
- increases in average chlorophyll a concentrations (Havens et al. 1995).

Phosphorus is considered to be the key nutrient contributing to the eutrophication of the lake (Federico et al. 1981). Increases in total phosphorus concentrations in the lake, coupled with decreases in nitrogen loading from reduced back pumping from the EAA, have shifted the TN:TP ratio from greater than 25:1 in the 1970s to around 15:1 in the 1990s. This shift has created conditions more favorable for the proliferation of nitrogen-fixing blue-green algae, which are responsible for the blooms occurring in the lake (Smith et al. 1995).

Target – Maintain average annual surface phosphorus loading to Lake Okeechobee no greater than 105 mt/yr.

Evaluation Method – A spreadsheet model has been developed and applied during the development of the Lake Okeechobee Protection Plan in 2004 and the 2007 update. This spreadsheet accounts for all phosphorus reduction measures that have been implemented and calculates the remaining load reduction required to meet the TMDL. The spreadsheet has been updated to include the 2000 through 2005 period of record.

The water quality measures contained in each alternative will be added to the spreadsheet to evaluate to what extent the phosphorus reduction goal has been achieved.

Performance Measure: Lake Okeechobee Extreme Low Lake Stage

Description – Ideally, lake stages fluctuate within a determined envelope based on an annual hydrograph. Research (Havens 2002) has confirmed that lake stages should ideally vary seasonally between 12.5 ft, NGVD (June-July low) and 15.5 ft, NGVD (November-January high). Extreme low lake stages fall below this envelope, with lake stage below 10 ft, resulting in negative impacts on the living communities in the littoral zone, the shoreline fringing bulrush zone, and all of the lake areas that support valuable submerged aquatic vegetation.

Rationale – Extreme low lake stages prevent water from reaching the submerged aquatic vegetation populating the littoral zone and shoreline regions. Without submerged aquatic vegetation, the habitats of wading birds, reptiles, fish, amphibians, and apple snails are endangered as these species rely on submerged aquatic plants for foraging and recruitment activities.

Invasive plant species such as torpedo grass and Melaleuca flourish in times of extreme low lake stage, replacing the original native vegetation. There is no proven method to control torpedo grass, except the use of a general herbicide that kills all surrounding area vegetation. Torpedo grass is poor habitat for fish and other aquatic animals as the growth is so dense there is no room for animal mobility. Nighttime dissolved oxygen levels in the grass have been recorded at zero, a condition that is not suitable for aquatic life.

Recovery from the adverse impacts of extreme low lake stage requires multiple years, including the grueling process of re-establishing a healthy submerged aquatic plant community.

Target – For extreme low lake stage, below 10 ft, the target is zero weeks.

Evaluation Method – The Regional Simulation Model (RSM) will be employed for all evaluations. The evaluation will be based on the period of record from 1970 through 2005.

In the case of extreme low lake stage, the maximum value of the raw score is 52 weeks / year x 36 years = 1,872 weeks. Based on observations of the impacts of only 15 weeks of extreme low lake stage during a drought in 2001, this value can be assigned as the worst case scenario, as it require multiple years for full recovery. An extensive loss of apple snails and woody vegetation in shoreline areas were documented. The duration for < 10 ft stage (15 weeks / year = 540 weeks in a 36 year model run) can be set as the point equivalent to a score of 0 on the standardized scale. To convert from a raw score to a standardized score, the following regression equation is applied:

$$\text{Standardized score} = \text{raw score} * -0.185 + 100$$

A linear increase in risk of ecological damage is assumed between the optimal conditions (0 weeks) and the most severe condition (540 weeks). This method is the most conservative approach to take until more data is acquired to support a more complex relationship. Thus, the equation will need to be re-calculated if the model period is extended beyond 36 years.

Performance Measure: Lake Okeechobee Extreme High Lake Stage

Description – Lake stages commonly fluctuate in response to a combination of seasonal, annual, and inter-annual variations in climatic conditions and water management operations. Published research (Havens 2002) states that lake stages should vary seasonally between 12.5 ft (National Geodetic Vertical Datum- NGVD, June-July low) and 15.5 ft (November-January high). Extreme high lake stage refers to a stage level above 17 ft, NGVD creating a dangerous condition prone to high waves, uplifted suspended solids, and unconsolidated mud deposition.

