CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDICES
to the
DRAFT INTEGRATED PROJECT MODIFICATION REPORT AND SUPPLEMENT TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

US Army Corps of Engineers
Jacksonville District
South Atlantic Division

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LIST OF APPENDICES

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX A

HYDROLOGY AND HYDRAULICS ANALYSES

Appendix A
Hydrology and Hydraulic Analyses

Table of Contents

Appendix A
Hydrology and Hydraulic Analyses

TABLES

PHOTOS

FIGURES

PLATES

Appendix A
Hydrologic and Hydraulic Analyses

1. Forward. This analysis updates and expands on the hydrologic models, operating criteria, and engineering requirements for the hydrologic and hydraulic analyses presented in the U.S. Army Corps of Engineers' (Corps) 1991 Feasibility Report on the Kissimmee River Restoration. The current study offers the initial opportunity in which the entire Middle and Lower Kissimmee basins could be analyzed as a fully-integrated hydraulic system with the Corp's one-dimensional unsteady flow routing model, UNET. UNET provides the analytical tool for designing the structural modifications (i.e., enlarged canals, increasing structural capacity) necessary to maintain existing flood control criteria upstream of S-65 for the recommended Section 1135 project. The analysis also utilizes a modified version of the South Florida Water Management District (SFWMD) period of record routing model, UKISS, to analyze and evaluate a multitude of proposed regulation schedules for Lake Kissimmee. The intent of the schedule optimization is to develop an operational scheme which primarily reestablishes historical flow characteristics to the Kissimmee River for restoration purposes, while at the same time providing increased environmental benefits to the Kissimmee chain of lakes because of a wider and more natural fluctuation of water stages. Because of the capabilities of the UKISS and UNET models, the current study also allowed flood control features to be designed through a coincident frequency approach whereby flood stages are considered to result from the joint probabilities of starting water surface elevation and rainfall frequency. The joint probability approach provided a more statistical basis for the flood control project and resulted in the design optimization and cost reduction of certain project features.

Previously, SFWMD and the Corps prepared Kissimmee River Restoration feasibility reports in 1990 and 1991 which used the hydrologic analyses produced by the Corps' 1985 Survey Report on the Kissimmee River. Both reports used the Corps' runoff hydrograph model (HEC-1) and routing model (CHANOP) for the upper basin down to the outlet of Lake Kissimmee. Below the outlet, a dynamic wave routing model (DWOPER) was used to simulate the restoration plan for the Kissimmee River. The CHANOP model is better suited for simulating the closely regulated existing Kissimmee River project and was used for the lower basin existing conditions.

In the 1990 and 1991 flood analyses of the recommended restoration plan, the assumed starting water surface elevation of Lake Kissimmee was raised to

52.5 feet, National Geodetic Vertical Datum of 1929 (NGVD)[1], rather than the 51.0 feet used in the 1985 report. These elevations represent the top of the Lake Kissimmee regulation schedule for the assumed 1 September flood date. This is an integral part of the new plan to re-regulate lakes in the upper basin and to extend the hydroperiod of the Kissimmee River. To offset the increase in flood stages on Lake Kissimmee, the plan also calls for an increase in the maximum early regulatory release from Lake Kissimmee from 3,000 cubic-feet-per-second (cfs) to 6,000 cfs.

Although this analysis is also predicated on raising the Lake Kissimmee regulation schedule by 1.5 feet, the starting water surface elevations (SWSEL) for flood events are not necessarily assumed be at the top of the seasonal lake regulation schedule but instead vary according to the stage-duration relationship generated by the UKISS period of record routing model. Since the UKISS routings indicate that lake levels only reach the top of schedule a relatively small percentage of the time, resultant flood stages for a given rainfall frequency based on the joint probability approach will be correspondingly lower than the top of regulation case. Although the growing acceptance of statistical and risk-based hydrology within the Corps provide credibility to the joint-probability approach, the results of the analyses are intrinsically linked to the specific regulation schedule. Conversely, a top of regulation approach provides the flexibility of making future adjustments within the schedule without further analyses since the most extreme condition (i.e., SWSEL of 51.0 or 52.5 feet) has already been verified.

Storm frequency in this appendix is shown as return period. Actual statistical analyses and flood risks are defined by exceedence probabilities of 0.2, 0.1, 0.04, 0.02, and 0.01 which represent return periods of 5-, 10-, 25-, 50-, and 100-year. The Standard Project Storm (SPS) and resultant Standard Project Flood (SPF) is defined as the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical area.

2. Hydrologic History.

a. First Survey. Historical information on the Kissimmee River basin dates back to the Seminole Indian Wars which ended in 1858. Forts Kissimmee and Bassinger were constructed along the Kissimmee River, Fort Gardner between Lake Kissimmee and Lake Hatchineha, and Fort Davenport near the Polk-Osceola County line where it crosses Reedy Creek. The first Survey of the

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[1] All elevations in this appendix are referenced to NGVD.

Kissimmee River was made by Lt. H. Benson of the Second Artillery, by direction of Col. H. Brown, commander of troops on the Caloosahatchee River; it was dated June 7, 1885. The survey gave the depths at different points along the river as well as tree growth. Lt. Benson wrote, "in my opinion a boat more than 60 to 70 feet in length drawing more than three feet of water could not go up the river, on account of the short bends, strong current and narrow channel".

b. Hamilton Disston. The area began to populate after the Civil War when settlers began moving into the Kissimmee basin. On July 20, 1881, Hamilton Disston and associates incorporated as the Atlantic and Gulf Coast Canal and Okeechobee Land Company. Four dredges were built by the company. One worked entirely on connecting Lake Okeechobee to the Gulf of Mexico through the Caloosahatchee River. The others worked from Lake Tohopekaliga to Lake Okeechobee. By August 1884, Disston's company had established a navigable waterway linking Lake Tohopekaliga with the Gulf of Mexico. East Lake Tohopekaliga was connected to Lake Tohopekaliga in 1884. However, the channel was little more than a ditch; navigable only by small boats. That year, the report of the State Engineer, H.S. Duval, stated that over two million acres had been permanently drained. Lake Tohopekaliga is reported to have dropped three feet in the first 30 days after Southport Canal was completed to Lake Cypress.

c. Navigation Study. Navigation began to flourish and dredging continued to tap into new headwater lakes. In 1888, dredging began from Lake Tohopekaliga up the east chain of lakes. Although the Kissimmee River had been dredged, the discharge capacity was still very small. The additional runoff from the new drainage area is likely to have held the river abnormally high for many years. Drainage works ceased in the early 1890's and the water table in the upper lakes basin began to stabilize at a lower level. The groundwater levels in the upper basin also stabilized and runoff to the Kissimmee River slowed. As discharge in the river slowed during the dry season, stages in the river began to fall to pre-dredging depths, and navigation was impacted. The navigation problem was probably not so much a lack of depth; but a lack of additional runoff created by upland drainage. These low water problems provided the impetus for the federal navigation survey study of the Kissimmee River in March 1901. This Survey provides us with the earliest record of water level elevation in the Kissimmee basin.

d. Higher Water Levels. The 1901 Survey shows the Kissimmee River and its headwater lakes at much higher stages than those recorded in recent history. Lakes Tohopekaliga, Cypress, Hatchineha, and Kissimmee were measured at stages of 63.82, 62.01, 60.86, and 58.84 feet NGVD, respectively, which are appreciably higher than the current wet season regulation schedule stages of 53.5, 51.0, 51.0 and 51.0 feet, respectively. However, the depths and sizes of the lakes found during the 1901 Survey were only slightly greater when compared to those found today.

3. Basin Description.

a. Location. The area under consideration is located in central Florida; it includes most of Osceola and Okeechobee Counties and parts of Orange, Polk, and Highlands Counties. It is bounded on the north by the lakes of the Orlando area, on the west by the Peace River watershed, on the south by Lake Okeechobee and the Indian Prairie-Harney Pond Canals area, and on the east by the upper St. Johns River Basin. The Kissimmee River is crossed from east to west by United States Highway 98, CSX Transportation Railroad (CSXT), State Road 70, and by State Road 60 near the outlet of Lake Kissimmee.

b. Kissimmee Basin. The entire Kissimmee River Basin comprises 3,013 square miles. The Lake Istokpoga area (622 sq. miles), lower Kissimmee River Basin (758 sq. miles), and the Upper Kissimmee Basin (1633 sq. miles) make up the principle divisions in the watershed. For description, the Upper Basin is subdivided into the East and West chains of lakes (732 sq. miles) and the Middle Lakes Basin (901 sq. miles). Lakes Kissimmee, Hatchineha, and Cypress were originally the principal source of the Kissimmee River but channel and drainage development work connecting the headwater lakes in the upper basin now place the source just south of Orlando. The watershed is about 105 miles long and has a maximum width of 35 miles. Elevations range from about 100 feet in the headwaters, and in excess of 200 feet in the high sandy ridge along the westerly boundary, to about 15 feet near Lake Okeechobee. Characteristics of the major subdivisions of the watershed are discussed in the following paragraphs.

c. East and West Chains of Lakes. The major lakes in the east and west chains are Gentry, Alligator, Preston, Mary Jane, Hart, East Tohopekaliga, and Tohopekaliga. Together with several minor lakes, they have a total surface area at normal stages of 70 square miles, or about 10 percent of the drainage area of the east and west chains. The flow divides generally in Alligator Lake. Northward flow is to Lake Mary Jane, thence south through Lakes Hart, East Tohopekaliga, and Tohopekaliga, thence to Cypress Lake; southward flow is through Lake Gentry and thence to Cypress Lake by way of Canoe Creek (C-34). A low, flat divide just east of Lake Mary Jane separates the Kissimmee River and upper St. Johns River watersheds. Overflow from the Kissimmee River Basin to the upper St. Johns River watershed once occurred during extreme high water. Boggy Creek, draining an area of about 77 square miles, discharges into East Lake Tohopekaliga. Shingle Creek, with a drainage area of 199 square miles, discharges directly into Lake Tohopekaliga.

d. Middle Lakes Basin. The principal lakes of the Middle Lakes Basin are Cypress, Hatchineha, Kissimmee, Tiger, Rosalie, Weohyakapka, and Marian. The combined surface area of those lakes plus that of several minor lakes is about 132 square miles, or about 15 percent of the total middle Kissimmee River drainage area. Lake Kissimmee is the most important and largest of the lakes in the Kissimmee River Basin, with a surface area of 55.5 square miles at the normal stage of about 51 feet. It is the southernmost storage area of the upper Kissimmee River watershed, collecting the inflow from 1,633 square miles of area before discharging into Kissimmee River. Cypress Lake, the collector lake for inflow from the east and west chains of lakes, discharges to Lake Kissimmee by way of Cypress-Hatchineha Canal (C-36), Lake Hatchineha, and Hatchineha-Kissimmee Canal (C-37). The average daily discharge from Lake Kissimmee for the period of gage record prior to the C-38 project was 1,180 cfs. The maximum daily outflow during the period of known record (c. 1928) was 8,820 cfs, which occurred during the 1948 flood. Elevations in the Middle Lakes Basin range from as high as 200 feet on the sandy ridge west of Lake Pierce (near the city of Lake Wales) to about 58 feet around Lake Kissimmee. Several important lakes in the Middle Lakes Basin are not in the main chain of lakes, but are tributary to it.

