ENVIRONMENTAL WATER MANAGEMENT PLAN

FOR THE UPPER ST. JOHNS RIVER BASIN PROJECT

Steven J Miller[1], Apurba K. Borah[2] , Mary Ann Lee[1], Edgar F. Lowe[1], and Donthamsetti V. Rao[2]

[1]Division of Environmental Sciences
[2]Division of Engineering

Department of Water Resources
St. Johns River Water Management District

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EXECUTIVE SUMMARY

The Upper St. Johns River Basin Project (USJRBP) extends approximately 40 miles from the northeast corner of Okeechobee County north of the Florida Turnpike, to Lake Washington in central Brevard County. The Project includes over 100 miles of flood protection levees, eight major gated spillway structures, and numerous smaller water control structures. The USJRBP covers an area of approximately 145,000 acres and drains an area of over 2,000 square miles.

Four marsh conservation areas and three water management areas comprise the majority of acreage within the USJRBP. The purposes of the marsh conservation areas are to temporarily retain flood water, provide for long-term water conservation storage, and to restore and preserve floodplain wetlands. Purposes of the water management areas are to temporarily retain flood waters and to improve the quality of agricultural and urban surface water discharges before they enter the marsh conservation areas. Water management areas may also provide water for farm irrigation.

The primary purpose of the USJRBP is flood protection. Secondary project goals include environmental enhancement and water supply. General environmental objectives of the USJRBP are to preserve and restore freshwater marsh habitats, improve water quality, and decrease stormwater discharges to the Indian River Lagoon (interbasin diversion). This Environmental Water Management Plan was developed to direct operation of USJRBP water control structures when project water levels are below flood control regulation schedules (Zone B). This plan will be incorporated into the U. S. Army Corps of Engineers Upper St. Johns River Basin Water Control Plan (COEWCP).

To achieve environmental objectives we are attempting to restore, to the greatest extent possible, the natural hydrologic regime which shaped the upper St. Johns River basin ecosystem. By creating a hydrologic regime which mimics natural cycles, optimum soil and vegetation characteristics will be maintained. In turn, this will help provide other environmental benefits such as enhanced fish and wildlife habitat and improved water quality. A number of hydrologic characteristics have been identified as being ecologically significant. These include: mean depth, frequency of inundation , maximum depth,

magnitude of annual fluctuation, timing of fluctuation, and water level recession rates. Environmental hydrologic criteria describing each of these characteristics are defined and presented for each project area. Criteria comprise a series of hydrologic statistics (or constraints) that form the boundaries of an acceptable hydrologic regime for that area. To meet environmental goals, these boundaries must not be exceeded.

Environmental water management plans were developed using simulated hydrologic stage data derived from the Upper Basin Hydrologic Model. Simulated daily stages were calculated by the model using historic daily rainfall data for a 42-year period (1942 -1989). Through an iterative process, a number of discharge scenarios were modeled for each project areas to derive a discharge schedule under which simulated stage data most closely met the environmental hydrologic criteria. Those discharge schedules were subsequently accepted for inclusion in this plan

The environmental hydrologic criteria address long-term hydrologic conditions. At times, circumstances may require that Zone B water levels be managed to solve short-term problems. Decision trees are presented to guide this process. In addition, a program to monitor hydrologic and biologic responses to project conditions will be developed. If monitoring data indicate hydrologic or environmental objectives are not being met, a process for amending this plan is described.

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1.0 INTRODUCTION

The purpose of the Environmental Water Management Plan is to provide water level regulation schedules which will maximize environmental benefits of the Upper St. Johns River Basin Project (USJRBP). This plan will be included as a part of the U. S. Army Corps of Engineers Upper St. Johns River Basin Water Control Plan (COEWCP), and will be used to direct the operation of project water control structures when water levels are below flood control regulation schedules (Zone B).

The primary purpose of the USJRBP is flood protection. Secondary project goals are environmental enhancement, water supply, and recreation. Regulation schedules outlined in the COEWCP have been designed to provide flood protection by increasing available stormwater storage capacity during the rainy season (April - September; Figure 1). When water levels are in Zone A, maximum discharges will occur. When water levels are in Zone B, discharges will be made consistent with the hydrologic schedules detailed in this plan.

The environmental objectives of the USJRBP are to preserve and restore freshwater marsh habitats, improve water quality, and decrease stormwater discharges to the Indian River Lagoon (interbasin diversion). The USJRBP will restore to marsh over 40,000 acres of land previously diked and drained for agriculture. In addition, the project will restore more natural hydrologic regimes on over 70,000 acres of existing marsh. Restoring more natural hydrologic conditions to existing marshes, as well as increasing marsh acreages, will enhance and increase habitat for fish and wildlife and improve water quality. Water quality will also be improved by using water management areas to segregate agricultural discharge from the marsh. The project will decrease the need to divert stormwater to the Indian River Lagoon by increasing stormwater storage capacity and improving downstream conveyance.

2.0 PROJECT DESCRIPTION

The USJRBP extends approximately 40 miles from the northeast corner of Okeechobee County

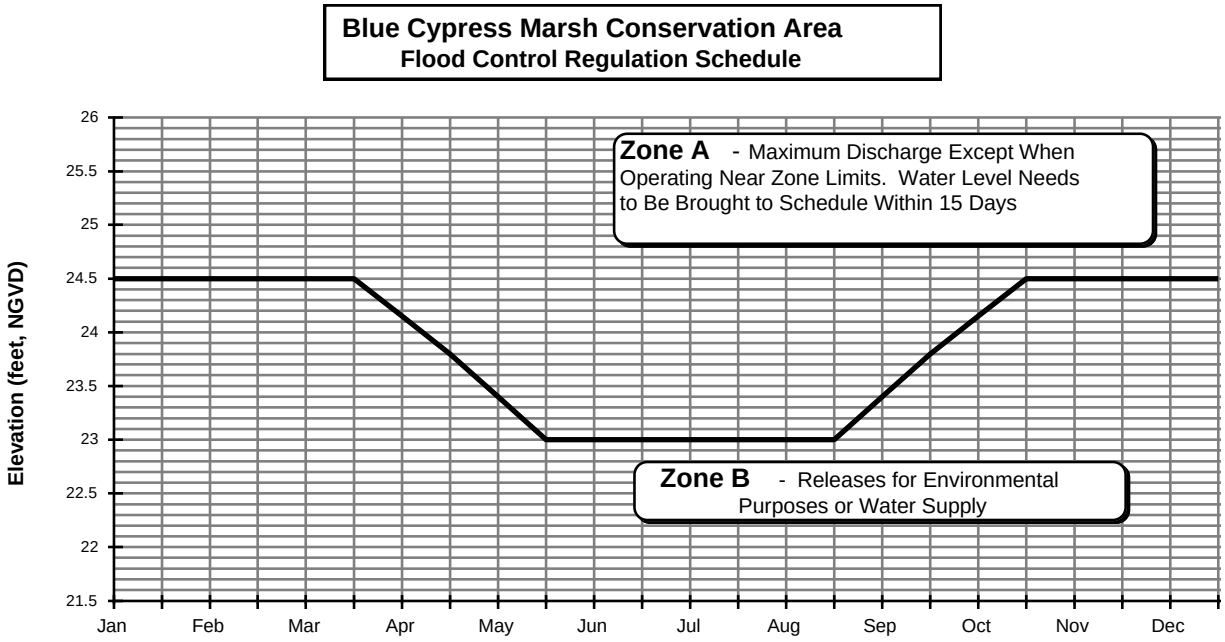

Figure 1. Flood control regulation schedule for the Blue Cypress Marsh Conservation Area.

north of the Florida Turnpike, to Lake Washington in central Brevard County (Figure 2). The immediate project area totals approximately 145,000 acres and drains an area of over 2,000 square miles. The Project includes over 100 miles of flood protection levees, eight major gated spillway structures, and 15 smaller water control structures such as culverts and weirs.

Four marsh conservation areas and three water management areas will comprise the majority of acreage within the USJRBP (Figure 2). The purposes of the marsh conservation areas are to temporarily retain flood water, provide for long-term water conservation storage, and to restore and preserve floodplain wetlands. The purposes of the water management areas are to temporarily retain flood waters from agricultural and urbanized lands, and to segregate farm discharges from the marsh conservation areas. The water management areas can also provide water for farm irrigation.

The following is a brief description of each project area. More detailed information on individual structural components of the project is presented in the COEWCP.

Figure 2. Map of the USJRBP.

Figure 3. USJRBP features located within Indian River County.

2.1 Fort Drum Marsh Conservation Area (FDMCA)

The FDMCA encompasses approximately 20,588 acres located between the Florida Turnpike, on the south, and State Road 60, on the north (Figure 3). The FDMCA is a unique and diverse area of freshwater marshes, forested wetlands, and former improved pasture, and native range. Eight general habitat types have been identified: pasture, pine flatwoods, live oak hammock, cabbage palm hammock, mixed hardwood swamp, cypress swamp, dry prairie, and freshwater marsh. Within the central portion of the property is a 3,000-acre forested hardwood swamp. In the middle of this swamp is an elevated live oak hammock. Existing floodplain marshes comprise approximately 6,600 acres. With the return of a

more natural hydrologic regime, it is anticipated that nearly 4,000 acres of lands formerly used for agriculture will be returned to marsh.

Under project design conditions water from the FDMCA was to be discharged north into the BCMCA through three culvert structures, S-252A, S-252B and S-252C (Figure 3). Structures S-252B and S-252C are ungated culverts whereas Structure S-252A consists of one ungated and two gated culverts. Under design conditions the gated culverts at S-252A were to remain closed until water levels in the FDMCA exceed 26.0 ft National Geodetic Vertical Datum (NGVD), or unless additional discharges were needed for environmental purposes. The Ft. Drum levee and control structures were completed in November 1991.

Analysis water level data collected both upstream and downstream of the FDMCA has revealed that design discharge conditions have not been met (Figure 4). As a result, from 1991 to 1995 water levels in the FDMCA have rarely fallen below 25.5 ft NGVD. To facilitate downstream discharge from this project area a getaway canal immediately north of State Road 60 connecting the three structures is scheduled to be constructed in 1996. In addition to this canal, a gated culvert structure (S-252D) will be constructed to connect the FDMCA to the BCWMA (Figure 3). This structure will be used to create more extreme drydown events.