Rationale – Extreme high lake stages allow strong, wind-driven waves to impact the littoral emergent plant and shoreline submerged plant communities. Uprooting of submerged and shoreline plants can occur, compromising the habitats of fish, apple snails, amphibians, reptiles, and wading birds. These species all rely on a healthy population of submerged vegetation for areas of foraging and recruitment.

Submerged aquatic vegetation is also at risk from the uplifting of thick suspended solids to the littoral zone from the mid-lake region where they usually settle. The suspended solids in the littoral zone reduce water quality and decrease light penetration needed for submerged aquatic vegetation to flourish (James and Havens 2005).

The transfer of nutrient-rich suspended solids into the littoral zone can also affect the periphyton biomass and taxonomic structure as a result of high stage events. Cattail is known to thrive in times of extreme high lake stage, compromising plant diversity by encouraging the dominance of one specie.

Finally, the deposition of unconsolidated mud over the natural peat and sand sediment at the bottom of the lake creates a shift in the balance of a healthy vegetative system. In general, extreme high lake stages result in reductions of submerged aquatic plants, prevention of germination of submerged plants, reductions in fish spawning, cattail plant dominance, compromised periphyton biomass, and an endangered habitat of amphibians, reptiles, apple snails, and wading birds.

Target – Extreme high lake stage target is zero weeks with lake stages above 17 ft, NGVD.

Evaluation Method – The Regional Simulation Model (RSM) will be employed for all evaluations. The evaluation will be based on the period of record from 1970 through 2005.

For extreme high lake stage (above 17 ft NGVD), the response algorithm relates the raw scores for each component of the performance measure to a standardized scale of 0 to 100. The maximum value for the raw score is 52 weeks / year x 36 years = 1,872 weeks. It is believed that maximum impacts occur at a low frequency. In 1998 and 1999, almost 100% of the lake's submerged aquatic vegetation community and over 100 m of littoral emergent vegetation were uprooted when the lake stage was extreme high for only 16 and 7 weeks, respectively. These recordings were the most severe cases of extreme high lake stage damage in 30 years. Therefore, the duration for > 17 ft stage is set as the point equivalent to a score of 0 on the standardized scale. To convert from a raw score to a standardized score, the following regression equation is applied:

Standardized score = raw score * -0.253 + 100

A linear increase in risk of ecological damage is assumed between the optimal conditions (0 weeks) and the most severe condition (396 weeks). This approach is the most conservative method to follow until data is acquired to support a more complex relationship. If the

model period is extended beyond 36 years, the equation must be re-calculated. For each component of this performance measure, results for planning alternatives can be displayed as simple bar graphs. The height of the bars corresponds to standardized scores for this performance measure.

Performance Measure: Lake Okeechobee Stage Envelope – Score Below Envelope

Description – Lake stages fluctuate in response to a combination of seasonal, annual, and inter-annual climatic conditions and operational practices. Research (Havens 2002) has confirmed that lakes stage should ideally vary seasonally between 12.5 ft, NGVD (June-July low) and 15.5 ft, NGVD (November-January high). A healthy variation of lake stages result in annual flooding and drying of the littoral zone, promoting development of diverse plant and animal communities. Decreasing water levels toward the end of winter and spring allow wading birds to easily prey on resources in the littoral zone. However, if the lake stage falls below the envelope too frequently, the littoral zone is threatened.

Rationale – The littoral zone and shoreline areas of Lake Okeechobee support submerged plant life. If the lake stage is frequently below the envelope, the vegetation does not receive the water it requires to flourish. Without submerged aquatic vegetation, the habitats of wading birds, reptiles, fish, amphibians, and apple snails are endangered. These species rely on a surplus of aquatic plants for foraging and recruitment activities.

When the lake stage falls below the envelope, it creates optimal conditions for invasive plant species such as torpedo grass and Melaleuca to replace the original native vegetation. There is no proven method to control torpedo grass, except the use of a general herbicide that kills all surrounding area vegetation. Torpedo grass is poor habitat for fish and other aquatic animals as the growth is so dense there is no room for animal mobility. Nighttime dissolved oxygen levels in the grass have been recorded at zero, a condition that is not suitable for aquatic life.