Lakes Marion and Pierce are both tributary to Lake Hatchineha from the west. Lake Marion has an outlet on its north side by way of Lake Marion Creek, which flows southeasterly about 8 miles to the northwest corner of Lake Hatchineha. Flow from Lake Pierce enters the southwest side of Lake Hatchineha by way of Catfish Creek, which flows about seven miles east and northeast from Lake Pierce. In the area west of Lake Kissimmee, Lakes Weohyakapka, Rosalie, and Tiger form a secondary chain of lakes which discharge generally north and east to Lake Kissimmee. Lake Marian (not to be confused with the Lake Marion that is tributary to Lake Hatchineha, mentioned above) and Lake Jackson discharge into the east side of Lake Kissimmee through Jackson Canal. Reedy Creek, which discharges into both Lakes Cypress and Hatchineha, is the largest tributary, with a drainage area of 207 square miles.

e. Lower Kissimmee River Basin. Excluding the Lake Istokpoga area, the Kissimmee River between the outlet of Lake Kissimmee and Lake Okeechobee has a drainage area of 758 square miles. The easterly divide separating that basin from the upper St. Johns River Basin is low and poorly defined, with elevations up to 75 feet. For the most part, the westerly divide is a well-defined ridge with elevations ranging up to 130 feet. The old river channel meandered extremely. The straight-line distance between Lakes Kissimmee and Okeechobee is 52 miles but the old river channel distance was about 100 miles, with a total fall of about 36 feet. The maximum observed discharge at the lower mouth of the Kissimmee River occurred in October 1953 when the discharge reached a peak of 17,800 cfs resulting in a stage of 27.0 feet at the State Road 70 Bridge. A peak flow of 17,400 cfs was observed during the 1948 flood with about 2,000 cfs of the total coming from the Lake Istokpoga area. The flood of August 1928 (prior to gage records), which resulted from a hurricane, caused the river to discharge an estimated 20,000 cfs and rise to elevation 29.0 feet at State Road 70 bridge near Okeechobee.

4. Historical Flooding.

a. General. Rainfall records, dating back to 1871 for the Kissimmee River basin and the adjoining St. Johns River Basin, document the repeated incidents of major storms and the extended periods of inundation associated with these storms. Since construction of C-38 began in the mid-1960's, only the 1969 storm has produced flooding. A discussion of the more severe floods follows:

b. Flood of 1945. Flooding of lengthy durations resulted from a hurricane that struck South Florida on September 15, 1945. The Kissimmee River Basin received average rainfalls of eight inches when the hurricane traveled northward through the center of the State. Because the area was already saturated from prior rains, areas of the Kissimmee basin experienced flooding for as long as eight months. The Reedy Creek tributary area was inundated for about three months, as well as tracts of fringe lands adjacent to the basin. The lower Kissimmee River Basin was flooded for most of the year. The peak outflow from Lake Kissimmee was 6,130 cfs and the peak stage of the lake reached 56.0 feet.

c. Flood of 1947. Flooding that occurred during 1947 was the most damaging of all recorded floods within the Kissimmee River Basin. About 250,000 acres were subjected to flooding of lengthy durations. An unusually wet summer followed by two hurricanes occurring on September 17, 1947 and October 12, 1947, caused the areas of the upper chains of lakes to flood for three months. The central valley, located between Lakes Cypress and Kissimmee, was inundated for about eight months. The peak outlet discharge from Lake Kissimmee reached 6,870 cfs at a peak stage in the lake of 56.9 feet.

d. Flood of 1953. Rainfall that was recorded during this time was one of the heaviest of any flood on record. An average rainfall of 46.8 inches occurred from June to October 1953. On October 9, 1953, a tropical disturbance traveled through the basin, bringing three to five inches of rainfall. The peak outflow from Lake Kissimmee was 7,170 cfs and the peak stage of the lake reached 56.8 feet.

5. Existing Flood Control Project.

a. Kissimmee River Project (Canal 38). Canal 38 (C-38) was authorized for flood control in 1954; designed between 1954 and 1960 and constructed between 1962 and 1971. The total length of C-38 is about 56 miles. There are six water control structures, S-65, S-65A, S-65B, S-65C, S-65D, and S-65E, each with tieback levees, that divide the river into five pools. S-65 is the outlet structure from Lake Kissimmee and uses the S.R. 60 road embankment as a tieback levee. Pool A is between S-65 and S-65A; Pool B is between S-65A and S-65B; Pool C is between S-65B and S-65C; Pool D is between S-65C and S-65D, and Pool E is between S-65D and S-65E. Structure 65E is located eight miles north of Lake Okeechobee.

b. Design. The Kissimmee structures are designed to step down the 36-foot drop of the river in six-foot increments. The canal is designed to pass the outflow from Lake Kissimmee plus local inflow for a storm equal to 30 percent of the SPF. The 30 percent SPF discharge capacity at Lake Kissimmee represents a 25 percent increase over historical capacity, thus, providing flood protection to the upper chain of lakes. In the lower C-38 basin, the design channel is capable of passing the twin-peaked hydrograph produced by the local inflow and the delayed peak from the upper basin. Even with higher inflow discharges, the C-38 project significantly reduced flood stages in the lower valley because of the reduction in surface friction and hydraulic conveyance provided by the canal. An example of this improved performance is the September 1969 flood when a peak discharge of +23,000 cfs occurred at the S.R. 70 Bridge resulting in a stage of 23.3 feet, compared to the pre-project peak of 17,800 cfs at a stage of 27 feet.

c. Lake Kissimmee Regulation. Lakes Kissimmee, Hatchineha, and Cypress are regulated by a single structure, S-65 located at the outlet of Lake Kissimmee, at the head of C-38. The lakes are currently regulated between elevations 48.5 and 52.5 feet according to the seasonally varying schedule, as shown in Appendix B, Figure B-7. The present regulation schedule for flood protection of the Kissimmee River valley uses the storage capacity in Lakes Kissimmee, Hatchineha, and Cypress above elevation 51.0 feet to temporarily store floodwaters from the upper lakes. The design discharge of 11,000 cfs from Lake Kissimmee is restricted to a firm capacity of 3,000 cfs until flooding recedes along the lower river; usually less than two weeks. When the river recedes to a point where the Kissimmee River structures can discharge their design flow at design stages, the discharge from Lake Kissimmee is increased to 11,000 cfs. For floods less than about 10-year recurrence frequency, the inflow hydrograph into Lakes Kissimmee, Hatchineha, and Cypress has already passed the peak and has dropped to below 11,000 cfs before S-65 is opened up to the 11,000 cfs maximum discharge. Therefore, the peak stage in Lake Kissimmee would occur at the time discharge at S-65 is increased to 11,000 cfs. Before C-38 was built, the outlet capacity of Lake Kissimmee was impacted by backwater effects from the reach of Kissimmee River immediately downstream of the lake. The maximum discharge recorded from Lake Kissimmee prior to the project was 8,800 cfs and occurred during the 1948 flood at a peak stage of about 57.0 feet. Today, the 11,000 cfs outlet capacity is available any time there is a 2.5-foot head differential across S-65. During floods, the full capacity usually becomes available on a rising stage in Lake Kissimmee at about 51 feet.

d. Regulation of Lakes Kissimmee, Hatchineha, and Cypress with Level II Backfilling Plan. The proposed regulation schedule is shown in Appendix B, Figure B-9. Primarily, this schedule raised the maximum stage of Lakes Kissimmee, Hatchineha, and Cypress from 52.5 feet to 54.0 feet; however, there are other differences. The new schedule proposed that, during March, the level of these lakes should not be allowed to rise or fall at a rate greater than 0.1 feet per week. This was based on a recommendation by the Florida Game and Fresh Water Fish Commission to facilitate fish spawning. There was also a minimum discharge requirement of 250 cfs at all times, except during March or when the Lakes were below 48.5 feet.

The new schedule shows a maximum 1 September stage of Lakes Kissimmee, Hatchineha, and Cypress of 52.5 feet. These are the date and starting water surface elevation used in the SFWMD hydrologic analyses. Accordingly, some discussion on the relationship of the regulation schedule to flood stages on the lakes is warranted. Theoretically, floods can occur almost any time. Therefore, the probability of a specific flood stage in Lake Kissimmee is a joint probability of antecedent lake stage and rainfall. Specifically, the total probability is the integral summation of the product of all the possible combinations that would produce that stage. The more traditional approach has been to start the storm at an average lake level which is usually represented by the 1 September stage on the regulation schedule. This was the approach followed in the 1990 and 1991 feasibility reports and all prior studies of the Kissimmee River Basin. However, the capabilities of the UKISS and UNET models enabled a joint probability approach to be used for the first time during the current study for the Middle Basin flood routings.