2.2 Blue Cypress Marsh Conservation Area (BCMCA)

The BCMCA encompasses approximately 29,500 acres bounded by State Road 60 to the south and the Fellsmere Grade to the north (Figure 3). The area includes 6,500-acre Blue Cypress Lake. The BCMCA is the most extensive natural marsh in the project area and is probably the least impacted by human activities. The BCMCA contains a mosaic of freshwater marsh plant communities dominated mainly by sawgrass and maidencane. A deeper marsh slough interspersed with cypress heads and tree islands runs north-south along the eastern portion of the area. Blue Cypress Lake supports a quality sport fishery and is surrounded by a cypress fringe. Historical studies have indicated that before extensive

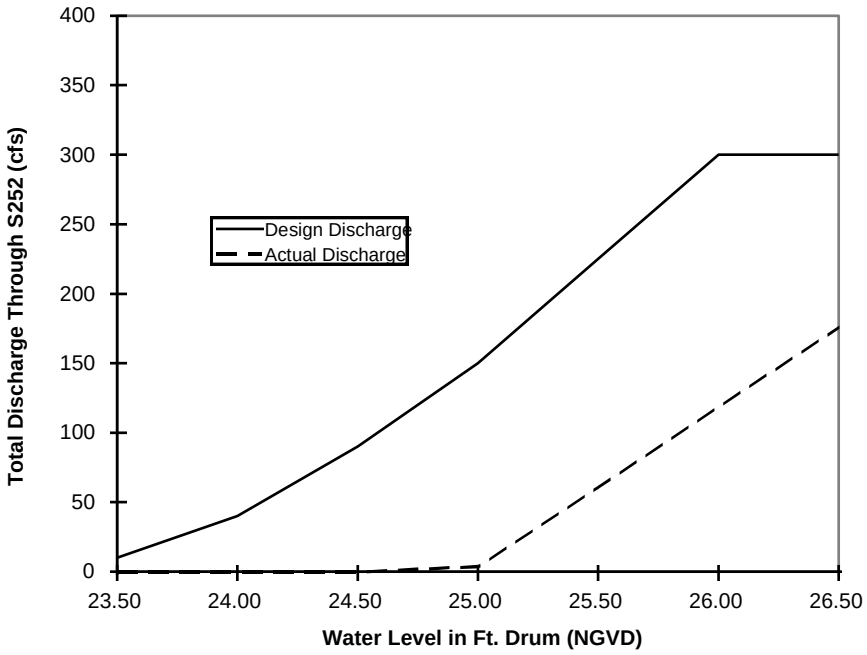

Figure 4. Design discharge (cubic feet per second; cfs) from all S-252 Structures combined compared to actual discharge through the structures measured from August 1991 through March 1993.

diking and draining occurred in the upper basin, most of the project area had vegetation similar to that in the BCMCA (Lowe et al. 1984).

Discharge downstream from the BCMCA will occur through three combination weir/culvert structures (S-250A, B, and C), one culvert structure (S-250D), and one gated structure (S-96C). Culverts will provide normal daily downstream flows; seasonal flood flows will occur over the fixed weirs. Flood waters will be primarily discharged from the BCMCA by Structure S-96C, which has a discharge capacity of 1,500 cfs. Under the COEWCP design conditions, maximum required discharges from S-96C will occur when water levels equal or exceed 24.5 ft NGVD during the dry season, and 23.0 ft NGVD during the wet season (Figure 1).

2.2.1 S. N. Knight Property

The S. N. Knight property is a 2,526 acre tract located on the west side of the BCMCA (Figures 2 and 3). Historically the site was part of the Upper St. Johns River floodplain , but it was diked and drained in the 1960's. A portion of the property was originally tilled for row crops but later, the entire area was converted to pasture. There has been significant soil subsidence on the property. On the average the property has subsided 4 to 5 ft., with a maximum of 7 ft of subsidence on the eastern boundary.

Restoration plans for S. N. Knight call for the area to eventually be hydrologically connected to the BCMCA. Because of the soil subsidence, reconnection will create approximately 1,900 acres of lake habitat and 400 acres of marsh. Until hydrologic reconnection, water levels in S. N. Knight will be regulated by levee gaps in the eastern levee located at a ground elevation of 25.5 ft NGVD. After reconnection, S. N. Knight will be the same as water levels in the BCMCA.

2.3 Blue Cypress Water Management Area (BCWMA)

The BCWMA encompasses 10,100 acres located north of State Road 60 and east of the BCMCA (Figure 3). It is bisected by State Road 512 into two connected areas, BCWMA-East and BCWMA-West. The BCWMA-East consists of approximately 4,900 acres of existing marsh with no project levee improvements. The BCWMA-West is approximately 5,200 acres of existing marsh enclosed by a perimeter levee.

The BCWMA-West is comprised of the Ansin West and the Lake Miami Ranch properties (Figure 3). Ansin West has marsh plant communities similar to those present in the eastern portion of the BCMCA, as it was not extensively drained and was hydrologically connected to the BCMCA prior to construction of the project. Lake Miami Ranch had been drained and farmed prior to project construction. Because of soil subsidence, this area is now a more open, deep-water habitat that supports a popular sport fishery (Cox et al. 1991).

The BCWMA-East is a low nutrient marsh system supporting emergent vegetation and tree islands. In BCWMA-East, ground elevations gradually rise from west to east. The BCWMA, and the eastern portion of the BCMCA, support a number of avian species listed as endangered, threatened, or species of special concern. Most notable of these is the federally-protected snail kite. During 1991 mid-winter snail kite surveys conducted by the Florida Cooperative Fish and Wildlife Research Unit, up to 140 birds were observed in the BCWMA (Bennetts and Maier 1992; B. Barnett, pers. comm., 1991). The majority of birds were found in BCWMA-East. Because of the relatively small area being utilized, actual snail kite densities (number of birds per hectare) in the BCWMA, were among the highest in Florida (Toland 1991). Kites have continued to both nest and forage in the BCWMA for the past five years suggesting this area constitutes prime habitat. Because the USJRBP is a Federally funded project and the snail kite is an endangered species, by law, water level regulation plans developed for the BCWMA must be sensitive to the needs of this species.

. BCWMA-East and West are connected by four gated culverts (S-251) at State Road 512 (Figure 3). S-251 will be operated to control water levels in BCWMA-East to prevent overdrainage, and to prevent reverse flows from BCWMA-West to BCWMA-East. The BCWMA will receive permitted agricultural discharges. Water will be discharged from the BCWMA into the SJWMA via the C-65 flowway and Structure S-96D. When stages in the BCWMA exceed 26.6 feet NGVD, discharge will occur from the BCWMA into the BCMCA via a 1,500 foot weir (S-254). Under the COEWCP design conditions, maximum required discharges through S-96D will occur when water levels in the BCWMA-West equal or exceed 25.5 ft NGVD during the dry season, and 24.5 ft NGVD during the wet season (Figure 5). If needed, water can also be transferred from the BCMCA into Canal C-65 through culvert Structure S-4.

2.4 St. Johns Water Management Area (SJWMA)

The SJWMA consists of approximately 6,280 acres located northeast of Blue Cypress Lake (Figure 3). Much of the SJWMA was drained and farmed prior to project construction. Because of soil subsidence, this area is now an open, deep-water environment. The northern and southern portions of the SJWMA contain large numbers of standing dead trees. The SJWMA has been stocked with sport fish by

the Florida Game and Fresh Water Fish Commission and supports a high quality largemouth bass sport fishery (Cox et al. 1991). This catch-and-release fishery is receiving national attention.

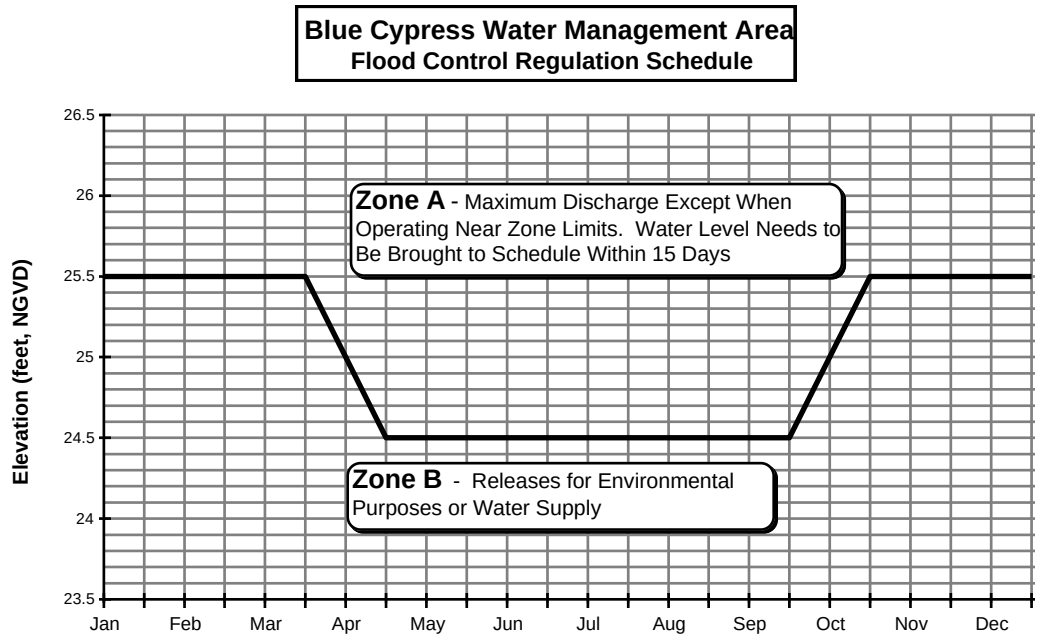

Figure 5. Flood control regulation schedule for the BCWMA outlined in the COEWCP.

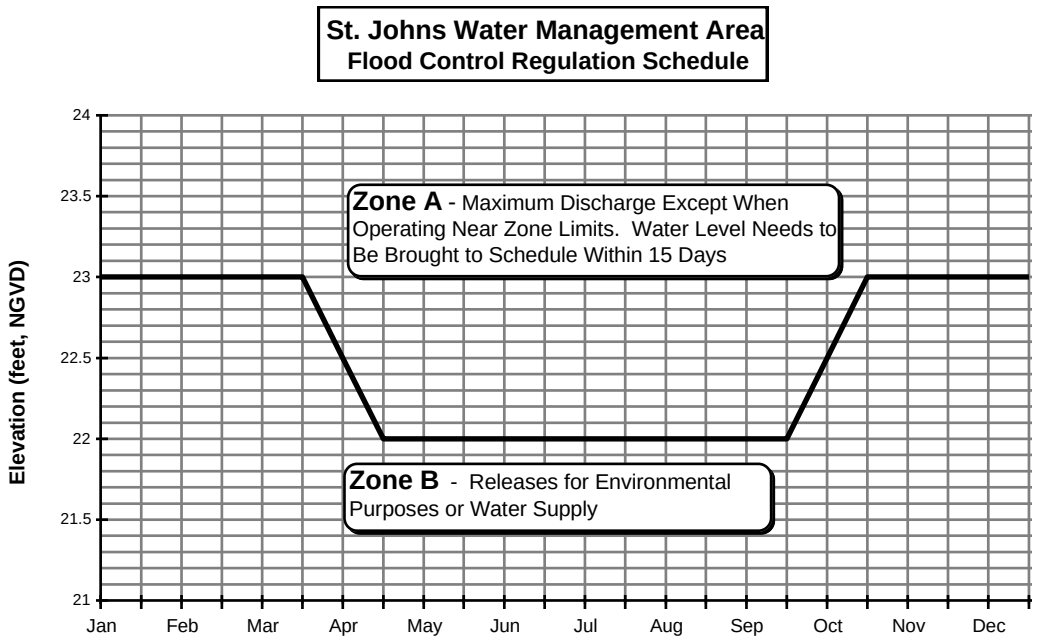

Figure 6. Flood control regulation schedule for the SJWMA outlined in the COEWCP.

The SJWMA receives inflows discharged from the BCWMA through S-96D, and permitted discharge from agricultural lands east of the SJWMA. Water levels in the SJWMA are regulated primarily by a gated spillway, Structure S-96B. When project construction is complete, will pass water downstream into the Three Forks Marsh Conservation Area (TFMCA). Additional discharges during flood events are also made to the Indian River Lagoon via Structure S-96 and the C-54 Canal and into the C-54 Retention Area via structure S-258. Under the COEWCP design conditions, maximum discharges through S-96B occur when water levels in the SJWMA exceed 23.0 ft NGVD during the dry season and 22.0 ft NGVD during the wet season (Figure 6).