When the lake stage falls below 12.56 ft, NGVD, navigation of the Okeechobee Waterway becomes impaired. At levels below 11 ft, NGVD, access to the lake for fishermen and recreational boaters becomes limited to channels and boat trails. It should be noted that the Lake Okeechobee commercial and recreational fishery is valued at over $480 million dollars (Furse and Fox 1994)

Lake stages below the envelope are beneficial in moderate occurrences. Periodic exposure of seed banks helps control plant dominance and can provide nutrition to animal communities. Low lake stage also exposes the littoral zone to oxidation of the organic material that accumulates over time, creating a healthy and clean system. Fires can arise in times of low lake stage which, in moderation, can prevent plant dominance such as cattail. A decrease in lake level during spring time helps to concentrate prey resources and promote wading bird nesting on the lake.

Target – For deviations of lake stages below the envelope, the target is established at 192 ft weeks. This score allows for the optimal range of both dry and flooded periods to encourage a thriving and diverse community.

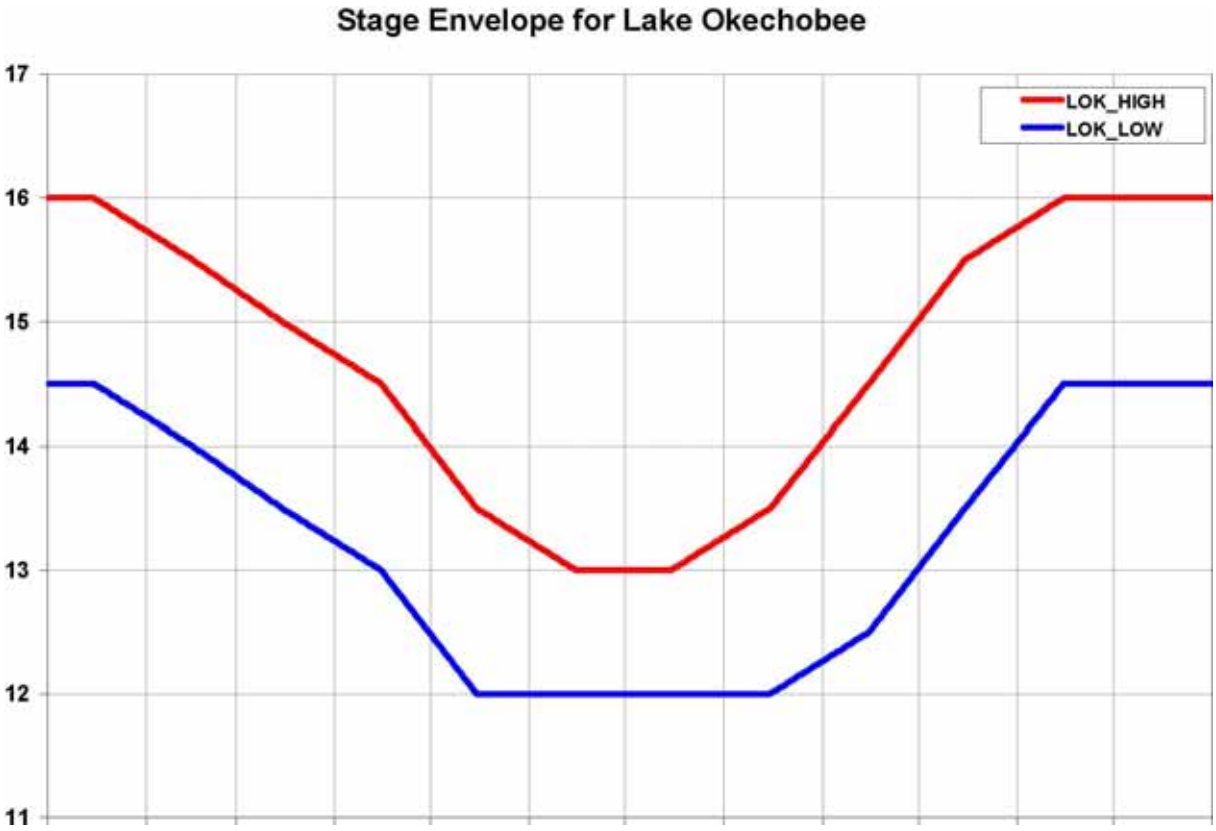
Evaluation Method – The Regional Simulation Model (RSM) will be employed for all evaluations. The evaluations will be based on simulation of the period from 1970 through 2005. For each week of the model simulation, the absolute value of the deviation (ft) of lake stage from the envelope is determined. The number of weeks below the envelope is tallied and the response curve is developed from the performance measure graphic. Zero values represent favorable conditions, the adjacent bands of 0.5 ft represent fair conditions, and the subsequent (1.0 ft) band represent poor conditions. The worst case scenario occurs when the hydrograph remains constantly in the poor zone (1,872 ft weeks). Therefore, the response curve is a line between the target (192 ft weeks) and the worst case scenario (1,872 ft weeks). Raw scores are calculated from the following equation:

Standardized score (%) = raw score * -0.0595 + 111.429

Except where the score falls below 192, the score remains at 100%. For each component of this performance measure, results for planning alternatives can be displayed as simple bar graphs. The height of the bars corresponds to standardized scores for this performance measure.

Lake Okeechobee Stage Envelope

This graphic illustrates how the evaluation is performed for the lake stage envelope, where the vertical axis is stage in ft, NGVD and the horizontal axis is in months of the year. The shaded central area is the stage envelope. In this example, hydrograph A has a score of 86 ft-weeks for stages above the envelope and a score of 0 for stages below the envelope. Hydrograph B has a score of 22 ft-weeks for stages above the envelope and a score of 0 for stages below the envelope. Hydrograph C has a score of 0 for stages above the envelope and a score of 110 ft-weeks for stages below the envelope. Actual scoring is based on a smooth envelope boundary.



Performance Measure: Lake Okeechobee Stage Envelope – Score Above Envelope

Description – Lake stages fluctuate in response to a combination of seasonal, annual, and inter-annual climatic conditions and operational practices. Research (Havens 2002) has confirmed that lakes stage should ideally vary seasonally between 12.5 ft, NGVD (June-July low) and 15.5 ft, NGVD (November-January high). A healthy variation of lake stages result in annual flooding and drying of the littoral zone, promoting development of diverse plant and animal communities. However, lake stage deviations above the envelope result in over flooding which is destructive to the littoral zone including aquatic vegetation and specie habitat.

Rationale – Lake stages above the envelope produce an excess of water creating wind-driven waves that impact the littoral emergent plant and shoreline submerged plant communities. Uprooting of submerged and shoreline plants can occur, compromising the habitats of fish, apple snails, amphibians, reptiles, and wading birds. These species all rely on a healthy population of submerged vegetation for areas of foraging and recruitment.

Submerged aquatic vegetation is also at risk from the uplifting of thick suspended solids to the littoral zone from the mid-lake region where they usually settle. The suspended solids in the littoral zone reduce water quality and decrease light penetration needed for submerged aquatic vegetation to flourish (James and Havens 2005). Without a population of healthy submerged aquatic vegetation, the sediment cannot be stabilized and specie habitat is endangered.

The transfer of these nutrient-rich suspended solids into the littoral zone can also affect the periphyton biomass and taxonomic structure. Cattail is known to thrive in times of high lake stage, compromising plant diversity by encouraging the dominance of one species.

Finally, the deposition of unconsolidated mud over the natural peat and sand sediment at the bottom of the lake creates a shift in the balance of a healthy vegetative system. In general, high lake stage results in a reduction of submerged aquatic plants, prevention of germination of submerged plants, reductions in fish spawning, cattail plant dominance, compromised periphyton biomass, and an endangered habitat of amphibians, reptiles, apple snails, and wading birds.

Target – The target is zero weeks for deviation of lake stage above the envelope.

Evaluation Method – The Regional Simulation Model (RSM) will be employed for all evaluations. The evaluation is based on simulations for the period from 1970 through 2005. For each week of the model simulation, the absolute value of the deviation (ft) of lake stage from the envelope is determined. Zero values represent favorable conditions, the adjacent bands of 0.5 ft represent fair conditions, and the subsequent (1.0 ft) band represent poor conditions.