6. Hydrology/Rainfall

Current Rainfall Procedure. The rainfall frequency analysis performed for this study included a review of the following:

Central and Southern Florida Project, Partial Definite Project Report, Part VI, Section 6. U.S. Army Corps of Engineers (September 1953)

Central and Southern Florida Project, General Design Memorandum - Kissimmee River Basin, Part II, Supplement 5. U.S. Army Corps of Engineers (1956)

Technical Paper No. 40 - Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years. U.S. Department of Commerce, Weather Bureau (1961)

Technical Paper No. 49 - Two to Ten Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States. U.S. Department of Commerce, Weather Bureau (1964)

ESSA Technical Report WB-7 , Frequency and Areal Distributions of Tropical Storm Rainfall in the United States Coastal Region on the Gulf of Mexico. U.S. Department of Commerce, Weather Bureau (1968)

Rainfall Analysis of Orange and Seminole Counties, based on eight long term daily rainfall gages. U.S. Army Corps of Engineers (1977)

NOAA Technical Report NWS 24, A Methodology for Point to Area Rainfall Frequency Rations. (1980)

Technical Publication 81-3, Frequency Analysis of Rainfall Maximums for Central and Southern Florida. South Florida Water Management District (1981)

Central and Southern Florida Project, Kissimmee River, Florida Feasibility Report. U.S. Army Corps of Engineers (1985)

The current study utilizes a combination of new analyses performed strictly for this report as well as previous data which was the product of detailed and comprehensive studies performed for the 1985 feasibility report. Any new rainfall values (i.e., 24-, 48-, 72-, 96-, and 120-hr amounts) generated were based on accepted methodologies outlined in the above listed standard technical publications. Previous information, such as the 30-day basin wide rainfall amounts published in the 1985 and 1991 reports, have again been used because of the thoroughness and expertise obvious in the original data development. However, the current study does embrace a different assumption as to the distribution of a "balanced storm" which results in greater run-off values when applied to HEC-1. The procedure for computing the rainfall for this study is outlined below:

Before the rainfall values taken from isopluvial maps from different sources could be compared, the rainfall amounts may have needed adjustments for several statistical factors. The point rainfall amounts given in isopluvial maps in TP 40 and 49 are for n-hour precipitation rather than observational-day precipitation. Accordingly, no adjustment is needed to convert from daily to hourly rainfall. However, the TP 40 and 49 statistical analyses use all high rainfall values (partial duration series) rather than yearly peaks (annual series). Therefore, the values taken from isopluvial maps in TP 40 and 49 require the following adjustments as shown below in Table A-1.

TABLE A-1

Partial to Annual Series Conversion Factors

	CONVERSION FACTOR FROM PARTIAL TO ANNUAL SERIES
2-YEAR	0.88
5-YEAR	0.96
10-YEAR	0.99
25-YEAR	1.00
50-YEAR	1.00
100-YEAR	1.00

The rainfall values contained in SFWMD Technical Publication 81-3 are based on annual series which do not require the above adjustment. However, the rainfall data analyzed were based on observational-day precipitation. Therefore, adjustments shown below in Table A-2 were made to convert the results to n-hour precipitation.

TABLE A-2

Daily to Hourly Precipitation Conversion Factors

FACTORS TO CONVERT DAILY TO HOURLY PRECIPITATION	
1 DAY TIMES 1.13 =	24 HOUR
2 DAY TIMES 1.04 =	48 HOUR
3 DAY TIMES 1.03 =	72 HOUR
4 DAY TIMES 1.03 =	96 HOUR
5 DAY TIMES 1.02 =	120 HOUR
6 DAY TIMES 1.02 =	144 HOUR
7 DAY TIMES 1.02 =	168 HOUR
8 DAY TIMES 1.02 =	192 HOUR
9 DAY TIMES 1.01 =	216 HOUR
10 DAY TIMES 1.01 =	240 HOUR

1. The isopluvial maps from NOAA Technical Publication 40 (1961) were used to develop 3-, 6-, 12-, and 24-hour point rainfall for annual recurrence frequencies of 2, 5, 10, 25, 50, and 100 years.

2. Using isopluvial maps in NOAA Technical Publication 49 (1961), the duration for the above frequencies was extended to 96, 168, and 240-hour point rainfalls.

3. SFWMD Technical Publication 81-3 was used to develop the 24, 48, 72, and 120-hour point rainfalls for frequency intervals ranging from 3-year to 100-year. Published in 1981, SFWMD TP 81-3 contains an additional 20 years of rainfall record over the NOAA reports and was used to develop a more consistent and current set of data.

A comparison of the TP 40 and 49 values with the SFWMD TP 81-3 numbers is shown in Table A-3 below.

TABLE A-3

Comparison of TP-40 and TP-49 with SFWMD TP 81-3
(Rainfall Depth in Inches)

	2-YR	3-YR	5-YR	10-YR	25-YR	50-YR	100-YR
NOAA TP-40							
6-HR	3.5		4.5	5.5	6.0	7.0	8.0
12-HR	4.3		5.3	6.3	7.5	8.3	9.0
24-HR	4.8		6.5	7.5	8.5	9.5	11.0
NOAA TP-49							
72-HR							
96-HR	6.7		8.2	9.8	11.8	13.4	15.4
120-HR							
168-HR	7.7		9.7	11.2	13.8	15.3	17.9
240-HR	8.6		11.1	13.6	15.2	17.7	19.2
SFWMD TP 81-3							
24-HR		5.0	5.6	7.6	9.6	10.7	11.9
48-HR		6.0	7.0	8.8	10.4	12.0	13.5
72-HR		6.4	7.7	9.8	11.8	12.6	14.4
120-HR		7.1	8.2	10.2	12.2	13.3	15.3

4. 30-Day Rainfall

The Corps' 1985 Kissimmee River study included a statistical analysis of monthly rainfall in the Kissimmee Basin. Analyses were carried out to determine the 30-day rainfall frequency at selected rain gages in the basin. The Thiessen polygon method of averaging the point rainfall frequency determined at these gages was used as the average point rainfall for the basin. Analyses were also carried out to determine the 30-day areal reduced basin rainfall frequency. This was obtained by analysis of Thiessen average daily rainfall data for the basin. The procedure for these analyses are contained in NOAA Technical Report NWS 24, A Methodology for Point-to-Area Rainfall

Frequency Ratios, Washington D.C., February 1989. Average point 30-day rainfall and average 2300 square mile basin rainfall are displayed in Figure A-2 of the 1985 report. The latter was also used for the current study and is shown Table A-4 below.

TABLE A-4

Kissimmee Basin (2300 Sq. Mile) Rainfall from 1985 Report

RAIN (in.)	DURATION (DAYS)					
FREQUENCY	1	2	5	10	20	30
5-YEAR	5.78	7.16	8.30	9.67	11.85	**13.42**
10-YEAR	6.40	7.92	9.18	10.69	13.11	**14.84**
50-YEAR	7.64	9.46	10.96	12.76	15.64	**17.71**
100-YEAR	8.14	10.08	11.68	13.60	16.67	**18.88**
SPF	9.28	11.48	13.31	15.50	19.00	**21.51**

Used in
This Study

5. After applying the correction factors to adjust to hourly rainfall and annual series, the point rainfall values from 3-hour to 10-day obtained from the NOAA and SFWMD TP's, as well as the 30-day point rainfall from the 1985 report, were graphed for each frequency (5-yr, 10-yr, 25-yr, 50-yr, 100-yr, and SPF). A set of parallel curves were then fit through all the available data to obtain a smooth curve for each of the six frequencies. It should be mentioned that the SFWMD TP 81-3 24-hour values were used exclusively since the TP 40 24-hour values appeared low when plotted on the graph.

6. From the above plotted rainfall versus duration frequency curves, the 1-, 2-, 3-, 4-, and 5-day (in hour) values were extracted from the graph to be used in the 5-day storm portion of the 30-day rainfall. See Table A-5 below.

TABLE A-5

Point Rainfall Values Extracted From Plotted Curves

Rainfall (in)	RETURN PERIOD IN YEARS						
DURATION	2	5	10	25	50	100	SPF
24-HR	5.20	6.40	7.53	9.15	10.60	11.90	14.88
48-HR	5.70	7.20	8.55	10.40	12.05	13.50	16.88
72-HR	6.10	7.70	9.10	11.05	12.80	14.35	17.94
96-HR	6.50	8.20	9.60	11.70	13.40	15.20	19.00
120-HR	6.85	8.65	10.10	12.40	14.00	16.10	20.13

7. Using NOAA Bulletin 52-8, the point rainfall values shown in Table A-5 were multiplied by the following factors to account for areal reduction of the 1600 square mile Kissimmee River basin. See Table A-6 below.

TABLE A-6

Areal Reduction Factors

DURATION	REDUCTION FACTOR TO 1600 SQUARE MILE KISSIMMEE BASIN
24-HR	0.77
48-HR	0.78
72-HR	0.79
96-HR	0.80
120-HR	0.81

8. After applying the reduction factors to the point rainfall values in Table A-5 and utilizing the 30-day areally reduced rainfall from the 1985 report, the following basin (1600 square mile) rainfall values were adopted for the current study. See Table A-7 below.