2.5 St. Johns Marsh Conservation Area (SJMCA)

The SJMCA consists of approximately 34,300 acres of freshwater marsh, pasture, forested wetlands, and shallow lakes lying between the Levee L74W (formerly the Fellsmere Grade) and US 192 (Figure 7). Downstream discharge from the SJMCA is not controlled. The SJMCA is bordered to the east by the TFMCA and the Sawgrass Lakes Water Management Area (SLWMA). To the west the SJMCA is bordered by agricultural lands, primarily pasture. When the project is complete, approximately 6,800 additional acres of this former pasture located immediately north of L-74W will be restored to marsh.

Principal habitats in the SJMCA are freshwater marsh, mixed hardwood swamp, cypress swamp, and shallow lake. The majority of acreage is marsh dominated by sawgrass, maidencane, and willow. Two shallow lakes, Lake Hell'n Blazes (381 acres) and Sawgrass Lake (481 acres), are located in the northern end of SJMCA just south of US 192. Both lakes have been severely degraded by the altered hydrology, reduced water quality, and increased sedimentation which followed historical floodplain development.

The SJMCA has also been degraded by altered hydrology. For many years, the Fellsmere Grade hydrologically isolated the SJMCA from the BCMCA during dry periods. In addition, the SJMCA was over-drained by the C-40 and South Mormon Outside Canals (Figure 6). Drainage of the marsh

Figure 7. USJRBP features in Brevard County.

facilitated colonization by undesirable vegetation and degraded water quality. In 1986, eight earthen canal plugs were constructed in the C-40 Canal to facilitate sheetflow and limit over-drainage of the marsh during the dry season. A single canal plug was also constructed in the Outside Mormon Canal.

Primary inflows to the SJMCA will occur from the BCMCA through Structures S-96C and S250A, B, C, and D (Figure 7). The SJMCA will also receive inflow from the TFMCA near river mile 273) and from the Jane Green Detention Area through Structures S-161 and S-161A (Figure 2).

2.7 Three Forks Marsh Conservation Area (TFMCA)

The TFMCA encompasses approximately 14,000 acres of former agricultural lands located on the east side of the river immediately north of the Fellsmere Grade (Figure 7). The TFMCA is comprised of three separate land parcels; Cross Triangle Ranch, Sartori East and Mary A. The Cross Triangle Ranch , which occupies the northernmost third of the TFMCA, is a mixture of pasture and wet prairie. Extensive sawgrass communities still exist on the property although it has been incompletely drained since the 1940's. Because of long-term drainage activities, peat soils in the Cross Triangle have subsided several feet. Sartori East was not drained and farmed until 1980. The District acquired this property in 1985 and it has been maintained since as an isolated rainfall-driven impoundment. This area is now dominated by herbaceous marsh intermixed with woody species such as primrose willow. The Mary A property was drained in the 1960's and was used for pasture and then for row crops. The property was also purchased by the District in 1985 and maintained as an isolated rainfall-driven impoundment. In 1990, the Mary A property was connected to the SJMCA and flooded to enhance project discharge capabilities. In 1992, this area was again isolated from the marsh and operated as a rainfall-driven impoundment. Currently the Mary A property area has been drawn down by pumping to provide aquatic weed control and to initiate restoration activities.

When the TFMCA is complete, all three properties will be hydrologically connected. Because of the substantial soil subsidence, a levee separating the TFMCA from the SJMCA will be needed to prevent overdrainage of the SJMCA during dry periods, and to maintain an acceptable hydrologic regime within both the SJMCA and the TFMCA. Proposed restoration plans for the TFMCA will result in the establishment of an open water area in the northern portion (ca. 7,000 acres), and approximately 7,000 acres of freshwater marsh in the southern portion of the area. A channel will be constructed to connect S-96B to the deeper water lake along the eastern levee of the TFMCA.

Inflows to the TFMCA will occur from the SJWMA through Structure S-96B and from the C-54 Retention Area through a pump station. Inflows to the TFMCA from agricultural lands to the east will occur through two culvert structures (S-255 and S-256). A flood control overflow weir and a culvert structure will connect the TFMCA to the SJMCA near river mile 280. Near river mile 273, a weir

having a crest elevation of 19.0 ft NGVD will discharge from the TFMCA into the SJMCA. A culvert structure (S-257), having a discharge capacity of 200 cfs, will also discharge water from the TFMCA into the SJMCA. S-257 will provide low flow augmentation and allow for a smooth transition to low flow conditions immediately after flows over the weir cease.

2.8 C-54 Retention Area

The C-54 Retention Area consists of 3,870 acres located immediately north of the SJWMA (Figure 7). The C-54 Retention Area will be used to store water during flood events and thereby reduce fresh water releases to the Indian River Lagoon. Water will be released into the C-54 Retention Area through structure S-258. Discharges from the C-54 Retention Area to the TFMCA can occur via a 40,000 gallon-per-minute pump located in the northwest corner of the retention area.

The C-54 Retention Area was previously drained and used for agriculture. The area is leased to the Florida Game and Fresh Water Fish Commission for the development of an intensively-managed waterfowl habitat called the T. M. Goodwin Waterfowl Management Area. However, stormwater storage remains the primary purpose for this area.

2.9 C-1 Retention Area

North of the TFMCA is a separate 1,280 acre water management system named the C-1 Retention Area which will be constructed to provide flood storage and some in-system treatment of stormwater from the C-1 western diversion project (Figure 7). The C-1 western diversion project is proposed, in concept, to divert drainage within the Melbourne-Tillman Water Control District. Information on inflow-outflow structures to this area and how water levels will be managed is not yet available.

2.10 Sawgrass Lake Water Management Area (SLWMA)

The SLWMA is a 2,240 acre area downstream of the TFMCA which will also be used to help alleviate adverse impacts of stormwater discharges from the C-1 western diversion project to help control flooding in the Turkey Creek Basin (Figure 7). The SLWMA will receive discharge from the C-1 Retention Area and will discharge into the St. Johns River near Lake Hell'n Blazes. The SLWMA will function as a treatment marsh. As with the C-1 Retention Area, this portion of the project is still in the conceptual design phase and information on inflow-outflow structures is not yet available.

2.11 Jane Green Detention Area

The Jane Green Detention Area consists of approximately 22,000 acres located south of US 192 (Figure 2). The Jane Green Detention Area is currently managed by the Game and Fresh Water Fish Commission and is referred to as the Bull Creek Wildlife Management Area. Within the Jane Green Detention Area there are eight major habitat types: dry prairies, pine flatwoods, sand pine scrub, xeric hammocks, hardwood hammocks, freshwater marshes, cypress swamps, and hardwood swamps. Except during large storm events, when the structures will be closed, hydroperiods in the Jane Green Detention Area will reflect natural conditions.

The Jane Green Detention Area was designed to provide temporary detention of upland stormwater without causing significant environmental degradation to the system. Discharge from the Jane Green Detention Area occurs through structures S-161 and S-161A. Both structures will remain open during normal water flow and will only be operated under flood conditions. The gates of S-161 and 161A will be closed when the river stage at U. S. 192 reaches 19.5 ft NGVD and will be held closed until the flood peak passes downstream.

2.12 Taylor Creek Reservoir

Taylor Creek Reservoir (10,400 acres) is located 1.2 miles northwest of the State Road 419 bridge and is designed to provide water supply and flood detention benefits (Figure 2). The reservoir has been operational since 1969. Water levels in Taylor Creek Reservoir are regulated by structures S-164

and S-231. Under COEWCP design conditions, maximum discharges will occur from Taylor Creek Reservoir when water levels equal or exceed 39.0 ft NGVD during the wet season and 43.0 ft NGVD during the dry season . Since Taylor Creek reservoir is privately owned except for the discharge structures, and will be used as a water supply reservoir, a Zone B regulation schedule is not proposed.

3.0 ENVIRONMENTAL HYDROLOGIC CRITERIA

3.1 Ecosystem Description and Environmental Goals

The upper St. Johns River basin is a complex and diverse ecosystem comprised of a mosaic of interconnected habitat types including freshwater marsh, shallow lake, river channel, and upland. The wide diversity of habitats supports a myriad of plant and animal species, many of which are threatened or endangered. The ecology of the basin has been shaped primarily by topography, the subtropical climate, and seasonal rainfall patterns. Rainfall averages greater than 50 inches per year, and more than 60% of this yearly total generally falls during the five months from June to October (Lowe et al. 1984). In its pristine condition, the upper St. Johns River basin had nearly 400,000 acres of floodplain wetlands. In addition to providing important habitat for fish and wildlife, the extensive wetlands historically enhanced river water quality, attenuated downstream flood peaks by retaining stormwater, and stored water during dry periods.

Beginning in the early 1900's, large acreages of the upper basin were drained by ditching and diking to provide land for agricultural development. These activities not only reduced the number of wetlands acres directly, but greatly altered the natural hydrology by reducing water retention times and accelerating flows. By 1983, conversion to agricultural uses had reduced total floodplain acreage by over 60%. Impacts of wetland loss and altered hydrology on fish and wildlife resources were dramatic. Significant declines in game fish, waterfowl, and wading bird populations were documented throughout the basin (for a review see Lowe et al. 1984).

The environmental goal of the USJRBP is to restore and preserve where possible, the ecological integrity of this unique wetland\riverine ecosystem. The primary environmental objectives are to restore or preserve where possible the natural attributes of species diversity and abundance, community diversity, and productivity of economically important species. To achieve these objectives, efforts must focus on restoring the natural hydrologic regime. By creating a hydrologic regime which mimics the natural condition, optimum soil and vegetation characteristics will be maintained. This, in turn, will help

provide other environmental benefits such as enhanced fish and wildlife habitat and improved water quality.

3.2 Development of Environmental Hydrologic Criteria

The environmental hydrologic criteria are a series of hydrologic statistics that form the boundaries of a natural hydrologic regime. To meet environmental goals, these boundaries should not be exceeded. In this sense, the hydrologic criteria are best viewed as constraints.

To better define what constitutes the natural hydrologic regime, studies were conducted in the BCMCA to determine the relationship between hydrologic conditions and spatial vegetation patterns. These studies were conducted in the BCMCA because aerial photographs indicate vegetation communities have changed little in this area in the past 40 years, and because daily water elevations were available back to the year 1956. Results revealed that distributions of plant communities in the BCMCA reflected a gradient in long-term hydrologic conditions caused by topographic relief (Lowe 1983).

Initially, five hydrologic characteristics were identified as ecologically significant. These were: mean depth, inundation frequency, maximum depths, magnitude of water-level fluctuation, and timing of water level fluctuation. Using historical water level data, each of these hydrologic conditions were numerically described. Numerical values were further refined into the initial set of hydrologic criteria (or constraints), proposed to govern Zone B regulation (Brooks and Lowe 1984). Two additional conditions, water level recession rates, and minimum water levels for lakes, were later recognized as being important and were added to the list. The hydrologic criteria were reviewed and further refined through discussions between District staff and representatives of the Florida Game and Fresh Water Fish Commission, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers.

3.2.1 Critical Marsh Elevations

The range of elevations and marsh types in the upper St. Johns River basin make the development of a single set of numerical operational criteria for the entire project area unrealistic.