The worst case scenario is one in which the lake stage hydrograph is always in the poor zone. This situation equates to a total score of 1.0 ft x 52 weeks / year * 36 years 1,872 ft weeks. The response curve is a line between the target (0 weeks) and the worst case scenario (1,872 ft weeks). Raw scores can be calculated from the following equation:

$$\text{Standardized score (\%)} = \text{raw score} * -0.0534 + 100$$

For each component of this performance measure, results for planning alternatives can be displayed as simple bar graphs. The height of the bars corresponds to standardized scores for this performance measure.

Performance Measure: Number of Times Proposed Minimum Water Level & Duration – Criteria Exceeded
Description – To determine the MFL for Lake Okeechobee, the following water resource functions were considered: provide water that can be used to maintain water levels in coastal canals, meet human needs, and protect the Biscayne aquifer against saltwater intrusion, supply water and provide water storage for the Everglades. The lake is a regionally important ecosystem that provides fish and wildlife habitat, supports commercial and sport fisheries, and maintains navigation and recreational use. Water supply to the Biscayne aquifer, Caloosahatchee River, St. Lucie Canal, the Seminole Indian Tribe, and the Everglades Agricultural Area were important considerations in the establishment of an MFL for Lake Okeechobee. Relationships were considered in defining significant harm (a loss of specific water resource functions resulting from a change in surface or ground water hydrology) and the proposed MFL was determined.
Rationale – Lake Okeechobee is a critical source of fresh water to maintain coastal ground water levels, preventing saltwater intrusion of the Biscayne aquifer. During dry periods, fresh water is discharged from the lake, helping to maintain a freshwater head within the coastal ground water aquifer which prevents inland movement of the saltwater front. Records show that when lake levels fall below 11 ft NGVD, the levels continue to decline rapidly, threatening the ability for the District to deliver water to coastal canals as a result of the physical limitations of the lake's outlet structures. During dry periods, the Everglades have been found to not be receiving sufficient water amounts to maintain viable aquatic ecosystems and to protect vegetation and wildlife from the threat of fires. The District's Best Management Practice Make-Up Water Rule, Part II of Chapter 40E-63, F.A.C quantifies the necessary amount of water to ensure a healthful Everglades system. The established MFL must support the littoral zone and the following fish and wildlife values: a commercial and recreational fishery valued at over $480 million dollars, a rich avifauna community that includes wading birds, migratory waterfowl, and federally-designated endangered snail kite and wood stork, ecotourism and recreation, including fishing, hunting, and bird and wildlife observation. When the lake stage falls below 12.56 ft NGVD, navigation of the Okeechobee Waterway becomes impaired. At levels below 11 ft NGVD, access to the lake for fishermen and recreational boaters becomes limited to channels and boat trails. However, when the lake stage reaches an extreme low condition, recreational access to the lake becomes significantly restricted, as much of the littoral zone is exposed as dry land. It is important to consider the dependency of the Everglades Agricultural Area, the Seminole Indian Tribe, and the Caloosahatchee and St. Lucie basins on fresh water flow from Lake Okeechobee. During drought conditions, agricultural water needs in these basins are determined based on weather, soil, and crop conditions.
Target – The lake level should not fall below 11 ft, NGVD for more than 80 days duration more often than once every six years.
Evaluation Method – The Regional Simulation Model (RSM) will be employed for all evaluations. The evaluation will be based on the period of record from 1970 through 2005 The number of years when Lake Okeechobee stages fall below 11 ft, NGVD for 80 days or more will be counted.