TABLE A-7

Kissimmee Basin (1600 Sq. Mile) Rainfall

Rain (in.)	RETURN PERIOD IN YEARS						
DURATION	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	SPF
24-HR	4.004	4.928	5.798	7.046	8.162	9.163	11.454
48-HR	4.446	5.616	6.669	8.112	9.399	10.530	13.163
72-HR	4.819	6.083	7.189	8.730	10.112	11.337	14.171
96-HR	5.200	6.560	7.680	9.360	10.720	12.160	15.200
120-HR	5.549	7.007	8.181	10.044	11.340	13.041	16.301
30-DAY	N/A	13.42	14.84	16.70	17.71	18.88	21.510

9. From Table A-7 the rainfall values for the peak five days of a 30-day storm for a given frequency were determined as follows:

No. 1 peak day = (24HR value)
No. 2 peak day = (48HR value - 24HR value)
No. 3 peak day = (72HR value - 48HR value)
No. 4 peak day = (96HR value - 72HR value)
No. 5 peak day = (120HR value - 96HR value)

For the variation of the daily basin rainfall values from 6 days to 30 days, the same procedure used in the 1985 report was again followed for the current study. For each frequency the difference between the 30-day rainfall and 5-day (120-HR) rainfall totals, both shown in Table A-7, will be varied according to the 1953 pilot storm used in the 1985 report. The rainfall between the fifth and thirtieth day will also be adjusted in magnitude proportionally so that the total rainfall adds up to the 30-day totals shown in the above table. A comparison of the peak 5-day rainfall (before evaporation) between the 1985 report and the 1995 (current) study is shown below in Table A-8:

TABLE A-8

Peak 5-Day Rainfall(Inches) for Two Corps Reports

Rain (in.)	5-YR		10-YR		25-YR	
DAY	1985	1995	1985	1995	1985	1995
1	0.3476	0.447	0.3844	0.491	N/A	0.618
2	0.3650	0.477	0.4036	0.520	N/A	0.684
3	0.4241	4.928	0.4689	5.7988	N/A	7.045
4	1.3769	0.688	1.5226	0.871	N/A	1.067
5	5.788	0.467	6.4005	0.501	N/A	0.631

Rain (in.)	50-YR		100-YR		SPF	
DAY	1985	1995	1985	1995	1985	1995
1	0.4587	0.608	0.489	0.807	0.5571	1.008
2	0.4817	0.713	0.5135	0.881	0.5851	1.101
3	0.5596	8.162	0.5966	9.163	0.6797	11.454
4	1.817	1.237	1.9371	1.367	2.2069	1.709
5	7.6383	0.620	8.1429	0.824	9.2773	1.029

10. Losses in this study due to initial abstraction and ground storage were accounted for by the SCS curve number technique. However, the SCS procedure is based upon rainfall occurring in a 24-hour period. Accordingly, the curve method would likely overestimate the losses for a 30-day storm. Thus, for a given amount of rainfall less runoff will occur if that rain occurs over a 30-day period than it would over a 24-hour period. One of the additional losses over a 30-day period is evaporation. In Florida, a general estimate of evaporative losses is about 1 inch per week. The 1985 report, and likewise the current study, adopted 3.8 inches of evaporative losses for the 30-day flood event. With the exception of the peak day, the 3.8 inches of evaporation were subtracted from each day's rainfall proportionally to the rainfall magnitude. Evaporation on the peak rainfall day is usually assumed to be very low and is therefore not included.

11. The 1985 report had the peak five days of rainfall distributed in the first five days of the storm. The rain was assembled in ascending order with the peak rain occurring on the fifth day. However, analyses showed that if this arrangement was used in conjunction with the SCS curve number technique, the result would be to extract too many losses out of the first five days of the storm. Accordingly, to approximate a balanced storm, the peak five days were moved to the center of the 30-day storm and arranged in a 5, 3, 1, 2, 4 distribution. Table A-9 below shows the rainfall amounts (after losses) used to generate the HEC-1 flood hydrographs for this study.

TABLE A-9

1995 Daily Rainfall and Distribution
(include evaporation losses)

1995 Study (Day)	1985 Report (Day)	5-YR	10-YR	25-YR	50-YR	100-YR	SPF
1	6	0.053	0.058	0.0603	0.057	0.053	0.048
2	7	0.222	0.242	0.2529	0.240	0.223	0.203
3	8	0.106	0.115	0.1206	0.115	0.106	0.097
4	9	0.192	0.210	0.2190	0.208	0.193	0.176
5	10	0.373	0.406	0.4243	0.403	0.374	0.341
6	11	0.030	0.032	0.0338	0.032	0.030	0.027
7	12	0.090	0.098	0.1026	0.098	0.090	0.082
8	13	0.339	0.370	0.3862	0.367	0.340	0.310
9	14	0.241	0.262	0.2740	0.260	0.241	0.220
10	15	0.101	0.110	0.1153	0.110	0.102	0.093
11	16	0.215	0.234	0.2444	0.232	0.215	0.196
12	17	0.030	0.032	0.0338	0.032	0.030	0.027
13	2	0.264	0.285	0.3823	0.366	0.501	0.640
14	4	0.380	0.505	0.6467	0.745	0.832	1.063
15	5	4.928	5.798	7.0455	8.162	9.163	11.454
16	3	0.258	0.301	0.3744	0.429	0.491	0.627
17	1	0.247	0.290	0.4147	0.373	0.537	0.685
18	18	0.101	0.110	0.1153	0.110	0.102	0.093
19	19	0.117	0.128	0.1333	0.127	0.117	0.107
20	20	0.249	0.271	0.2836	0.270	0.250	0.228
21	21	0.189	0.206	0.2148	0.204	0.189	0.172
22	22	0.124	0.136	0.1418	0.135	0.125	0.114
23	23	0.143	0.156	0.1629	0.155	0.144	0.131
24	24	0.026	0.028	0.0296	0.028	0.026	0.024
25	25	0.011	0.012	0.0126	0.012	0.011	0.010

TABLE A-9 (Continued)

1995 Daily Rainfall and Distribution
(includes evaporation losses)

1995 Study (Day)	1985 Report (Day)	5-YR	10-YR	25-YR	50-YR	100-YR	SPF
26	26	0.000	0.000	0.0000	0.000	0.000	0.000
27	27	0.121	0.132	0.1375	0.131	0.121	0.110
28	28	0.072	0.078	0.0814	0.077	0.072	0.065
29	29	0.286	0.312	0.3259	0.310	0.287	0.262
30	30	0.113	0.124	0.1291	0.123	0.114	0.104
Totals(inches)		9.620	11.041	12.9000	13.911	15.081	17.710

7. Hydrologic Models.

a. HEC-1 Flood Hydrograph Model.

(1) General. The Corps' flood hydrograph model (HEC-1) was used to compute flood discharges for the 5-year, 10-year, 25-year, 50-year, 100-year, and SPF storm frequencies. The Kissimmee Basin was divided into seventy-four sub-basins with twenty-four of the sub-basins draining into the upper/middle chain of lakes and the remaining fifty draining into the four pools along C-38 from S-65 to S-65D. The model simulates the rainfall runoff response to the watershed by representing the basin as a system of hydraulically connected sub-basins. Each sub-basin is simulated as a group of hydrologic and hydraulic parameters which describe aspects of the rainfall runoff process within each sub-basin. Principal parameters used in the hydrologic simulation are average basin rainfall, infiltration, losses, land slope, soils, stream length, soil cover, and land use. Another parameter used was the SCS's formula of small watershed lag. This is a mathematical composite of several hydrologic parameters.

Dimension-less unit hydrographs generated by HEC-1 were used to model the rainfall runoff process in the Kissimmee River basin. However, the standard unit hydrograph shape, developed by the Soil Conservation Service (SCS) based on the ratio between the rising and falling limbs of a triangular unit graph, were inappropriate for the area. The shape of the unit hydrographs were instead patterned after those presented in the Kissimmee River GDM, Part II, Supplement 5 (1956). The standard peak rate factor was changed from

484 to 312 which produced unit hydrographs with lower peak flows and longer recession limbs.

Principal hydraulic parameters used in the HEC-1 model are channel conveyance, channel roughness, and channel storage. These parameters are primarily used to route storm runoff hydrographs through channel storage to downstream junctions. However, the existing Kissimmee River (C-38) is highly regulated and outflows are predominately tailwater driven. Therefore, a new routing model was required. HEC-1 was used to develop the inflow hydrograph for input into the new routing model, UNET.

(2) Middle Basin HEC-1 Model.

(a) General. The Upper Basin is divided into a Middle Basin Chain of Lakes and an East and West Upper Chain of Lakes. Due to a limited scope of new topographic surveys, a revised HEC-1 model was developed strictly for the Middle Basin Chain of Lakes. Hydrology and routings for the East and West Upper Chain of Lakes were obtained from a previous study and input as upstream inflow hydrographs into the current HEC-1 model at the S-63A and S-61 boundary locations. A subsequent report will address the hydrology and hydraulic performance of the Upper Chain of Lake's flood control system to determine if the canals and water control structures in the system should be modified.

The Middle Basin drainage area was divided into 22 sub-basins extending from the northern boundary of the watershed near Orlando to the southern outlet of the basin at S-65. The basin divides were developed from a compilation of previous Corps and SFWMD studies and new analysis of existing USGS quadrangles. Basin divides were digitized and drainage areas computed with a measuring feature in the CADD software MicroStation. Sub-basins were delineated for each of the 10 major lakes (Kissimmee, Hatchineha, Cypress, Rosalie, Tiger, Jackson, Marian, Weohyakapka, Marion, and Pierce) in the chain as well as for certain tributaries and natural storage basins which tend to attenuate peak flows. In particular, Lake Marion Creek, Catfish Creek, Horse Creek, Tiger Creek, and Reedy Creek tributaries were modeled for this purpose. Non-contributory drainage areas based on USGS quadrangle topography were also identified within certain sub-basins and deleted from the runoff contribution to the overall basin.

Previous HEC-1 modeling of the Middle Basin upstream of S-40 along Reedy Creek had separated the approximately 184 square mile area into 6 sub-basins divided along topographic divides. This most upstream region of the Middle Basin is characterized by a myriad of small and medium-sized lakes which normally represent some storage potential in a storm event. Historical gaging records along Reedy Creek near Loughmann indicate a peak discharge of less than 1,000 cfs for the contributory drainage area of 110 square miles during the 1940-1988 period of record. Based strictly on drainage area, this discharge value appears low and indicates that there are likely attenuating factors within the basin which warrant further study. Apparently, some of the flow attenuation can be attributed to the restriction of Reedy Creek at the U.S. 17 railroad and highway bridge crossings just upstream of Loughmann which results in the diversion of some flow to Lake Tohopekaliga.