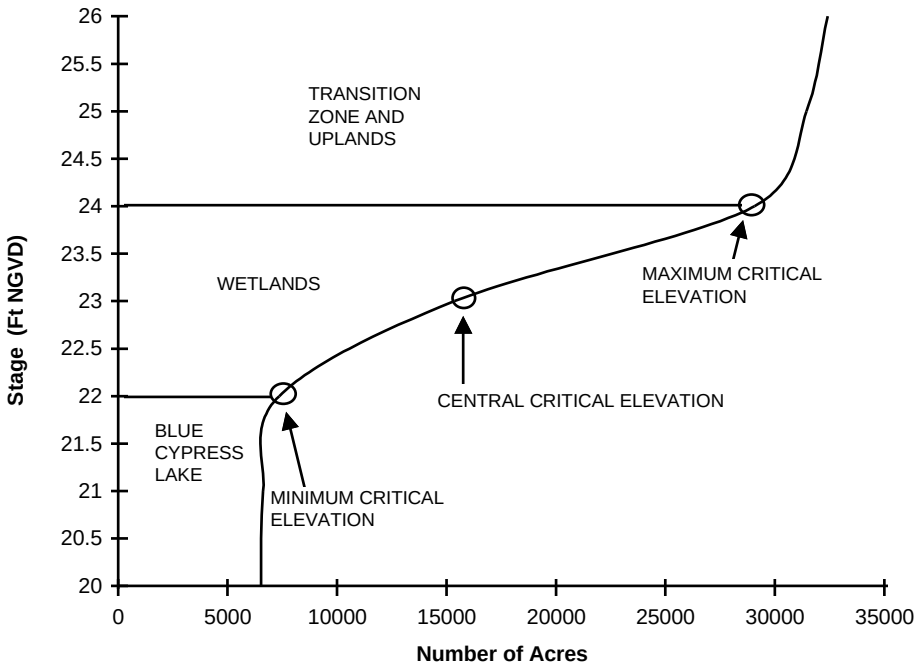

Figure 8. Stage-area curve for the BCMCA showing critical marsh elevations and their relationship to wetland acreage.

Therefore, criteria were developed relative to a set of critical elevations (minimum, maximum and central) determined specifically for each project area (Table 1). For the FDMCA and the BCMCA, minimum and maximum critical elevations are defined as those elevations which delimit the majority of wetland acreage present within each area and are derived from inflection points on the stage-area curves (Brooks and Lowe 1984; Figure 8). The central critical elevation corresponds to the arithmetic mean of these two values (Table 1).

In the SJMCA, where elevational gradients are more extreme, using overall stage-area curves was discovered to be inappropriate for determining critical elevations. Here the central critical elevation was assigned to the average ground elevation determined for individual river miles from wetted perimeter curves (Table 1). Maximum and minimum critical elevations for each river mile could not be calculated because the floodplain in this area is narrow, nearly flat, and bordered on each side by flood control levees.

Table 1. Critical Marsh elevations for the USJRBP.

	Critical Elevations (ft. NGVD)			
Project Area	*Central*	*Maximum*	*Minimum*	*Other Levels*
FDMCA	24.0	25.0	23.0	-[1]
BCMCA	23.0	24.0	22.0	20.0, 18.2, 17.7[2]
SJMCA-RM 281	21.4	-[1]	-[1]	-[1]
-RM 277	18.0	-[1]	-[1]	-[1]
-RM 272	16.0	-[1]	-[1]	-[1]
TFMCA	18.0	-[1]	17.5	16.5
BCWMA	24.0	-[1]	-[1]	23.5,23.0,22.5,22.0[3]
SJWMA	20.5	-[1]	-[1]	19.5, 19, 18.5[2]
SLWMA	Not Available	Not Available	Not Available	Not Available

[1] Not Applicable (See text for individual project area descriptions)
[2] Minimum levels for natural lakes
[3] Infrequent drydown levels for protecting snail kite habitat

For the TFMCA and the BCWMA, critical elevations have been assigned to reflect differing project area goals, such as maintenance of a viable sport fishery in the TFMCA or protecting endangered species in the BCWMA (Table 1). For the BCWMA, absolute lower limits for drydowns have been set. The specific hydrologic criteria and the rationale for their selection are presented in separate sections for each area.

3.2.2 Hydrologic Criteria for the FDMCA and the BCMCA

The environmental hydrologic criteria represent levels that should constrain long-term (30 years or greater) hydrologic conditions. A long-term perspective is needed to account for the natural stochastiscity that is inherent in the long-term hydrologic cycles to which the system has adapted. For example, unusually wet or unusually dry conditions have occurred naturally at infrequent intervals throughout time. Even though these more extreme events were infrequent, they were still important to determining overall community structure and function. By looking at long-term hydrologic data sets we can attempt to ensure that extreme events still occur at a natural frequency.

The environmental hydrologic criteria for these marsh conservation areas and the basis for their selection as ecologically important components of the natural hydrologic regime are:

1. MEAN DEPTH - The Long Term (30yr) Average Water Depth Should Be No Less Than The Central Critical Marsh Elevation.

The mean depth and inundation frequency of the central critical elevation should such that there will be no net loss of organic soils through oxidation. One of the ecological consequences of draining and developing upper basin wetlands has been a shift from deposition to oxidation of peat soils. The oxidation of exposed peat soils has caused ground elevations to subside over two feet in some areas (Brooks and Lowe 1984). Studies conducted in the Everglades have demonstrated that to prevent soil subsidence, a mean water table depth of not less than 0.25 feet below the ground surface must be maintained (Stephens 1974).

2. FREQUENCY OF INUNDATION - The Long Term Frequency Of Inundation For The Central Critical Marsh Elevation Should Be At Least 60%.

The mean depth criterion by itself may not be sufficient to prevent soil subsidence because the soil must be saturated for some minimum length of time within a typical year. In the work conducted in the Everglades, water depth was held constant. Where water level fluctuates, a frequency distribution of depths skewed toward the maxima could cause soil subsidence even though the mean depth was no lower than -0.25 feet. Soils have not subsided in the BCMCA, where based on historical stage data, the average inundation frequency of the central critical elevation is 60% (Lowe 1983; Brooks and Lowe 1984).

3. MAXIMUM ELEVATIONS (14, 30, AND 60 DAY)

14 DAY - The Water Elevation Should Not Exceed 4 Feet Above The Minimum Critical Marsh Elevation For More Than 14 Continuous Days More Frequently Than 1 Year Out Of 10.

30 DAY - The Water Elevation Should Not Exceed 3.5 Feet Above The Minimum Critical Marsh Elevation For More Than 30 Continuous Days More Frequently Than 1 Year Out Of 10.

60 DAY - The Water Elevation Should Not Exceed 2.5 Feet Above The Minimum Critical Marsh Elevation For More Than 60 Continuous Days More Frequently Than 1 Year Out Of 10.

These criteria were established to prevent extreme water depths from being maintained for long enough durations to cause significant damage to marsh plant communities occupying the lower critical elevations (Brooks and Lowe 1984). Plant tolerances to extreme water depths were established by analysis of historic stages relative to the distribution of the dominant plant species along an elevation gradient in the BCMCA (Lowe 1983).

4. MINIMUM RANGE OF YEARLY FLUCTUATION -

A) During At Least 25% Of The Years The Maximum Critical Marsh Elevation Should Be Inundated For At Least 30 Consecutive Days.

B) During 20% To 30% Of The Years The Minimum Critical Marsh Elevation Should Be Exposed For At Least 30 Consecutive Days,

C) The Long Term (30yr) Average Annual Water Level Fluctuation Should Be At Least The Distance Between 0.5 Feet Below The Minimum Critical Marsh Elevation And 0.5 Above The Maximum Critical Marsh Elevation.

Fluctuations in water level are critical to establishing and maintaining both spatial and temporal aspects of habitat heterogeneity in marsh ecosystems. Based on historical stage data, the average annual water level fluctuation in the BCMCA was 3.7 feet (Brooks and Lowe 1984). Water level fluctuations and their duration affect physical and chemical properties of wetlands such as nutrient availability, degree of substrate anoxia, sediment properties and pH (Mitsch and Gosselink 1986). These in turn directly impact the biotic components of the wetlands, such as plant species composition, diversity, and productivity. Even slight alterations in the hydrologic regimes of wetlands can cause massive changes in plant community dynamics. In addition, reproductive strategies of many wetland animals are dependent upon water fluctuation cycles. Nesting success of most species of wading birds is linked to dry season

drawdowns which concentrate fish and invertebrate food organisms (Kushlan et al. 1975; Kushlan 1976; De Sottele 1982; Bancroft et al. 1990).

5. TIMING OF FLUCTUATION -

A) Timing Of Fluctuation Should Be Such That Minimum Water Levels Occur Between April 1 And June 30 In More Than 50% Of The Years And Maximum Water Levels Occur Between September 1 And November 31 In More Than 50% Of The Years.

B) Minimum Yearly Water Levels Should Not Occur Between September 1 And October 31 Nor Should Maximum Yearly Water Levels Occur Between April 1 And May 31 With An Average Frequency Greater Than Once In 30 Years.

Temporal aspects of water level fluctuations are as important as the magnitude of the fluctuations themselves. For example, breeding cycles of many wading birds are timed to occur between the middle and the end of the dry season to coincide with the concentration of prey (Kushlan et al. 1975; Kushlan 1976; Frederick and Collopy 1989; Bancroft et al. 1990). Breeding cycles of alligators are timed so hatching generally occurs during the middle of the wet season, when food is most abundant (Fogarty 1974). The dry season is a major factor determining the species composition and abundance of fish communities in the Everglades (Loftus and Kushlan 1987).

6. WATER LEVEL RECESSION RATES - Water Level Recession Rates Should Not Exceed 1.2 Feet During Any 30 Day Period Nor Exceed 0.5 Feet During Any 7 Day Period When Stage Levels Are Less Than Or Equal To 1 Foot Above The Maximum Critical Marsh Elevation.

Water level recession rates can have a dramatic impact on wetland animal communities. Studies in the Everglades have documented a correlation between rate of recession during the spring and the number of wading birds nesting, and their overall nesting success (Kushlan et al. 1975; Frederick and Collopy 1989). Rapid recession rates also apparently initiated earlier nesting. Rapid recession rates can

have potentially detrimental impacts on aquatic biota by degrading water quality. Rapid recession rates which occurred during the late summer caused massive fish kills in the Kissimmee River Restoration Demonstration Project, when nearly 60% of the floodplain was drained over a period of three days (Toth et al. 1990).

7. <u>MINIMUM WATER LEVELS FOR NATURAL LAKES</u> - One-Day Minimum Water Levels Which:

A) Exclude Fish From The Littoral Zone (Zone Of Rooted Vegetation), Should Not Occur More Frequently Than Once Every 5 Years,

B) Cause Mean Lake Depth To Be Less Than 3 Feet, Should Not Occur More Frequently Than Once Every 50 Years,

C) Cause Mean Lake Depth To Be Less Than 2.5 Feet, Should Not Occur More Frequently Than Once Every 100 Years.

These criteria are necessary to prevent extreme drawdowns from occurring too frequently. Drawdowns can beneficially impact lake ecosystems by causing consolidation of organic sediments, increased sportfish production, increased invertebrate production, littoral zone habitat enhancement, and short-term control of nuisance vegetation (Greening and Doyon 1990). However, if drawdowns are extreme enough, oxygen depletion can occur and cause massive fish kills. Fish kills caused by low dissolved oxygen levels reduce species diversity and favor rough fish such as bowfin and gar, which are adapted to survive these conditions (Kushlan 1974; Loftus and Kushlan 1987). If fish kills occur frequently enough, these species will become dominant in those lakes. Several studies have documented that aquatic vegetation provides important cover, spawning, and nursery habitats for a number of game fish species (for a review see Janacek 1988) . If lake levels fall below the vegetated littoral zone too frequently, declines in reproductive success and increased predation could lead to long-term declines in game fish populations in these lakes (Durocher et al. 1984).