Performance Measure: Number of Times Caloosahatchee Estuary High Discharge Criteria Exceeded – Mean Monthly Flows >2,800 cfs and Mean Monthly Flows > 4,500 cfs
Description – The Lake Okeechobee WSE Regulation Schedule is applied to regulate (flood control) discharges to the Caloosahatchee River, and subsequently to the Caloosahatchee Estuary, when lake stages are high. The Caloosahatchee River has primary capacity for local inflows and is only utilized for Lake Okeechobee discharges when there is secondary capacity available. The number of times that the Caloosahatchee Estuary high discharge criterion is exceeded must be limited to prevent destructive impacts on the estuary.
Rationale – Lake Okeechobee discharges into the Caloosahatchee Estuary via the Caloosahatchee River. Alterations in the Caloosahatchee River and Lake Okeechobee operations have resulted in a surplus of fresh water discharged into the estuary. The resulting high fluctuations in salinity and water quality can have a negative impact of the estuarine biota. Due to water management practices, the Lake Okeechobee watershed is larger than it was historically, resulting in larger volumes of water and higher nutrients being discharged from the lake into the estuary. High nutrients can create algal blooms in the estuary which block sunlight from submerged aquatic vegetation communities. Oysters, located at the mouth at Shell Point, have been shown in historical records to be an integral feature of the estuary. Shoal grass and oysters are sensitive to high freshwater inflows. During periods of high inflow, the decrease in salinity results in poor spat productions, slower growth, and excessive valve closure. The upstream area of the estuary is the most vulnerable, with high mortality rates at times of extended high discharge. Juvenile oysters are the most sensitive, as salinities of below 5 ppt will result in over a 95% mortality rate. In upstream areas, recruitment peaks in March, similar to the time that Lake Okeechobee must be discharged for flood control, a coincidence that exposes oyster larvae to lethal low salinities. Oysters and submerged aquatic vegetation are Valued Ecosystem Components (VECs), as they help sustain the ecological structure and function of the estuary by providing food, living space, and foraging sites for other naturally occurring estuarine species. Without these VECs, the overall health of the estuary is severely compromised.
Target – No more than 3 events with mean monthly flows at S-79 greater than 2,800 cfs and no events with mean monthly flows greater than 4,500 cfs.
Evaluation Method - The Regional Simulation Model (RSM) will be employed for all evaluations. The evaluation will be based on the period of record from 1970 through 2005. The number of average monthly S-79 flows between 2,800 cfs and 4,500 cfs will be tallied for each alternative.

Performance Measure: Number of Times Salinity Criteria Not Met for the Caloosahatchee Estuary – Mean Monthly Flows < 450 cfs and Mean Monthly Flows > 2,800 cfs

Description – A healthy, naturally-diverse and well-balanced estuarine ecosystem can exist only if the salinity regimes are controlled within the desirable range. Lake Okeechobee discharges have a significant impact on how well desirable salinity regimes are maintained in the Caloosahatchee Estuary.

Rationale – Sea grasses in the upper estuary require high salinity (over 20 psu (Doering and Chamberlain 2000)) and clear water (Dennison et al., 1993) with no time periods of greater than 1 week at salinities below 10 psu (Moffler and Durako, 1987) or blue light levels below 5% of surface irradiance.

Tape grass requires low salinities less than 10 psu and clear water (Kemp et al., 2004), and no continuous time periods of salinities greater than 20 psu. Oysters, located at the mouth at Shell Point, have been shown in historical records to be an integral feature of the estuary. Shoal grass and oysters are sensitive to high freshwater inflows. During periods of high inflow, the decrease in salinity results in poor spat productions, slower growth, and excessive valve closure. The upstream area of the estuary is the most vulnerable, with high mortality rates at times of extended high discharge. Juvenile oysters are the most sensitive, as salinities of below 5 ppt will result in over a 95% mortality rate. In upstream areas, recruitment peaks in March, similar to the time that Lake Okeechobee must be discharged for flood control, a coincidence that exposes oyster larvae to lethal low salinities.

Natural resources in the San Carlos Bay area are adversely affected by large freshwater releases. The numerous mangrove islands and mangrove shoreline support oysters and meadows of sea grass. Oysters and submerged aquatic vegetation are Valued Ecosystem Components (VECs), as they help sustain the ecological structure and function of the estuary by providing food, living space, and foraging sites for other naturally occurring estuarine species. Finally, the biotic richness and aesthetic appeal make San Carlos Bay a popular recreational and fishery location with significant economic value.

Target – Maintain mean monthly flows at S-79 between 450 cfs and 2,800 cfs with no more than 3 events with mean mothly flows greater than 2,800 cfs.

Evaluation Method - The Regional Simulation Model (RSM) will be employed for all evaluations. The evaluation will be based on the period of record from 1970 through 2005.

The number of mean monthly flows outside of the desirable range from 450 cfs to 2,800 cfs will be tallied for each alternative.