To better estimate the storage potential of Reedy Creek upstream of S-40, the Reedy Creek Improvement District (RCID) was contacted and information on their UNET modeling results for 10-year and 100-year/3-day storm events centered over the upper Reedy Creek Basin was obtained. Results from their detailed UNET modeling indicate that the peak discharges at S-40 for the 10-year and 100-year events are 2984 cfs and 3791 cfs, respectively. Utilizing this flow information, a storage-discharge relationship was developed in HEC-1 for the 184 square mile sub-basin calibrated against the RCID UNET values. This storage-discharge relationship more accurately reflects the storage and routing potential of the basin than the previous multiple sub-basin approach.

(b) Basin Data. Summation of the areas for the 22 sub-basins resulted in a total drainage area for the Middle Basin of 945 square miles. In conjunction with the combined drainage area of 631 square miles for the East and West Chain of Lakes at S-63A and S-61, the total drainage area for the Upper Kissimmee Basin at S-65 is approximately 1576 square miles.

Except for the Upper Reedy Creek Basin, curve numbers for each of the sub-basins are essentially the same as those used in the larger basins delineated in the Corps' previous studies in 1985 and 1991. However, due to the physical reconfiguration of sub-basins the hydrologic parameter of lag was recomputed for the current study effort. Various lag formulas and methodologies were used to compute an average lag value for each sub-basin, although the SCS and Manning's approaches were predominantly utilized in the final selection. Table A-10 lists some of the hydrologic parameters for the Middle Basin sub-basins. The drainage areas and divides for the Middle Basin are shown on Plate A-1.

(c) Routing Data. Stage/volume relationships for lakes and lake outlet rating curves were obtained from the original 1956 Kissimmee GDM as well as other sources including USGS quadrangle measurements, SFWMD records, and more recent topographic surveys around the lakes.

(d) Base Flow Factors. Base flow factors, in cfs per square mile, were developed for each of the storm frequencies by calibrating HEC-1 stages on Lake Kissimmee with observed historical stages for a known storm. These factors are useful in establishing a base flow condition within the basin often the result of significant antecedent moisture conditions or persistent groundwater contributions to the basin runoff. The historical floods selected for model calibration were the 1953, 1960, and 1969 storms. According to frequency analyses performed by the Corps and SFWMD, the 1969 storm represents approximately a 20-year event and is the most severe storm to date with the flood control project in-place. The 1953 and 1960 storms occurred prior to the C-38 channelization and represent between a 40 to 50 year event. The final base flow factors selected were 1.375, 1.375, 1.875, 1.875, 2.20, and 2.75 for the 5-year, 10-year, 25-year, 50-year, 100-year, and SPF frequencies, respectively.

(e) Existing and With-Project Conditions. The first attempt in computing existing and with-project flood stages for Lake Kissimmee under a series of storm events was made with the HEC-1 Middle Basin model. The major difference in the modeling for the two conditions is the method in which outflows from Lake Kissimmee through S-65 are addressed. The existing conditions operation of S-65 is governed by local inflows into Pool A which require that S-65 discharges be reduced to 3,000 cfs when tailwater reaches a predetermined stage. Since HEC-1 is incapable of assessing tailwater impacts, discharges out of S-65 were obtained from a previous CHANOP analysis which is specifically adapted to complex structure operations. These CHANOP discharges were applied to the HEC-1 model in the form of an inflow hydrograph coupled with an outlet rating curve which produced the same net outflows from the system as the CHANOP values. For the with-project or backfill condition, outflows from the HEC-1 model through S-65 were modeled as a stage-discharge rating curve based on the original concept of a 6,000 cfs firm and 11,000 cfs full discharging structure. The rating curve still assumes that the stated discharges will be available at the given headwater stage and is not capable of determining if downstream tailwaters in the Lower Basin will restrict discharges. The obvious limitations in HEC-1 to assess the S-65 tailwater impacts lead to the selection of a comprehensive routing model (UNET) integrating the Middle and Lower Basins in a dynamic mode. Although superseded by subsequent UNET results, Table A-11 shows the original HEC-1 stages computed for Lake Kissimmee under existing and with-project conditions.

(3) Lower Basin HEC-1 Model.

(a) General. The HEC-1 model for the Kissimmee Lower Basin extends from S-65 to S-65D and develops runoff for the basins and tributaries which drain into C-38. The lower basin was not modeled downstream of S-65D because the current backfill reach terminates upstream of S-65D and tailwater effects impacting the discharge of S-65D are not expected because of the large discharge capacities of S-65D and S-65E and the downstream proximity of Lake Okeechobee. In contrast to previous HEC-1 studies by the Corps in 1985 and SFWMD in 1990, the current modeling effort delineates various sub-basins within each of the four main pools. The majority of the sub-basins are associated with a tributary stream or slough which drains into C-38. Due to the upland nature and ample slope of most of the tributaries, all runoff from the sub-basins is unrouted and reaches C-38 with a negligible backwater effect. The lower basin HEC-1 model was developed strictly to provide hydrograph input for the integrated flood routing model, UNET, and is not capable of computing flood stages for the lower basin.

(b) Basin Data. The majority of the 50 sub-basins in Pools A through D were delineated in the Corps' 1991 Feasibility Report. The current effort involved digitizing and measuring the drainage areas, recomputing lags for the more critical basins in Pools A and B, and utilizing the same curve numbers which were used in the 1985 and 1991 Corps studies. Some minor redefinition of sub-basin boundaries occurred in Pools A and B where inflow and potential tailwater effects on S-65 could affect the performance of the Middle Basin project. However, an effort was made to maintain the overall drainage area of 626.6 square miles between S-65 and S-65D. Table A-12 lists some of the hydrologic parameters for the lower basin sub-basins. Also, Table A-13 provides a comparison by Pool of lower basin drainage areas between this report and previous studies. Drainage areas and divides are shown for the Lower Basin on Plate A-2.

b. UNET.

(1) General. UNET, a one-dimensional unsteady flow program, was the dynamic-routing model used to simulate flood flows and stages in a fully developed network of open channels and storage areas. UNET was originally developed by Dr. Robert Barkau and is available for U.S. Army Corps of Engineer's use through the distribution and support of the Hydrologic Engineering Center (HEC), Davis, California.

UNET is particularly effective in solving split flow in two or more channels, especially when the flow is subcritical and the division of flow depends on the stages in the receiving channels. These stages are a function of channel geometry and downstream backwater effects. Another feature of UNET is the storage area which can provide or divert water from a channel based on the water surface elevation in the storage area. In addition to solving the continuity and momentum equations for the network system, UNET provides the user with the ability to apply several external and internal boundary conditions, including: flow and stage hydrographs, gated and uncontrolled spillways, bridges, culverts, and levee systems.

UNET input generally consists of a CSECT or geometry file which defines the physical configuration of the hydraulic network including reach connections, channel cross-sections, storage area sizes, and structures (i.e., culverts, bridges, spillways). To facilitate model application, UNET cross-sections are input in a modified forewater HEC-2 format. Secondly, the UNET or .BC input file contains all the internal and external boundary conditions (i.e., hydrographs, gate opening sequences, rating curves) which are applied to the CSECT file.

Both the Corps' 1991 Feasibility Report and the 1990 SFWMD Report utilized CHANOP as the Middle Basin hydraulic routing model and DWOPER as the Lower Basin model. The current study utilizes UNET exclusively in both the Middle and Lower Basins. UNET is particularly superior to CHANOP in simulating the dynamic interplay between flow and stage for the various interconnecting lakes in the Middle Basin. Unlike CHANOP, UNET allowed the three main stem lakes (Kissimmee, Hatchineha, and Cypress) to be modeled as separate entities thereby identifying the respective headlosses between the lakes and ultimately leading to an optimization of design channel enlargements for Canals 35, 36, and 37. Due to modeling constraints and a lack of topographic information in the canals, previous studies in 1990 and 1991 had computed a common peak flood stage for the three lakes.

(2) Middle Basin UNET Model.

(a) General. As with the HEC-1 model, a UNET model was developed initially only for the Middle Basin above S-65. However, consideration of potential tailwater effects restricting the discharge from S-65 eventually lead to the development of a Lower Basin UNET model as well.

Figure A-1 shows a schematic of the UNET models for the Middle Basin under existing and with-project conditions. The CSECT or cross-section files for these two models are identical. It is only the UNET or boundary condition input files which vary. However, it is with the boundary condition files by which the increased lake regulation schedule and the different S-65 operating criteria between existing and with-project conditions are reflected in the model. The existing conditions flood routing model accounts for the fluctuation of starting water surface elevations on Lakes Kissimmee, Hatchineha, Cypress, and Tiger between elevations 49.0 to 51.0 feet, the with-project condition model accounts for possible stages between elevations 48.5 to 52.5 feet.

Although there are additional lakes in the Middle Basin, only the lakes which would potentially be impacted by a change in the Lake Kissimmee regulation schedule are included in the UNET model. However, hydrology and HEC-1 flood routings were also developed for the other major lakes (i.e., Lakes Weohyakapka, Marion, and Pierce) and input as upstream boundary hydrographs into the UNET model shown. The previous hydrologic modeling for the Upper Basin chain of lakes was included in the current UNET model as upstream boundary hydrographs at the S-61 and S-63A locations.

(b) Topographic Input Data. Survey cross-sections for the majority of the canals and tributaries connecting the major lakes of the Middle Basin were obtained in 1991 to assist in constructing the UNET model. New cross-sections taken at 500 foot intervals were obtained along Canals 34, 35, 36, and 37. Cross-sections surveyed at wider-spaced intervals were obtained for the canals and tributaries connecting the branch lakes (i.e., Jackson, Marian, Rosalie, Tiger) with the main stem of lakes. These sections were used to evaluate the effects of the increased Lake Kissimmee regulation schedule on the branch lakes.