3.2.3 Hydrologic Criteria for the BCWMA

Managing wetlands to protect snail kite nesting habitat entails establishing a hydrologic regime which maintains a balance between prolonged hydroperiods, which are optimal for apple snail (*Pomacea paludosa*) populations (Kushlan 1975; Turner 1994), and periodic drydowns, which are essential to maintaining woody shrubs for nesting substrate (Bennetts et al. 1988; Toland 1991). Although additional information on the specific inundation frequencies of suitable kite foraging habitat are needed, available information suggests that to optimize nesting habitat, drydowns to a central marsh elevation should occur at least every three to four years and the marsh should not dry out more frequently than once every 1.6 to 1.7 years (Bennetts et al. 1988). To maximize nesting success it has been suggested that water depths of at least 1.5 ft should be maintained under nest sites during the breeding season (January to July; Sykes 1987; Toland 1991). Optimal foraging habitats for snail kites may have longer hydroperiods than optimal nesting habitats, although these habitats are not considered to be exclusive of each other. (R. Bennetts pers. comm.).

Table 2. Stage-area relationships (in acres) for the BCWMA. This table does not include Lake Miami Ranch which has an area of 2,850 acres lying below the 22.5 ft contour.

Elevation (ft NGVD)	Ansin West	Ansin East	Jewish Federation	Total	% of Total Acreage
22.0	8.1	64.8	12.2	85.1	1.2%
22.5	459.1	1572.0	151.3	2182.4	30.9%
23.0	1451.7	3429.4	463.6	5344.9	75.7%
23.5	1605.3	3806.6	850.9	6262.8	88.7%
24.0	1662.5	4029.8	896.8	6589.1	93.3%
24.5	1720.1	4113.5	928.9	6762.5	95.8%
25.0	1776.4	4194.5	951.7	6922.6	98.0%
25.5		4279.0	970.2	7025.7	99.5%
26.0			1007.1	7062.5	100.0%

The majority of marsh acreage in the BCWMA, excluding Lake Miami Ranch, lies between 22.0 and 23.5 ft NGVD (Table 2). In Lake Miami Ranch, the majority of acreage (approx. 2,000 acres) lies between 20.0 and 22.5 ft NGVD. An area which was important to snail kite nesting efforts in 1992 and

1993 is the Jewish Federation, which constitutes the easternmost acreage of BCWMA-East (Toland 1993). The majority of acreage in the Jewish Federation lies between 22.5 ft and 23.5 ft NGVD (Table 2).

The water management plan developed for the BCWMA will create a hydrology which has extended hydroperiods and infrequent drydowns below a central marsh ground elevation of 23.0 ft NGVD. The elevation of 23.0 ft NGVD was established as a lower critical limit based on documented kite use of the area in conjunction with analysis of stage-area curves and on-site visits by agency staff. A major concern was that drydowns below 23.0 ft NGVD could cause a rapid decline in the apple snail population. Apple snail populations generally remain low for approximately two years following an extreme drying event (U.S. Fish and Wildlife Service 1986; R. Bennetts pers. comm.). Extreme drydowns which occur with a greater return frequency than once every two years may have the potential to prevent apple snail populations from recovering and reaching population levels which will support snail kites.

The environmental hydrologic criteria for the BCWMA and the basis for their selection as ecologically important components of the natural hydrology are:

1. <u>MEAN WATER ELEVATION</u> - The Long Term (30yr) Average Water Elevation Should Be No Less Than 24.0 Ft NGVD.

A mean water level elevation criterion of 24.0 ft was established to provide extensive acreage of shallow, frequently inundated marsh. Water levels at 24.0 ft will inundate approximately 4,800 acres of the BCWMA to depths between 1.5 and 2.0 ft.

2. <u>FREQUENCY OF INUNDATION</u> - The Long Term Frequency Of Inundation For The 24.0 Ft NGVD Contour Should Be At Least 75%.

A frequency of inundation criterion was needed in conjunction with mean depth criteria to insure that strongly skewed or bimodal depth frequency distributions do not occur. An inundation frequency of 75% was chosen to ensure a prolonged hydrology for this elevation (R. Bennetts per. comm.).

3. MAXIMUM WATER ELEVATIONS - Water Elevations Should Not Exceed 26.0 Ft NGVD For More Than 30 Continuous Days More Frequently Than 1 Year Out Of 10.

Water levels at or above 26.0 ft NGVD, which occurred for an extended interval during 1991, were observed to severely stress many upland tree species in the eastern half of the BCWMA (B. Barnett; B. Toland per. comm.). Many of these trees were used by snail kites for nesting. In addition, water levels above 26.0 ft will violate flood control constraints established for the BCWMA.

4. MINIMUM RANGE OF ANNUAL DRYDOWNS -

A. A One-Day Low Water Elevation Of 23.0 Ft NGVD Should Not Occur More Frequently Than Once Every 2.5 Years Nor Less Frequently Than Once Every 4.5 Years.

This criterion was established to prevent more extreme drydowns from occurring too frequently but yet ensuring that occasionally drydowns to this level will occur. At a water elevation of 23.0 ft, approximately 1,700 acres in the BCWMA (excluding Lake Miami Ranch) will be dry. Approximately 3,162 acres will have water depths of 6 inches or less and 2,180 acres will have depths greater than 6 inches. This is expected to provide enough refugia to ensure adequate survival of apple snail populations through the dry season. The return frequency of 2.5 years and 4.5 years corresponds to the lower and upper limits of the optimal drydown intervals for maintaining snail kite nesting habitats (Bennetts et. al. 1988).

B. The 23.0 Ft NGVD Elevation Should Be Exposed For 30 Continuous Days At Least Once Every 5 To 7 Years.

This criterion will allow for occasional drydowns to 23.0 ft NGVD to occur for a sufficient duration to rejuvenate the exposed marsh habitat. Drydown durations of 30 days correspond to the estimated minimum exposure interval needed to allow for seed germination of many species of herbaceous vegetation such as sawgrass (Alexander 1971; Gerritsen and Greening 1989).

C. The 22.5 Ft NGVD Elevation Should Be Exposed For 30 Continuous Days Once Every 7 To 10 Years.

This criterion will allow for infrequent exposure of the majority of acreage in the BCWMA. This drydown will expose the majority of sawgrass and deep marsh habitat.

D. The 22.5 Ft NGVD Elevation Should Not Be Exposed For 60 Continuous Days More Frequently Than Once Every 10 Years.

This criterion will prevent more extensive drydowns from occurring for excessive durations.

E. The 22.0 Ft Ngvd Elevation Should Be Exposed For 30 Continuous Days Once Every 10 To 15 Years.

This drydown will allow for complete exposure of the BCWMA at infrequent intervals.

5. <u>TIMING OF FLUCTUATIONS</u> - Timing Of Annual Fluctuations Should Be Such That Minimum Levels Occur Between April 1 And June 30 In More Than 50% Of The Years And Maximum Levels Occur Between September 1 And November 31 In More Than 50% Of The Years.

This criterion re-establishes the natural wet-dry season cycle.

6. <u>WATER LEVEL RECESSION RATES</u> - Recession Rates When Stages Are Above 24.5 Ft Are Unregulated. When Water Levels Are At Or Below 24.5 Ft, Recession Rates Should Not Exceed 1.2 Feet During Any 30 Day Period Or Exceed 0.5 Feet During Any 7 Day Period.

7. MINIMUM WATER LEVELS - Water Levels Should Exceed 22.0 Ft Ngvd At Least 95% Of The Time. Water Levels Should Not Fall Below 20.0 Ft Ngvd.

To maintain the integrity of the sport fishery in Lake Miami Ranch, maximum depths should rarely fall below 2.5 ft (D. Cox, pers. comm., 1991). Below 22.0 ft NGVD, the lake will have approximately 600 acres with a depth of 2.5 ft or greater. If water levels fall to 20.0 ft, only a very small number of acres in the BCWMA will provide suitable game fish habitat and extensive fish kills are likely to occur.

3.2.4 Hydrologic Goals for the SJWMA

The SJWMA is a reservoir for which flood control, water quality, and water supply objectives precede habitat enhancement or preservation goals. Therefore, hydrologic criteria as outlined for other project areas were not developed for the SJWMA. Instead, hydrologic goals were developed which would preserve, to the greatest extent possible, the integrity of the quality largemouth bass fishery (Cox et al. 1991) which currently exists in the reservoir. It must be emphasized, however, that environmental goals may not be met by the water management strategies currently being developed to maximize the water quality benefits of the SJWMA.

The topography of the SJWMA is relatively flat with a mean elevation of approximately 16 ft NGVD. The SJWMA does not have a surrounding marsh. Hydrologic goals for the SJWMA are:

1. MEAN DEPTH - The Long Term (30yr) Average Water Depth Should Be No Less Than 20.5 Ft Ngvd.

A mean water elevation of 20.5 ft NGVD will allow for an average depth of 4.5 ft.

2. FREQUENCY OF INUNDATION - The Long Term Frequency Of Inundation For The 20.5 Ft Ngvd Contour Should Be At Least 60%.

3. MINIMUM WATER LEVELS -

A) Water Levels Should Not Fall Below 19.5 Ft Ngvd More Frequently Than Once Every 5 Years.

B) Water Levels Should Not Fall Below 19.0 Ft Ngvd More Frequently Than Once Every 10 Years.

This criteria will maintain a minimum depth at or greater than 3.0 ft, but still allow for infrequent extreme drawdowns to improve habitat quality.

C) Water Levels Should Not Fall Below 18.5 Ft Ngvd More Frequently Than Once Every 100 Years.