Performance Measure: Number of times St. Lucie High Discharge Criteria Exceeded – Mean Monthly Flows > 2,000 cfs

Description – The Lake Okeechobee WSE Regulation Schedule is applied to regulate (flood control) discharges to the St. Lucie Canal, and subsequently to the St. Lucie Estuary, when lake stages are high. The St. Lucie Canal has primary capacity for local inflows and is only utilized for Lake Okeechobee discharges when there is secondary capacity available. The number of times that the St. Lucie Estuary high discharge criterion is exceeded must be limited to prevent destructive impacts on the estuary.

Rationale – The St. Lucie Canal was constructed in the 1920's by the Everglades Drainage District. The canal was enlarged and incorporated into the Central and Southern Florida Project. In addition to the St. Lucie Canal, several other canals have been constructed to drain into the St. Lucie Estuary, resulting in an area of over 775 square miles draining into the estuary. Freshwater flow into the estuary are often excessive in the wet season. Thick deposits of mud have also degraded the estuary with mucky silt that covers large portions of the estuary bottom, creating a habitat unsuitable for submerged aquatic vegetation. The sediments deposited can also be re-suspended by the wind, preventing light penetration to reach any aquatic vegetation.

Oysters historically covered an area of nearly 1,400 acres in the St. Lucie Estuary. By 1997, only 207 acres of oyster habitat were identified, equating to an 85% loss in oyster cover. Excessive freshwater discharges from Lake Okeechobee occurred in 1998 and 1999, killing more than 90% of the remaining oysters. These flows were above 2,000 cfs and produced salinities below 1 ppt. Salinity is a key factor in the fate of oyster vitality. Adult oysters prefer salinity ranges between 10 and 30 ppt. Juvenile oysters are the most sensitive, as salinities of below 5 ppt will result in over a 95% mortality rate.

Oysters and submerged aquatic vegetation are Valued Ecosystem Components (VECs), as they help sustain the ecological structure and function of the estuary by providing food, living space, and foraging sites for other naturally occurring estuarine species. Oyster bars provide habitat for gastropod mollusks, polycheate worms, decapods crustaceans, boring sponges, fish, birds, and over 300 macrofauna species. The American oyster can filter 4-34 liters of water per hour, removing phytoplankton, particulate organic carbon, sediments, pollutants, and microorganisms from the water column. This filtering process results in greater light penetration, promoting submerged aquatic plant growth.

Target – Minimize the number of mean monthly flows between 2,000 and 3,000 cfs and avoid mean monthly flows above 3,000 cfs .

Evaluation Method – The Regional Simulation Model (RSM) will be employed for all evaluations. The evaluation will be based on the period of record from 1970 through 2005.

The number of mean monthly flows between 2,000 and 3,000cfs and the number of mean monthly flows greater than 3,000 cfs will be tallied for each alternative.

Performance Measure: Number of Times Salinity Envelope Criteria Not Met for the St. Lucie Estuary

Description – In its natural condition, the St. Lucie Estuary contained a variety of mangroves, oyster bars, and submerged aquatic vegetation. Now, almost 775 square miles drain into the estuary, due to extensive agricultural and urban drainage projects. As a result, freshwater flow into the estuary becomes excessive during the wet season and thick deposits of mud have degraded the estuary with mucky silt that covers large portions of the estuary bottom, creating a habitat unsuitable for submerged aquatic vegetation. The sediments deposited may also be re-suspended by the wind, preventing light penetration to reach any aquatic vegetation. Currently, only the lower areas of the estuary can still support submerged aquatic vegetation.

Rationale – Salinity is a key factor in the fate of oyster vitality. Adult oysters prefer salinity ranges between 10 and 30 ppt. Juvenile oysters are the most sensitive, as salinities below 5 ppt will result in over a 95% mortality rate. The SFWMD separated flows into sized flow events and the flow events were correlated to the subsequent median salinities. Using these classifications, a relationship was established between the discharge and salinity for very low salinities. Flow ranges of 725 – 3280 cfs were found to produce salinities from 1 – 5 ppt. Flows of 2000 cfs, the middle of the flow class, resulted in salinities of 3 ppt (the value associated with high oyster mortality in 1998 and 1999. Thus, 3 ppt and 2000 cfs are the threshold salinity values for survival. Salinity levels above the threshold level threaten valuable submerged aquatic vegetation and oyster bars.