Existing cross-sections taken in 1979 were used to model the Short Canal reach. Also, in an attempt to account for the storage potential of the Reedy Creek basin downstream of S-40 to Lake Cypress, cross-sections were developed for this and the Dead River from USGS quadrangle map contours.

(c) Structural Input Data. Survey data for bridges crossing the Canals 34, 35, and 37 were obtained along with the channel cross-sections in 1991. Hydraulic data and dimensions for the Lake Rosalie Control Structure (G-103) and Lake Marion Control Structure (G-113) were obtained from the SFWMD Structures Description Manuals. The Lake Jackson Structure Feasibility Study published by SFWMD provided design data for the proposed culvert structure and Jackson Canal channel improvements.

(3) Lower Basin UNET Model.

(a) General. The UNET Lower Basin model was developed subsequent to the Middle Basin model and was joined with the latter to form an integrated model for the purpose of: 1) evaluating potential tailwater effects of high stages in Pools A and B on the discharge capacity of S-65 and thus the hydraulic performance of the Middle Basin project; 2) modeling the Lower Basin under the backfill condition to compare lower basin flood stages with values published in the 1991 Feasibility Report. The establishment and comparison of the UNET lower basin flood values is critical in determining the need for additional land acquisitions in the lower basin, particularly since SFWMD's land acquisition program is already underway.

Refer to Figures A-2 and A-3 for schematics of the lower basin UNET model. The model essentially consists of one reach, C-38, which extends from S-65 to S-65D. The fifty hydrographs generated from the HEC-1 lower basin model are input at lateral inflow locations to represent inflows into C-38 from contributory sub-basins, tributaries, and canals. The lateral inflows were not modeled as separate UNET reaches because of a lack of accurate topographic data; however, review of the USGS quadrangle map contours indicated that because of their upland nature and ample slope, particularly the critical tributaries in Pools A and B, the majority of tributary flood hydrographs would reach the Kissimmee River floodplain with little attenuation due to storage. Because of this assumption, it was crucial that the C-38 cross-sections in the lower basin model extend sufficiently to high ground to account for all available storage within the floodplain.

Unlike the Middle Basin model, both the CSECT and boundary condition input files for the lower basin vary between existing and with-project conditions. This is because physical reconfiguration of the C-38 reach occurs in the with-project (with backfill) condition. Some of the physical changes include the backfilling of C-38 from reach mile 39.30 in Pool B to reach mile 17.10 in Pool D, the complete removal of S-65B, S-65C and their associated tieback levees, and the partial degrading of the S-65A tieback levees. The backfilling of C-38 also involves the selection of an increased Mannings "n" roughness value for the revegetated section of the floodplain adjacent to the restored river.

S-65 is modeled as a submerged-controlled rating curve which computes a given discharge based on a corresponding set of headwater and tailwater conditions at the structure. The discharge (Q)used in the rating was computed from the standard flow equation:

$$Q=cA\sqrt{(2gH)}$$

c (structure discharge coefficient) = 0.75
A (flow area) = total width of structure gates x gate opening
H (hydraulic head) = headwater-tailwater stage

Under both existing and with-project conditions, the assumption is that full available discharges are made from the structure when the headwater reaches 0.2 feet above schedule. However, under existing conditions, S-65 discharge is then reduced to 3,000 cfs, regardless of headwater, when the tailwater reaches 49 feet. This constraint is designed to not exceed the design inflow capacity at

S-65A and thus avoid flooding in Pool A. S-65A and S-65B, under existing conditions, are also modeled as submerged rating curves allowing full available discharges with no additional restrictions applied.

Because of the elevation of the tieback levees at each structure, floodplain flows moving downstream under the existing system will be forced to discharge through each of the S-65(A-D) structures before entering the next downstream Pool. However, under the with-project (backfill) conditions, there is potential for concentrated flow through the structure and overland flow around the structure because of the significantly lowered tieback levees at S-65A. UNET modeling for this situation was handled with the CSECT spillway option in conjunction with modifying the tieback levee cross-section. The spillway option calculated flow through the S-65A structure based on given data of crest elevation, gate width, discharge coefficient, and a time series of gate openings. Overland flow across the levee was computed by the standard UNET equations solving flow, conveyance, and stage between cross-sections.

(b) S-65 Operation. The existing flood control project is designed to convey a 30 percent SPF (approximately a 7-year event) flood event within the C-38 canal, which translates to approximately an 11,000 cfs peak flowing in Pool A. The local sponsor currently owns the lands necessary to withstand the 11,000 cfs flow in Pool A at a design headwater of elevation 46.3 feet at S-65A (translates to about elevation 49.5 feet at S-65 tailwater). S-65 is operated such that the total discharge at S-65A (S-65 releases plus local inflow into Pool A) does not exceed 11,000 cfs and therefore maintains flood stages within available sponsor-owned lands. Under the with-project condition, backwater effects from the restored river section in Pool B under a 30 percent SPF flow already translate to a peak stage at the S-65 tailwater of about elevation 51.5 feet. Any attempt to maintain a tailwater comparable to existing conditions would require the reduction of S-65 releases to less than 5,000 cfs, which in turn would lead to an unacceptable rise in the Lake Kissimmee and Upper Basin lake stages. Therefore, in order to maintain the flood protection upstream of S-65, S-65 must be operated to make full available discharges to the Lower Basin.

(c) Topographic Input Data. The detailed topographic information needed to define the floodplain geometry in the UNET Lower Basin model was developed primarily from cross-section surveys obtained by the Corps in 1993-1994. Cross-sections at approximately 1000-foot stations were obtained along a baseline that followed the C-38 alignment from S-65 downstream to S-65D. Since UNET is a one-dimensional flow model, cross-sections were taken generally perpendicular to the flow path and extending outward to encompass the SPF flood stage. The cross-sections, particularly on the east side of the basin, extend across a large portion of the contributory sloughs and thus account for the majority of the available storage in the floodplain. During subsequent design memorandums for the Kissimmee River Restoration, two-dimensional flow modeling, utilizing a detailed topographic grid for the entire floodplain and major sloughs, will be used to better define lower basin flood stages as well as evaluate the hydrologic performance of the "restored" system.

(d) Structural Input Data. The UNET submerged rating curves for S-65, S-65A, S-65B, and S-65C and the downstream rating curve for S-65D were developed from design and as-built data compiled on each spillway structure. This data is published in the U.S. Army Corps of Engineer's (Jacksonville District) document, "Water Control Manual for Kissimmee River - Lake Istokpoga" dated November 1994. Included in the manual are a brief description, operating criteria, hydraulic design data, discharge rating curves, and maximum allowable gate openings for each S-65(A-E) structures.

(4) UNET Model Evolution.

(a) General. The development of the UNET model into a fully-integrated hydrologic routing tool for the Kissimmee River basin followed a logical, deliberate progression intended to provide increasingly accurate and comprehensive results. To this end, new topographic information for Pools A, B, C, and D continues to be incorporated into the model as it becomes available. Flexibility of the model also allows for relatively simple incorporation of alternative proposals including new water control structures or physical reconfiguration of existing channels, levees, and roadways.

(b) Middle Basin Model.

(i) Existing Conditions. Initially the existing conditions Middle Basin UNET model was a mixture of a UNET network combined with previous CHANOP results. Because the operation of S-65 was so closely linked to downstream tailwater, it was virtually impossible to model S-65 with a UNET rating curve based solely on headwater, as was assumed for the with-project condition. Therefore, the previous S-65 discharges developed by CHANOP were applied to the UNET model in a manner similar to the HEC-1 existing conditions model. However, this combination of modeling results was unsuccessful and deemed unacceptable. The necessity of constructing a UNET model to assess tailwater effects on S-65 discharges ultimately lead to the development of the Lower Basin and fully-integrated UNET models which resulted not only in improved results for existing conditions, but eventually for the with-project conditions as well.

(ii) With-Project Conditions. The first model consisted of the network shown on Figure A-1. S-65 was modeled as a downstream rating curve with discharges restricted to 6,000 cfs or less until Lake Kissimmee reached a stage of elevation 53.8 feet. Maximum discharge for S-65 was set at the design discharge of 11,000 cfs and was available at a minimum stage of 53.85 feet. The with-project condition assumes backfill in C-38, however, tailwater effects restricting the S-65 discharge are neglected because no lower basin model exists to evaluate them. Canals 35, 36, and 37 are modeled at their existing bottom widths of 20, 48, and 70 feet, respectively, and the SWSEL on Lake Kissimmee is 52.5 feet. Result of the Middle Basin UNET model under with-project conditions are shown in Table A-14.

(iii) Full-Design Canals. Under this condition, Canals 35, 36, and 37 in the with-project model are improved to bottom widths of 40, 80, and 160 feet, respectively. The canal improvements were implemented to reduce the tailwater at S-61 to design stages listed in the original Kissimmee GDM with the intent of not impacting flood control for Lake Tohopekaliga and the entire upstream west chain of upper lakes. These canal sizes represent the initial design iteration and were computed using HEC-2 and 10-year discharges under a steady-state condition with a starting backwater stage of 54.05 feet on Lake Kissimmee. Subsequent design iterations made with the UNET unsteady flow model ultimately resulted in smaller (optimized) canal sizes. Results of the Middle Basin UNET model with the 40, 80, and 160 foot design canals incorporated are shown in Table A-14.

(c) Integrated Model (Lower Basin Added).

(i) General. The development of comparable UNET models for existing and with-project conditions established a reasonable method of designing and evaluating improvements. The relative success of a design proposal could be determined to the extent it satisfied the governing flood control criteria for the Middle Basin, which was to not worsen existing peak stages for any flood frequency at any location in the basin. However, this criteria was modified for Lakes Kissimmee, Hatchineha, and Cypress to include only stages above elevation 54 feet, since the project sponsor, SFWMD, has already committed to purchase lands to this elevation. An additional impetus for not increasing existing flood stages was to ensure that stage impacts from the Middle Basin project did not extend upstream of the S-61 and S-63A locations, thus maintaining the existing level of flood protection in the Upper Chain of Lakes.