3.2.5 Hydrologic Criteria for the TFMCA

The TFMCA will be managed as a single project area. Because ground elevations in the TFMCA vary between 13.0 and 20.0 ft (Figure 9), the entire area cannot be restored to marsh . Deeper open-water habitat will be created in those areas which have experienced subsidence. In the deeper open-water habit, a significant sport-fishery is expected to develop. Water management activities in the TFMCA have been developed which are sensitive to the maintenance of this sport-fishery. Under the current plan, approximately 11,000 acres of open-water habitat and 3,000 acres of marsh will be created (Figure 9). To meet environmental objectives for the TFMCA, the following criteria were established:

1. MEAN DEPTH - The Long Term (30 Yr) Average Water Depth Should Be No Less Than 18.0 Ft Ngvd.

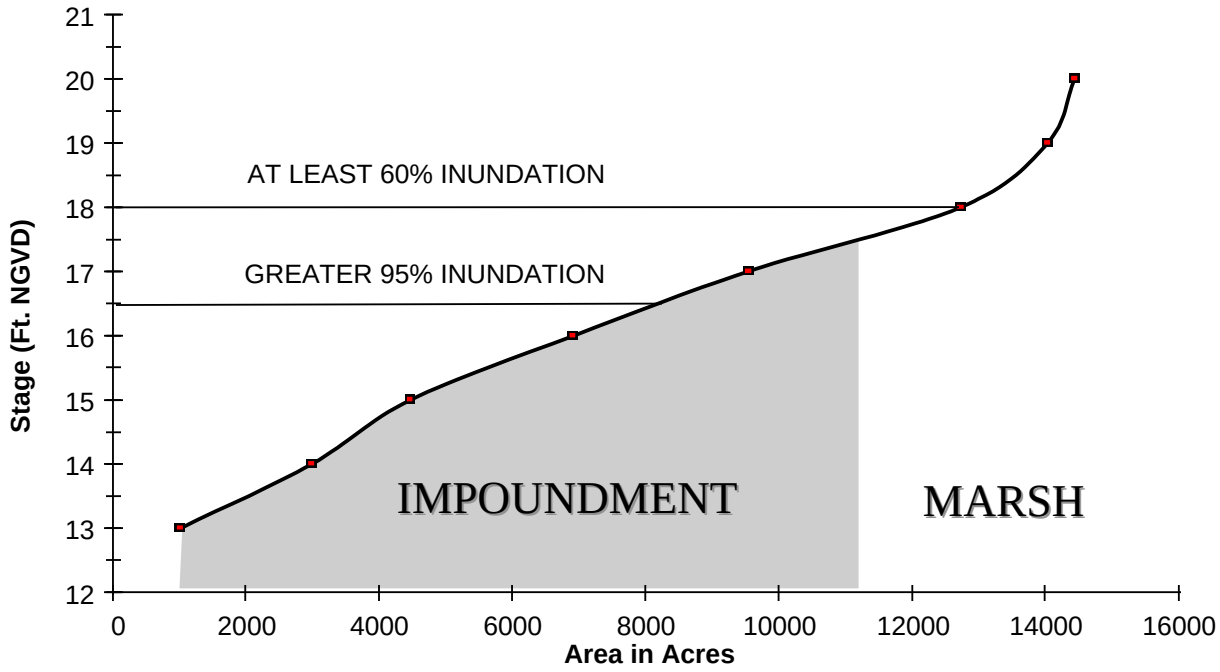

Figure 9. Stage-area curve for the TFMCA.

At a water elevation of 18.0 ft approximately 13,000 acres of the TFMCA will be inundated to an average depth of 3 ft. Approximately 5,000 acres of the area will have depths ranging between 3 ft and 5 ft. Herbaceous marsh should be restored over approximately 3,000 acres in the southern area of the TFMCA between the 17.5 ft and 18.5 ft elevations.

2. <u>FREQUENCY OF INUNDATION</u> - The Ground Elevation Of 18.0 Ft Ngvd Should Be Inundated At Least 60% Of The Time.

The ground elevation of 18.0 ft NGVD corresponds to the mean elevation of those areas in the TFMCA which are to be restored to wetlands. An inundation frequency exceeding 60% should prevent soil subsidence and ensure the mean water level of 18.0 ft is not attained from a strongly skewed inundation frequency curve.

3. <u>MINIMUM RANGE OF YEARLY FLUCTUATION</u> - The 17.5 Ft Ngvd Contour Should Be Exposed For At Least 30 Days In At Least 20% To 30% Of The Years.

This allows for the ecological benefits of drydown in those areas which will be restored to marsh.

4. <u>TIMING OF FLUCTUATION</u> - Timing Of Fluctuation Should Be Such That Minimum Water Levels Occur Between April 1 And June 30 In More Than 50% Of The Years And Maximum Water Levels Occur Between September 1 And November 31 In More Than 50% Of The Years.

This restores the natural seasonality of water level fluctuation.

5. <u>STAGE RECESSION RATES</u> - Stage Recession Rates Should Not Exceed 1.2 Feet During Any 30 Day Period Or Exceed 0.5 Feet During Any 7 Day Period When Stages Are Less Than 19.0 Ft Ngvd.

This prevents too rapid drainage of wetland areas.

6. <u>MINIMUM WATER LEVELS</u> - Water Levels Should Equal Or Exceed The 16.5 Ft Ngvd Elevation At Least 95% Of The Time.

To maintain the integrity of the reservoir, principally in terms of sport fishery resources, maximum depths should rarely fall below 3.5 ft.

3.2.6 Hydrologic Goals for the SLWMA

The SLWMA is still in the conceptual design phase and hydrologic goals have yet to be established.

3.2.7 Hydrologic Criteria for the Jane Green Detention Area

The Jane Green Detention Area is designed to provide temporary detention of upland stormwater. Hydroperiods in this area will reflect natural conditions, except during flood events.

Flooding imposes severe stress on many plants due mainly to the anoxic conditions which develop in the soil (Biagiotti-Griggs and Girardin 1980). To prevent deleterious effects of prolonged flooding on the forested riparian ecosystem the water management regulation schedule for this area reflects flood tolerances of the dominant tree species found area (Biagiotti-Griggs and Girardin 1980; Table 3).

Table 3. Maximum inundation schedule for the Jane Green Detention Area. Discharges will occur to ensure ground elevations in the area are not flooded for continuous intervals (days) which exceed those listed.

Ground Elevation (ft NGVD)	Maximum Flooding Duration (days) Allowed Between March 15 - October 31	Maximum Flooding Duration (days) Allowed Between November 1 - March 15.
35.0 - 45.0 ft	2	2
30.0 - 34.9 ft.	14	14
26.0 - 29.9 ft.	30	60
23.0 - 25.9 ft.	60	90
Less than 23.0 ft.	90	120

4.0 ZONE B WATER LEVEL REGULATION

Plans for regulating Zone B water levels were developed using simulated water level data generated by the Upper St Johns River Basin Hydrologic Model developed by the District (Suphunvorranop and Tai 1982). Simulated water levels were derived from historic rainfall records and calculated runoff. Hydrologic statistics, such as 30-year mean depth, were compared to the environmental criteria. If criteria were not met, projected regulation plans were altered and simulations performed again. Our goal was to assess hydrologic regimes for all project areas under COEWCP design conditions, and then to suggest adjustments to the regulation schedules for those areas where the environmental hydrologic criteria were not met.

Water management plans presented in this plan are based upon simulated hydrologic data derived from 48 years (1942 - 1989) of historic rainfall data. Because these data may not reflect future rainfall conditions and because of the degree of uncertainty inherent in this type of modeling effort, hydrologic model simulations may not accurately represent actual post-project hydrologic conditions. Therefore, these management plans may have to be modified if post-project monitoring indicates the environmental hydrologic criteria are not being met.

4.1 Zone B Water Level Regulation of the FDMCA

Hydrologic model simulations for the FDMCA revealed that under current discharge conditions , water levels in the FDMCA are predicted to be significantly higher than is desirable (Table 4). The Maximum Water Elevation criterion will be exceeded at least once every two years. In addition, the minimum critical elevation will only be exposed for 30 continuous days in only 2% of the years. To increase discharge from the FDMCA and lower water levels, a canal connecting the discharge structures will be constructed in 1996. Because of higher ground elevations to the north in the BCMCA, however, more extensive drydowns of the area may not be achieved. Extreme drydown events will be achieved by opening Structure S-252D which is also scheduled to be under construction in 1996. The operation

Table 4. Environmental hydrologic criteria-related performance summary for the FDMCA under current discharge conditions.

Criteria	Constraint Level	Simulated From 1942-1989 Data	Criteria Met?
Mean Water Level	24.0 ft	25.62	**Yes**
Freq. of Inundation	24.0 ft = 60%	95.8%	**Yes**
Maximum Water Elevations	More Than 1/10 Years Not To Exceed:	Occurred:	
14 day	27.0 ft	Once Every 2.0 Years	**No**
30 day	26.5 ft	Once Every 1.6 Years	**No**
60 day	25.5 ft	Once Every 1.1 Years	**No**
Minimum Range of Yearly Fluctuation	Continuous 30 day Levels Hi = 25.0 Lo = 23.0	Occurred in:	
High	25%	100% of years	**Yes**
Low	20% - 30%	2% of Years	**No**
Avg. Fluct.	2.0 ft	3.03 ft	**Yes**
Timing of Fluctuation	Occurs > 50% of Years	Occurred in:	
Minimum Levels	Apr 1 - Jun 30	81% of Years	**Yes**
Maximum Levels	Sep 1 - Nov 31	62% of Years	**Yes**
	More Than 1/30 Years Should **Not** Occur	Occurred:	
Minimum Levels	Sep 1 - Oct 31	0/48 Years	**Yes**
Maximum Levels	Apr 1 - May 31	1/48 Years	**Yes**
Recession Rates		Met Greater than:	
7 Day	< 0.5 ft	99.8% of time	**Yes**
30 Day	<1.2 ft	99.9 % of time	**Yes**

schedule for S252-D will be developed after the effects of the canal have been assessed.

4.2 Zone B Water Level Regulation of the BCMCA

Flood control discharges from the BCMCA through Structure S-96C are currently regulated by the following schedule. When water levels in the BCMCA exceed 25.0 ft, discharge through S-96C will be 1,500 cfs. If water levels in the BCMCA are above the regulation schedule but are below 25.0 ft (Figure 1), the discharge through S-96C will be 1,000 cfs.

To meet environmental objectives, 75 cfs will be discharged continuously from S-96C when water levels in the BCMCA are below the flood control schedule.

Table 5. Environmental hydrologic criteria-related performance summary for the BCMCA.

Criteria	Constraint Level	Simulated From 1942-1989 Data	Criteria Met?
Mean Water Level	23.0 ft	23.2	Yes
Freq. of Inundation	23.0 ft = 60%	63.0%	Yes
Maximum Water Elevations	More than 1/10 Years Not To Exceed:	Occurred:	
14 day	26.0 ft	Never Occurred	Yes
30 day	25.5 ft	Never Occurred	Yes
60 day	24.5 ft	Once Every 15.7 Years	Yes
Minimum Range of Yearly Fluctuation	Continuous 30 day at Hi=24.0; Low=22.0	Occurred in:	
Hi	At Least 25% of yrs.	25.5% of Years	Yes
Low	20% - 30% of Years.	72.3% of Years	Yes
Avg. Fluct.	3.0 ft	2.9 ft	Yes
Timing of Fluctuation	During > 50% of Years Occurred Between	Occurred in:	
One-Day Yearly Min.	Apr. 1 - June 30	72.9% of Years	Yes
One-Day Yearly Max.	Sept. 1 - Nov. 31	66.7% of Years	Yes
	Frequency < 1/30 Years		
	Apr. 1 - May 31	Occurred Once Every:	
One-Day Yearly Max.	Sept.1 - Nov. 31	Never Occurred	Yes
One-Day Yearly Min.		Never Occurred	Yes
Recession Rates	> Than 95% of Time	Met Greater than:	
7 Day	< 0.5 ft	99% of time	Yes
30 Day	<1.2 ft	96% of time	Yes
Minimum Water Levels for Blue Cypress Lake	Water Level Should Not Fall Below	1-day low during period = 19.2 ft	
1 out of 5 Year	20.0 ft	1 out of 12 years	Yes
1 out of 50 Year	18.2 ft	0 out of 47 years	Yes
1 out of 100 Year	17.7 ft	0 out of 47 years	Yes

This discharge for environmental purposes assumes that design discharge conditions through the S-250 structures are being met. Any deficiencies in design discharges through the S-250 structures will be corrected for by additional discharge through S-96C.

Under this discharge schedule all the environmental hydrologic criteria established for the BCMCA are met (Table 5). Figure 10 shows simulated mean monthly water levels for the BCMCA under a continuous 75 cfs discharge.