Oysters and submerged aquatic vegetation are Valued Ecosystem Components (VECs), as they help sustain the ecological structure and function of the estuary by providing food, living space, and foraging sites for other naturally occurring estuarine species. Oyster bars provide habitat for gastropod mollusks, polychaete worms, decapods crustaceans, boring sponges, fish, birds, and over 300 macrofauna species. The American oyster can filter 4-34 liters of water per hour, removing phytoplankton, particulate organic carbon, sediments, pollutants, and microorganisms from the water column. This filtering process results in greater light penetration, promoting submerged aquatic plant growth.

Target – Achieve no more than 31 events with average monthly flows less than 350 cfs. Avoid more than 28 events with 14-day moving average discharges from local basins (C-23, C-24, and the Tidal Southfork Basins) greater than 2,000 cfs for more than 14 days. Avoid events when 14-day moving discharges are greater than 2,000 cfs for more than 14 days as a result of C-44 flows plus local basin flows.

Evaluation Method – The Regional Simulation Model (RSM) will be employed for all evaluations. The evaluation will be based on the period of record from 1970 through 2005.

The number of average monthly flows to the St Lucie Estuary between 350 cfs and 2,000 cfs will be tallied for each alternative.

Performance Measure: Water Year (Oct-Sep) LOSA Demand Cutback Volumes
Description – Lake Okeechobee is the primary source of supplemental irrigation for four major adjacent agricultural basins: North Shore, Caloosahatchee, St. Lucie and EAA. Collectively, these basins are referred to as the Lake Okeechobee Service Area (LOSA). During the dry season when precipitation is low, local sources of irrigation become scarce and the need for supplemental irrigation becomes necessary. With the current absence of substantial off-site storage, Lake Okeechobee is presently the only source of supplemental irrigation for these basins. Average annual supplemental irrigation requirement from Lake Okeechobee amounts to about half a million acre-ft.
Rationale – Water levels in Lake Okeechobee are compared to a seasonally fluctuating Supply Side Management Zone in the WSE Regulation Schedule. If water fall into the Supply Side Management Zone, projections of rainfall, ET, and water supply demands are made for the remainder of the dry season and water supply cutbacks are applied as appropriate. During seven years of the 1970 to 2005 period of record, substantial water restrictions were imposed on the LOSA. These restrictions were implemented to protect the region's water resources on a long-term basis. However, the water supply demands that were not met during these drought periods resulted in significant economic impacts to the water users.
Target – Minimize the water supply cutback volumes during the seven years of the period of record with the largest cutbacks.
Evaluation Method - The Regional Simulation Model (RSM) will be employed for all evaluations. The evaluation will be based on the period of record from 1970 through 2005. The volume of water supply demand that is not met will be tallied for each of the seven years that caused the largest unmet demands.

Performance Measure: Mean Annual EAA/LOSA Supplemental Irrigation Demands Not Met
Description – Lake Okeechobee is the primary source of supplemental irrigation for four major adjacent agricultural basins: North Shore, Caloosahatchee, St. Lucie and Everglades Agricultural Areas. Collectively, these basins are referred to as the Lake Okeechobee Service Area (LOSA).
Rationale – During the dry season when precipitation is low, local sources of irrigation become scarce and the need for supplemental irrigation becomes absolutely necessary. With the current absence of substantial off-site storage, Lake Okeechobee is presently the only source of supplemental irrigation for these basins. Average annual supplemental irrigation requirement from Lake Okeechobee amounts to about half a million acre-ft (SFWMD, 2000a). Lake Okeechobee also provides urban water supply to the Lower East Coast and to several municipalities surrounding the lake. Additionally, the Seminole Tribe of Florida is entitled to water supply based on the Water Rights Compact (Pub. L. No. 100-228, 101 Stat. 1556, and Chapter 87-292, Laws of Florida, and codified in Section 285.165, F.S.
Target – Minimize the percentage of water supply demands that are not met in the EAA and LOSA.
Evaluation Method – The Regional Simulation Model (RSM) will be employed for all evaluations. The evaluation will be based on the period of record from 1970 through 2005. The percentages of demands not met will be tallied for the EAA and LOSA.