The modeling progressed in the following order: 1) development of existing and with-project (backfill) models and stage comparison; 2) iterative process to design channel improvements to Canals 35, 36, and 37; 3) design of additional outlet capacity at S-65; and 4) comparison of Lower Basin stages with previous modeling to determine additional land requirements.

(ii) Existing Conditions. The fully-integrated model includes the Middle and Lower Basin UNET models joined together at S-65. S-65 is modeled as a submerged rating curve (maximum capacity of 11,000 cfs at head of 2.5 feet) which computes discharge based on headwater and tailwater; however, discharge is restricted to 3,000 cfs when tailwater exceeds elevation 49.0 feet. S-65A, S-65B, and S-65C are also modeled as submerged rating curves with their full-height tieback levees represented with cross-sections. A downstream rating curve is used to simulate outflow from the model at S-65D. Canals 35, 36, and 37 are represented with existing bottom widths and side slopes and the Lake Kissimmee SWSEL for the flood event fluctuates between elevation 49.0 to 51.0 feet. C-38 is left intact (no backfill) and Mannings "n" values of 0.03 and 0.15 used for the channel and overbanks, respectively. Peak stage results for the integrated UNET existing conditions model is shown in Table A-15.

(iii) With-Project Conditions. The fully-integrated model is identical to the existing conditions model except for the following changes: 1) S-65 discharges are based strictly on what the headwater and tailwater will allow; 2) S-65A is modeled as a spillway with a time series of gate openings; 3) S-65B and S-65C are removed; 4) Lake Kissimmee SWSEL varies between elevation 48.5 to 52.5 feet; and 5) C-38 is backfilled from river mile 39.30 to river mile 16.43 with a Mannings "n" value of 0.30 for the backfill and overbank sections. Peak stages for the integrated UNET with-project model are shown in Table A-15.

(iv) Design Canals. Although the intent of the full-design canals was to reduce the upstream with-project stages to acceptable levels, comparison of the resultant UNET stages with existing conditions indicated that the canals were over designed (too large). Since the original sizes of the canals were determined with HEC-2, it was decided to optimize the canal sizes using UNET as the design tool. Various alternatives with different canal sizes were run with UNET and the resultant peak lake stages compared to existing conditions to evaluate which canal arrangement was the most efficient. The combination of Canal 35 (20' bottom width), Canal 36 (60' bottom width) and Canal 37 (90' bottom width) was the best alternative and, with the exception of the 25-year stage on Lake Kissimmee, resulted in acceptable stages at all locations for each storm frequency. A significant reduction in canal sizes and construction costs, Canal 35 (40' to 20'), Canal 36 (80' to 60'), and Canal 37 (160' to 90') were achieved through the design optimization process.

(v) Additional S-65 Outlet Capacity. Although the improvements to C-36 and C-37 resulted in acceptable stages upstream of Lake Kissimmee, the increased conveyance in the canals caused the downstream stages in Lake Kissimmee to increase. Since the design sizes of Canals 35, 36, and 37 were already minimized, the only means of further reducing the stage on Lake Kissimmee was to design additional outlet capacity at S-65. Additional capacities of 33 percent and 67 percent of the original 11,000 cfs (3-bay) structure were run with UNET, these options are commonly referred to as Plan 2 (4-bay total outlet capacity at S-65) and Plan 1 (5-bay total outlet capacity at S-65). Results for Plan 1 and Plan 2 can also be found in Table A-15. Plan 2 is an unacceptable alternative because the 25-year peak stages for Lakes Kissimmee and Tiger exceed both the existing stages and the 54-foot elevation.

(d) Sensitivity Runs.

(i) Removing Backfill. The impact of the backfill on Lower Basin conveyance and the tailwater effect on the discharge from S-65 have long been concerns for the hydrologist involved in Kissimmee River studies. To determine the backwater effect resulting strictly from the backfill required that a comparative analysis be performed between conditions in which the only modified parameter was the backfill. This could be accomplished with two approaches: 1) run the with-project condition (Lake Kissimmee SWSEL at 52.5 feet) and remove the backfill from the C-38 reach, or 2) run the existing conditions (Lake Kissimmee SWSEL at 51.0 feet) and insert the backfill in the C-38 reach. Interestingly, the impact attributable to backfill is different for the two methods, indicating that the S-65 operating criteria, which varies for existing and with-project conditions, and the lake SWSEL (available storage) are the more important parameters affecting peak flood stages on Lake Kissimmee. The results for the backfill and SWSEL sensitivities are indicated in Table A-16. This sensitivity analysis was performed prior to final plan selection and is provided strictly for the reader to ascertain the relative impact of the above mentioned variables on peak flood stages in the Upper Basin lakes.

(ii) Manning's "n" Values for Backfill. The hydraulic resistance of the future reestablished marsh-filled floodplain is perhaps the most important parameter in the UNET analysis. Manning's Roughness Coefficient ("n") is a major determinant of flow velocity and conveyance which directly affect flood stages. Sensitivity analyses on a range of "n" values from 0.1 to 0.5 showed that even minor variations in the value can have a significant impact on flood stages as shown on Table A-17. The value of 0.3 used in this study was selected for the same reasons discussed in the Appendices (page A-15) of the Corps' 1991 Feasibility Report. Further verification of the 0.3 value was obtained by calibrating the current Lower Basin UNET model to the historical rating curve at the Fort Kissimmee gage, located about 16.1 miles downstream of S-65, as shown on Figures A-8 and A-9.

(iii) Lag for Lake Kissimmee. Because of the large area and flatness of the Lake Kissimmee sub-basin a wide variation in calculated lags was observed depending on the computation methodology selected. The previous 1985 Corps study had used a value of 16 hours for the basin lag. However, the SCS and Mannings approaches for the current study resulted in much larger values between 50 and 100 hours. To assess the sensitivity of lag time on computed peak stage for Lake Kissimmee, three UNET runs were made for the 25-year frequency with lag values of 16.8, 33.6, and 50.4 hours. The resultant peak stage on Lake Kissimmee for all three runs was 54.47 feet, thus illustrating the relative insensitivity of runoff lag in determining flood stages. Lake Kissimmee is such a large lake that overall rainfall volume, rather than timing of the inflow, is a much more critical factor in determining ultimate flood stages.

(iv) Rainfall Distribution. The difference in rainfall distribution between the previous 1985 and 1991 Corps reports and the current study was discussed in the Hydrology/Rainfall section of this report and depicted in Table A-9. The tendency of the early-month storm to overestimate losses in comparison with the mid-month balanced storm was also noted. Therefore, the effects of the distribution on HEC-1 generated runoff and hydrographs and ultimately on UNET peak water stages is an extremely important factor in explaining the higher flood stages for the current study and is illustrated in Table A-18.

(v) Variation of Lower Basin Flood. It is sometimes the practice of the Corps of Engineers to define a flood event for the overall project as the combination of different magnitude events each occurring within a defined sub-area of the overall project. For example, a 100-year flood for a reservoir may be defined as the 100-year rainfall event applied to the reservoir in conjunction with a 10-year tailwater stage occurring in the outlet channel downstream of the reservoir. Although this approach was not used in the Kissimmee 1135 study, the sensitivity of applying a 10-year rainfall to the Lower Basin in combination with the 5-, 25-, 50-, 100-year, and SPF Middle Basin floods and comparing the resultant stages with the standard flood frequency combinations (i.e., 5-year Middle Basin flood with 5-year Lower Basin flood, etc...) was investigated. Results for the sensitivity are shown in Tables A-19 and A-20.

(vi) Lake Jackson Water Control Structure. The Florida Game and Fresh Water Fish Commission (GFC) in 1992 proposed the Lake Jackson Restoration Plan with the intent of improving the aquatic habitat and developing a quality sport fishery in the lake. Working with the GFC, SFWMD was tasked to design the outlet water control and conveyance improvements necessary to regulate stages on Lake Jackson from a dry season high of 53.5 feet mean sea level (msl) to a wet season pool level of 51.0 msl. According to SFWMD's Lake Jackson Project Feasibility Report dated February 12, 1993, it is "understood that such improvements are in their conceptual stage and the final Kissimmee River Restoration Project design may require eventual modification to the water works constructed under this project."

From SFWMD's analysis, the improvements required to insure existing flood levels are not exceeded include enlargement of Jackson Canal (50-foot bottom width at design invert of 45.0 msl with 2.5H:1V side slopes) from the lake outlet to a location 4000 feet downstream. For water control, five (5) 84-inch diameter CMP culverts at invert elevation 45.0 msl with standard 108-inch wide risers, (riser top elevation 53.5 msl), and a 50-foot long reinforced concrete auxiliary spillway (trapezoidal section at a crest elevation of 53.5 msl), are recommended.

In May 1993, SFWMD requested that the Corps review the design and advise if the proposed 1.5 foot increase in the Lake Kissimmee regulation schedule would affect the discharge of the proposed Lake Jackson structure. After incorporating the proposed works into the UNET model it was concluded that the peak stages and discharges for Lake Jackson were not affected by the 1.5-foot increase in the Lake Kissimmee schedule. According to SFWMD, the structure was constructed and in-place by August 1994.

(5) Model Calibration.

(a) HEC-1. After the initial development of the Middle Basin HEC-1 model down to S-65, calibration of the model with observed floods was necessary. Since computed stages are the critical parameter in assessing the flood control performance of the project, it was decided to calibrate the model on the observed Lake Kissimmee stage under a set of historical floods. The selected floods of 1953, 1960, and 1969 were the largest of the Kissimmee Basin over the last 40 years. The 1947 storm was also extremely large but stage and rainfall records for the period were inadequate.