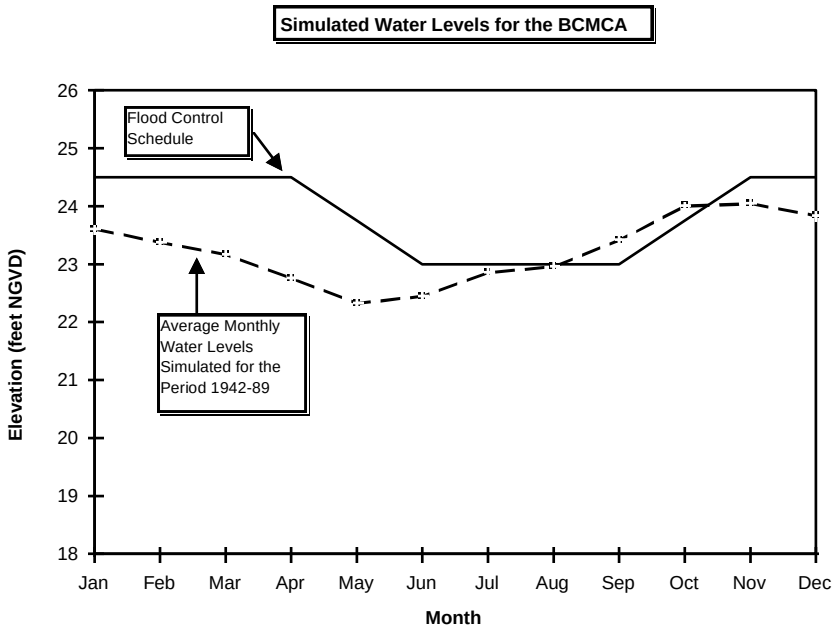

Figure 10 . Average monthly water levels simulated for the BCMCA under a continuous discharge of 75 cfs.

4.2.1 Hydrologic Simulations for the S. N. Knight Property

The S.N. Knight Property will be hydrologically reconnected to the BCMCA. Therefore, hydrologic conditions within S.N. Knight will mimic water levels within the BCMCA. Under the BCMCA regulation schedule, approximately 2,200 acres of S. N. Knight will be permanently impounded (Figure 10).

4.3 Zone B Water Level Regulation of the BCWMA

The flood control schedule for the BCWMA is presented in Figure 6. When water levels are below the flood control schedule the following water management plan will be implemented:

When water levels in the SJWMA reach 19.7 ft NGVD, 300 cfs will be discharged from the BCWMA through S-96D until such time that 1) water levels in the SJWMA reach or exceed 21.0 ft NGVD, or, 2) water levels in the BCWMA reach or fall below 23.2 ft NGVD.

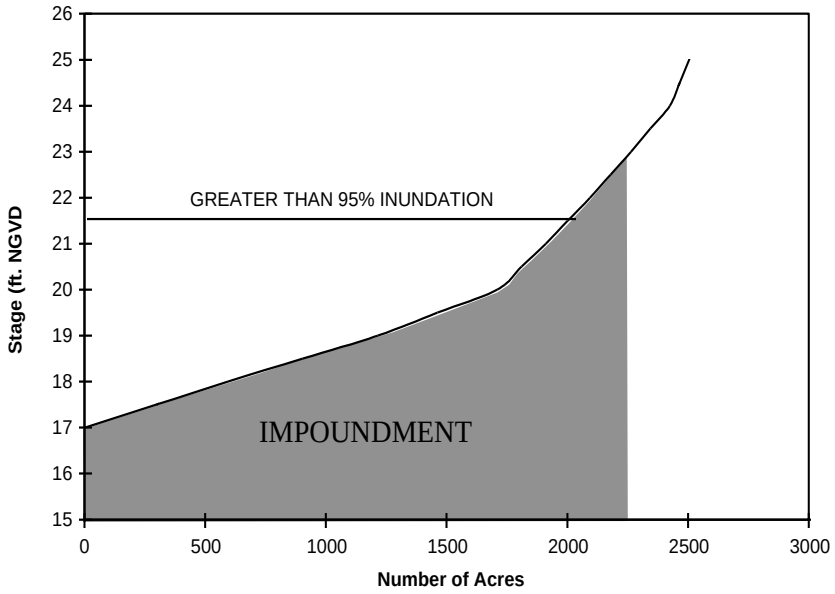

Figure 11. Stage-area curve for the S. N. Knight Property. Water levels in S. N. Knight will be the same as water levels in the BCMCA.

Water releases from the BCWMA were initiated based on water levels in the SJWMA in order to maintain natural stochastic variability in the hydrologic regime. Maintaining a regulation schedule based on water levels in the BCWMA alone would tend to stabilize water levels between allowable seasonal highs and lows. This water release schedule for the BCWMA will create prolonged hydroperiods with periodic drydowns which are optimal for snail kites (Table 6). However, the more extreme drydown events, which are essential to maintaining the habitat may not occur frequently enough (Table 6). For a more complete description of how the water management plan for the BCWMA was derived see Miller et al. (1995).

4.4 Zone B Water Level Regulation of the SJWMA

Discharges from the SJWMA will controlled entirely by the flood control schedule and there will not be any Zone B discharges for environmental purposes (Figure 6).

Table 6. Environmental hydrologic criteria-related performance summary for the BCWMA.

Criteria	Constraint Level	Simulated From 1942-1989 Data	Criteria Met?
Mean Water Level	24.0 ft	24.4	Yes
Freq. of Inundation	24.0 ft = 75%	74.0%	Yes
Maximum Water Elevation 30 Day	More than 1/10 Years Not To Exceed: 26.0 ft	Never Occurred	Yes
Range of Annual Drydowns		Occurred :	
1 Day	Down to 23.0 ft Once Every 2.5 to 4.5 Years.	Once Every 2.8 Years	Yes
30 Day (Continuous)	Down to 23.0 ft At Least Once Every 7 Years.	Once Every 3.1 Years	Yes
30 Day (Continuous)	Down to 22.5 ft At Least Once Every 10 Years.	Once Every 23.5 Years	No
30 Day (Continuous)	Down to 22.0 ft At Least Once Every 15 Years.	Never Occurred	No
60 Day (Continuous)	Should Not Go Down To 22.5 More Frequently Than Once Every 10 Years.	Once Every 47 Years	Yes
Timing of Fluctuation	During > 50% of Years Occurred Between	Occurred in:	
One-Day Yearly Min..	Apr. 1 - June 30	77.0% of Years	Yes
One-Day Yearly Max.	Sept. 1 - Nov. 31	60.0% of Years	Yes
Recession Rates	> Than 95% of Time	Met Greater than:	
7 Day	< 0.5 ft	99% of time	Yes
30 Day	<1.2 ft	96% of time	Yes

The environmental goal of maintaining hydrologic conditions which will support a quality sport fishery in the SJWMA are not met under this plan. The simulated mean water level was 21.56 ft NGVD and the 20.5 ft elevation (mean depth = 4.5 ft) was flooded 91% of the time. However, drydowns of the reservoir to elevations which cause the average depth to be less than 3.5 ft. occurred at least once every 3.4 years. Drydowns which caused the average depth to be 3.0 ft or 2.5 or less occurred once every 5.2 and 6.7 years, respectively. Extensive fish kills within the SJWMA are possible during these more extreme drydown events. These model results for the SJWMA should be viewed as preliminary because water levels in the SJWMA are highly dependent upon agricultural operations. Currently the SJRWMD

is updating the hydrologic model assumptions to more closely simulate actual agricultural withdrawals and discharges.

4.5 Zone B Water Level Regulation of the TFMCA

The TFMCA is not scheduled to be operational until 1999. Because of the recent creation of the C-1 Retention Area and modifications to the TFMCA the inflow and outflow structures to the TFMCA have not yet been designed. As soon as the design of these structures is complete, a water management schedule which meets the environmental hydrologic criteria which have been established for the TFMCA will be developed.

4.6 Zone B Water Level Regulation of the SJMCA

Water levels in the SJMCA cannot be predicted until the finalized design for the TFMCA is completed. Initial hydrologic evaluations indicated that the hydrologic criteria in both the TFMCA and the SJMCA would be met by maintaining a 50/50 split of the combined discharge from S-96B and S-96C. This 50/50 split is being used as a general target for meeting the environmental criteria. Any water management plan which is accepted for the TFMCA will have to also ensure that the environmental hydrologic criteria for the SJMCA are met.

4.7 C-54 Retention Area

Simulations predicting how frequently discharge into the C-54 Retention Area occurs have yet to be conducted. Discharge into the C-54 Retention Area will be ultimately affected by the discharge capabilities downstream of the SJWMA.

4.8 Sawgrass Lake Water Management Area

Water level management strategies have not yet been developed for this area.

4.9 Jane Green Detention Area

When water levels in the St. Johns River at U.S. 192 reach 19.5 ft NGVD, the gates of structure S-161A will be closed to retain flood water in the Jane Green Detention Area. Flood waters will continue to be retained until the flood peak passes downstream. Once water levels in the river start to recede, S-161A will be re-opened gradually. Water will be released as gradually as possible without causing the flood duration curves developed for this area to be exceeded (Table 3).

4.10 Taylor Creek Reservoir

Water control strategies sensitive to downstream ecosystem needs have not yet been developed. In the interim when discharge is necessary, S-164 will be opened in increments not to exceed 50 cfs at 24-hour intervals except during storm emergencies. Decreases in discharge from S-164 will occur at intervals not to exceed 100 cfs per 24 hours.

5.0 PROJECT MONITORING

To ensure that the environmental goals of the USJRBP are being met, a program to monitor both biological and hydrologic responses will be implemented. It is critical that the impacts of the project be closely monitored. Without such an effort it will be unclear whether project goals are being achieved; more importantly it is unlikely that problems will be recognized in sufficient time to correct them. Monitoring will include programs to evaluate water quality, floristic and faunistic changes, hydrologic conditions, and impacts on endangered species.

Monitoring may indicate that additional criteria are needed or that the current criteria need modification. In addition, modifications in the critical elevations for project areas may be necessary. For example, in some areas of the SJMCA the critical elevations occupy a very narrow range of elevations. If the hydrologic criteria are not being met at any of these sites, it may reflect slight inaccuracies in the assigned critical elevations, rather than problems with the hydrologic regimes. A comprehensive project monitoring network will provide important information to further refine the hydrologic criteria. In addition, this type of information will be important to further developing and refining the hydrologic models used to predict the impacts of operational modifications on basin hydrology.

6.0 MODIFICATIONS TO ZONE B WATER MANAGEMENT

It is probable that some environmental needs for water management will not be met by the long-term environmental criteria. At times, water levels may need to be manipulated within Zone B to manage short-term unanticipated problems. Two decision frameworks have been developed which anticipate the general types of problems that may arise, identify priorities, and provide appropriate methods of response. The principal agencies involved in these decisions are the St. Johns River Water Management District, the U.S. Army Corps of Engineers, the Florida Game and Fresh Water Fish Commission, and the U.S. Fish and Wildlife Service. Other agencies will be consulted as appropriate.

6.1 Emergency Events

Decisions in the case of emergency events, such as a chemical spills, fish or bird kills of any type, or sudden threat to an endangered species, will be handled as described below (Figure 12):

I). The event must be verified. The event is considered unverified if it has not yet been observed by agency personnel. Networking with key agencies should begin upon notification, regardless of whether or not the event is verified. The notified agency should network with other key agencies to coordinate field verification and an initial assessment. Key agencies are those which need to be initially involved. For example, a fish kill in the SJWMA would directly involve the District and the Game Commission but not necessarily the U.S. Fish and Wildlife Service.

II). Once an event has been verified, an analysis of the event will be conducted to determine if alterations in the regulation schedule can remedy or mitigate the impacts. Suggested alterations in the regulation schedules will be reviewed with all agencies. An attempt will be made to reach consensus with all agencies on the appropriate plan of action. If an agreement cannot be reached, the District will retain the authority to select the schedule alteration to be considered.

III). Once a plan of action is selected, the District will determine the technical feasibility of implementing the change with regard to hydrology and engineering constraints.

IV). If the change is technically feasible and will not violate flood control constraints, the District will examine potential impacts of the change with regard to water supply, environment, and water quality. All positive or negative impacts of the proposed change will be evaluated against the potential consequences of taking no action.

V). If the proposed schedule change is technically feasible and environmentally sound and if all agencies are in agreement, official notifications will be made and the change implemented. If an inter-

EMERGENCY ACTIONS

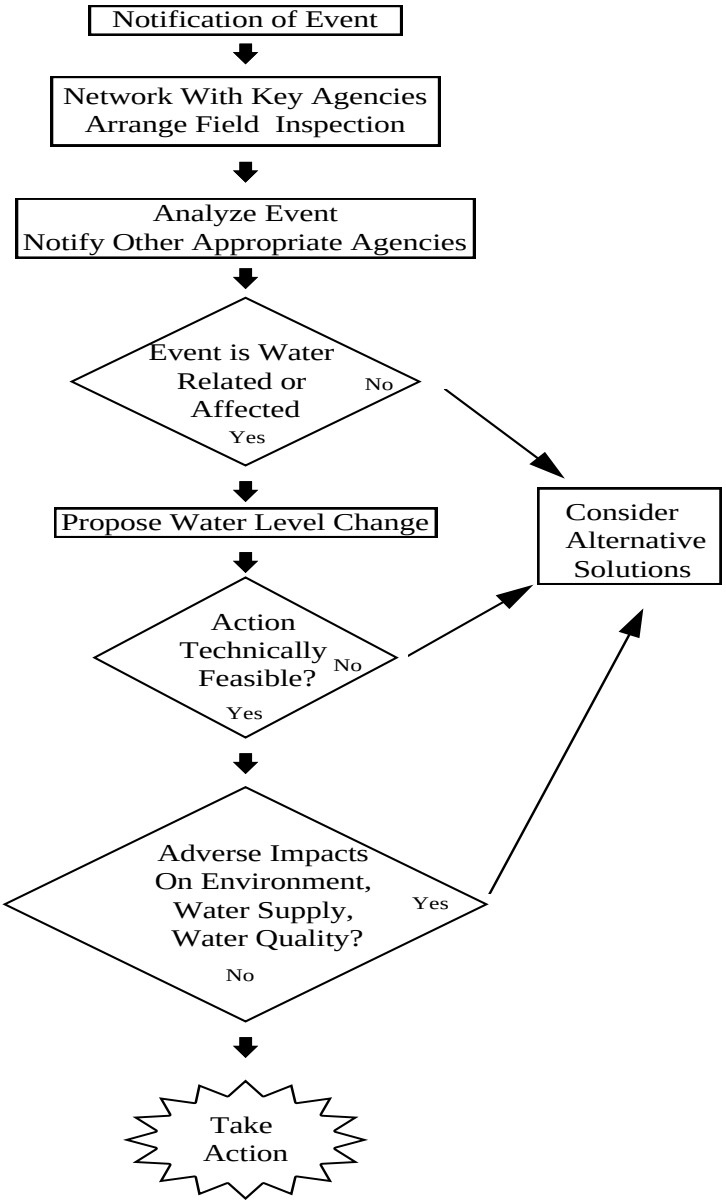

Figure 12. Decision tree for implementing emergency water level management actions.

agency agreement cannot be reached, the District will retain the authority to implement or not implement the regulation change.

6.2 Non-Emergency Actions

Decisions concerning water level management actions which are not an emergency will be made using this framework (Figure 13).

I). The agency proposing a Zone B schedule change will present to all involved agencies information which illustrates the need for the requested action. Information will also be presented which shows how the proposed change will accomplish stated goals.

II). If there is agreement as to the proposed schedule change, the District will determine the technical feasibility of implementing the change. The District retains the authority to reject proposed changes if they are not logistically or technically feasible.

III). If a regulation schedule change is technically feasible, will not violate flood control constraints, and is generally agreed upon by all the agencies consulted, the District will examine potential impacts of the change with regard to water supply, environment, and water quality. Positive or negative impacts of the proposed change will be evaluated against the potential consequences of taking no action.

IV). If the proposed schedule change is found to technically feasible and biologically sound and agencies are in agreement of the benefits of the change, official notifications will be made and the change implemented. If inter-agency agreement cannot be reached, the District will retain the authority to implement or not implement the regulation change.

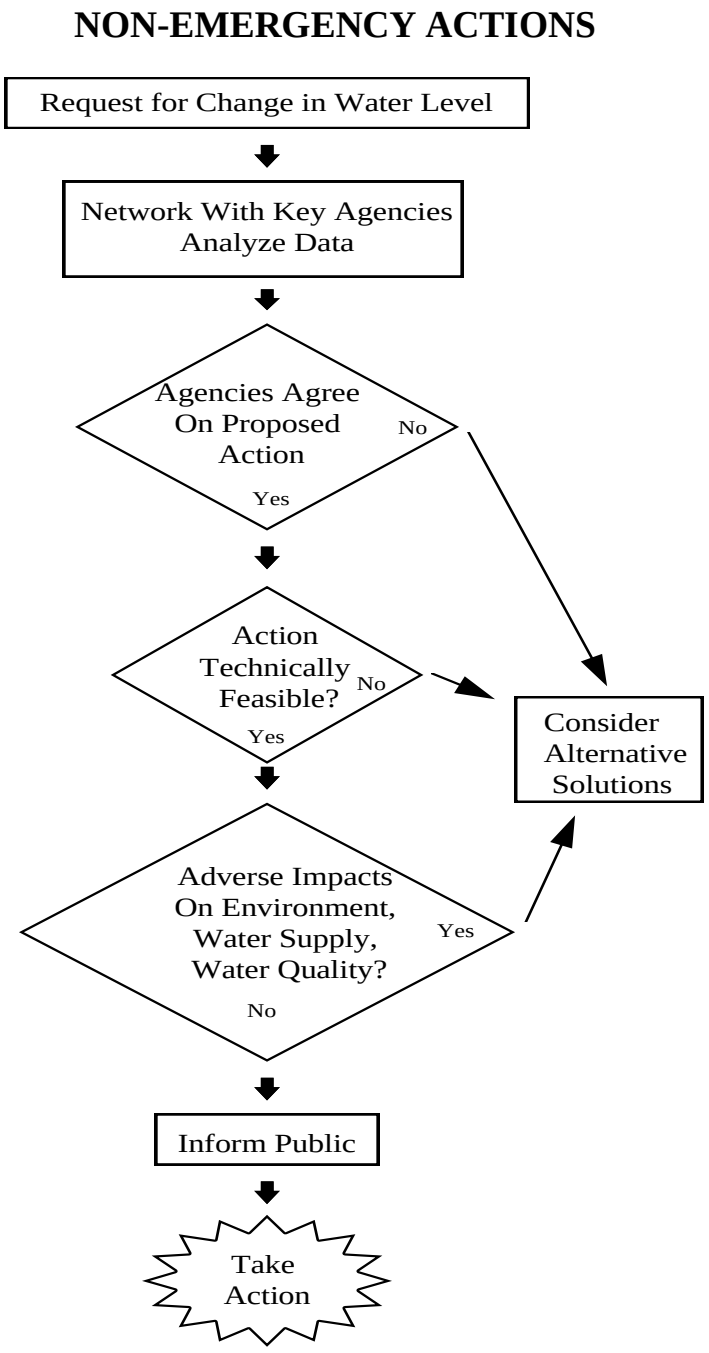

Figure 13. Decision tree for altering long-term water level management plans.

7.0 ADDITIONAL CONSIDERATIONS

7.1 Interim Conditions

Construction of the USJRBP is scheduled to be completed around the year 2000. During construction it may not be possible to operate completely within environmental constraints or decision-tree frameworks. When necessary, Zone B management will have to take into consideration construction needs, interim conveyance problems, and environmental needs.

Until the completion of the TFMCA, there is a plan in place for augmentation of Lake Washington during emergency low-flow conditions (lake levels below 12.0 ft NGVD). This would be accomplished by constructing a culvert through canal plug E-8 in the C-40 Canal. The culvert would not be operated unless the lake elevation drops to 11.6 ft NGVD and water quality in the C-40 Canal is no poorer than that in Lake Washington.

7.2 Restoration of District-Owned Lands

When the USJRBP is complete, over 40,000 acres of previously diked and drained land will be restored to marsh ecosystem. Most of this land was used for agriculture and has experienced various degrees of subsidence. Eventually, water levels in areas scheduled for restoration will be regulated by the environmental criteria developed for the project area into which they have been incorporated. However, a phased restoration process for these areas may involve short-term manipulation of water levels that do not reflect the established criteria. For example, before areas are extensively flooded it is important that desirable wetland plant communities become established. This may be accomplished by maintaining water levels at, or just below the soil surface, to enhance germination of certain wetland plant species. Restoration plans which detail the hydrologic needs will be written for each restoration site by the District.

8.0 AMENDING THE WATER MANAGEMENT PLAN

8.1 Modification of COEWCP Regulation Schedules

Modifications to the regulation schedules outlined in the COEWCP may become necessary if the environmental objectives of the project are not being met. Contact concerning proposed modifications will be initiated with the U. S. Army Corps of Engineers through the office of the Chief, Water Management and Meteorology Section, Hydrology and Hydraulics Branch, Engineering Division. Proposed schedule modifications will not be permitted if flood control constraints will be violated. Changes in project purposes and the regulation of project areas must be coordinated through other involved federal and state agencies as well as the Corps of Engineers. These agencies include the U. S. Fish and Wildlife Service, the U. S. Environmental Protection Agency, the U. S. Geological Survey, the Florida Department of Environmental Regulation, and the Florida Game and Fresh Water Fish Commission.

8.2 Modification of Zone B Regulation Schedules

The District will monitor the biologic and hydrologic responses to the Zone B regulation schedules presented in this plan. If the hydrologic responses are not as expected, modification of the Zone B regulation schedules will be implemented. Any proposed changes in Zone B regulation schedules will necessitate further simulation modeling to determine the effects of the proposals on hydrologic conditions throughout the project. The principal coordinating agencies: U.S. Army Corps of Engineers, the Florida Game and Fresh Water Fish Commission, and the U.S. Fish and Wildlife Service, and any others as appropriate, will be notified of the schedule changes in advance. All proposed changes must be approved by the District Governing Board. Changes cannot be made, except according to the procedures described in Sec 8.1 above, if they result in violation of the flood control regulation schedule.

8.3 Modification of Environmental Hydrologic Criteria

If the hydrologic criteria are met but biological responses are not as expected, there may be a need to add to or modify the hydrologic criteria. Any proposed changes of this type will be reviewed by District staff, and all involved agencies will be consulted. Changes of this type are considered to be changes in the U.S. Army Corps of Engineers Water Control Plan and will be coordinated as described in Sec. 8.1 above. These changes must also be approved by the District Governing Board.

An addition to the environmental criteria being considered is a rate of water level increase criterion. Rapid water level increases have been associated with declining dissolved oxygen levels and fish kills. The ecological effects of water level rise need to be investigated further before a specific criterion can be proposed.

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