The basic approach was to obtain daily rainfall data from all available gages in the basin area during the flood event and generate a composite basin daily rainfall by Thiessen weighting the gages. Observed daily lake stages and S-65 discharge values from Lake Kissimmee were also obtained. After applying the composite rainfall values to the HEC-1 model and accounting for the daily lake outflows in the form of a downstream rating curve at S-65, the model was run. The HEC-1 computed Lake Kissimmee stages were then plotted in the form of a stage-graph and compared with the shape of the observed stage curve to assess the validity of the model. A plot of the Lake Kissimmee HEC-1 versus historical stages for the three calibrated floods are shown in Figures A-4 through A-6.

(b) UNET.

(i) Middle Basin. The September 1969 flood was the only flood event in the Middle Basin since the completion of the Kissimmee Project which could be used to calibrate the UNET model. Since the S-65 daily releases were available from gaging records it was possible to use the Middle Basin UNET model with a downstream rating curve modified to account for the actual outflows from the system. The flow hydrographs generated from the HEC-1 1969 calibration were inserted into the UNET model at the appropriate physical locations. Stage records were used to assign the actual starting water surface elevations for Lakes Kissimmee and Cypress. After running the UNET model, the computed stage hydrographs for Lake Kissimmee were compared with the observed 1969 lake stages to assess the accuracy of the UNET model. Figure A-7 shows a graphical comparison between the computed and historical stages demonstrating a relatively high level of correlation for the UNET and historical results.

(ii) Lower Basin. Calibration of the Kissimmee Lower Basin UNET model for the backfill conditions was accomplished by comparing the stage-discharge curve generated by UNET with the historical rating curve for a known location along the original Kissimmee River. Fort Kissimmee, located about 16.1 miles downstream of S-65 in Pool B and approximately adjacent to the proposed upstream terminus of the C-38 backfill reach, presented the best available location for the comparison. Figure A-8 reflects that the UNET stages, with a Manning's "n" value of 0.3 for the backfill, are slightly higher than the historical Fort Kissimmee stage for a given discharge.

(6) Tributary Lake Analyses.

(a) General. The following three lakes are connected directly to Lake Kissimmee either through natural tributaries or man-made canals. Hydraulic analyses were conducted with UNET to determine if and to what extent an increase in the Lake Kissimmee regulation schedule would impact the flood stages in the three lakes and tributaries.

(b) Lake Tiger. Lake Tiger and Lake Kissimmee are at approximately the same natural ground elevation (the 50-foot contour closely parallels the waters edge for both lakes on the USGS quadrangles) and are hydraulically connected by Tiger Creek. Tiger Creek is a small, mildly meandering natural stream which flows from Lake Tiger to Lake Kissimmee through a flat, swampy expanse of marshes over a distance of about 9,000 feet. Under normal stage and flow conditions, the head loss through Tiger Creek generally results in Lake Tiger exhibiting a 0.1 to 0.5 feet higher water stage than Lake Kissimmee. The head loss may increase to over 1 foot in the early phases of a flood when discharges through Tiger Creek are high and the Lake Kissimmee stage is still relatively low (i.e., less than elevation 51 feet). However, as the stage in Lake Kissimmee rises due to a larger flood event and approaches or exceeds 54 feet, the head difference between the two lakes is reduced to 0.1 feet or less. Improvements to Tiger Creek will result in a reduction in the head difference, however, Lake Tiger will invariably show a slightly higher stage than Lake Kissimmee.

Since the Lake Tiger flood stage is intrinsically linked to the Lake Kissimmee flood stage, outside of isolating Lake Tiger and installing a substantial pump station, there is no structural measure to insure that the Lake Tiger with-project stages can be reduced below those of Lake Kissimmee. Therefore, the flood control solution for Lake Tiger must be similar to that already recommended for Lake Kissimmee, which is a combination of implementing Plan 1 (C-36 and C-37 improvements, S-65 enlargement) and acquiring interest in lands to elevation 54 feet around Lake Tiger.

The prospect of a pumping station for Lake Tiger flood control was further pursued and cost were compared to the non-structural measure of purchasing real estate interests between elevation 52.5 and 54.0 feet around the lake. Sizing of the pump station based on the critical 25-year flood frequency indicated that a 1650 cfs capacity pump station would be required at the Tiger Creek outlet of Lake Tiger. Preliminary cost estimates, based on a similar sized pumping station, indicate that the machinery costs (pumps and drivers) and superstructure alone for a 1650 cfs pumping station would exceed $10,000,000. Additional costs would be incurred for inlet and outlet channels, culverts, and tieback levees extending to high ground. Annual operating and maintenance costs as well as environmental mitigation are additional considerations making the pumping option even less attractive.

(c) <u>Lake Rosalie</u>. Lake Rosalie is connected to Lake Kissimmee through Zipperer Canal, a man-made canal about 2.0 miles in length. G-103, a SFWMD weir structure is installed in the canal about 1.6 miles downstream from Lake Rosalie and helps, in part, to control the level in Lake Rosalie. The natural outlet of Lake Rosalie, however, is Rosalie Creek, a meandering stream at the south end of the lake, which discharges at a natural sill elevation of 50 feet downstream to Lake Tiger. According to SFWMD, Lake Rosalie is currently regulated between elevation 54.0 to 54.5 feet. If the G-103 weir crest is maintained at an elevation higher than the proposed Lake Kissimmee regulation schedule, which appears to be the current practice for Lake Rosalie, flood impacts from Lake Kissimmee will not extend upstream of the weir. Refer to "Lake Rosalie Analysis", Table A-21 for results.

Hydraulic analyses for the reach of Zipperer Canal downstream of G-103 were also made and according to Table A-22, "Zipperer Canal Analysis" show that the adverse stage impacts (note 25-year values) will be limited to an elevation of 54 feet or less.

(d) Lake Jackson. Lake Jackson is connected to Lake Kissimmee through Jackson Canal, a man-made canal approximately 2.75 miles in length. The Lake Jackson Water Control Structure (LJWCS), installed in 1994, was designed to maintain Lake Jackson at a higher stage (elevation 53.5 feet) in order to improve the aquatic habitat of the lake. Although the peak stages in Lake Jackson increased after the LJWCS was installed these impacts are attributable to the structure itself and to the higher regulation schedule for Lake Jackson. Table A-23, "LJWCS, Lake Jackson and Lake Marian Analysis" show that these locations are sufficiently elevated to remain unaffected by the changes in the Lake Kissimmee regulation schedule and S-65 capacity. Stage impacts resulting specifically from the increased Lake Kissimmee regulation schedule were limited to Jackson Canal downstream of the LJWCS. However, Table A-24 reveals that backwater effects due to implementation of Plan 1 would be restricted to river mile 6.0 to 6.5 along Jackson Canal and would be on the magnitude of 0.1 feet. Lake Kissimmee is considered to be at river mile 5.25 and LJWCS at river mile 7.5.

8. Joint Probability Analysis.

a. Hydrologic Criteria. In the process of performing rainfall runoff modeling, there are several hydrologic parameters that are unknown and which must be assumed before the analyses can begin. One of these relates to the antecedent hydrologic condition that will be present at the beginning of design storms. Whether the lakes, reservoirs, and/or canals in the basin are at a low, mean or high stage when the storm occurs, will have a significant effect on resulting peak flood stages. In past design studies, the criteria for the Central and Southern Florida Project has assumed that design storms will occur on hydrologic conditions expected during the wet season. Rainfall records show that most rainfall and large storms occur during the months of June, July, August, and September, commonly referred to as the hurricane season. For lakes that are regulated for flood control, the water level is prevented from exceeding a specified stage during the wet period to provide storage for storm water runoff. Therefore, the design storm for regulated lake basins was assumed to occur when the lake was at the maximum stage permitted by the regulation schedule during the wet season. For plotting purposes the storm has been shown to occur on 1 September. However, this was somewhat arbitrarily chosen and the 1 September date has no special significance.

The top of the wet season regulation schedule on Lake Kissimmee is currently 51.0 feet. Accordingly, the design criteria used for construction of upstream levees, canals, and structures 61 and 63A were based on rainfall runoff models that assumed that Lake Kissimmee would be at elevation 51.0 feet at the beginning of the design flood. That assumption is reasonable because the current regulation schedule and operating criteria for Lake Kissimmee tends to keep the lake at elevation 51.0 feet. If the lake exceeds 51.0 feet from June to September, S-65 is opened to a maximum discharge of 11,000 cfs to bring the lake back to the schedule. When the lake is below 51.0 feet, no releases are made. Of course, during extremely dry years the lake will be below elevation 51.0 feet during much of the, if not the entire, wet season; and, this deviation is not considered in determining flood stage probabilities. However, the criteria is appropriate for design because upstream levees, canals, and structures had to be designed to function on conditions that are likely to occur. For the period of record 1970 to 1988 under the current regulation schedule and operating criteria, Lake Kissimmee was on schedule during the wet season about 40 percent of the time.

The primary purpose of the rainfall runoff modeling in this study was not to design; but, to analyze and compare the hydrologic effects of the existing and proposed new regulation schedules, to insure that the Kissimmee project continues to function, and to maintain the same level of flood protection in the middle and upper Kissimmee basins as it was originally designed for all lands above 54.0 feet elevation. Below elevation 54.0 feet some increase in the flood risks could not be avoided because of the physical limit to gravity discharge from Lake Kissimmee with restoration of the Kissimmee River. Evaluation of the flood actuarial impacts of the new zoned regulation schedules requires a determination of the real flood risks for each schedule. The past criteria of beginning the analyses with the lakes at the top of the wet season schedule is not valid for zoned schedules.

The new alternative schedules are zone schedules, and while they may appear to be similar to the existing schedule, they differ greatly in performance. The alternative schedules permit Lake Kissimmee to rise an additional 1.5 feet to elevation of 52.5 feet during the wet season, However, discharge from the lake is not terminated when the lake falls below 52.5 feet. The new schedules have discharge zones and significant discharges will continue from Lake Kissimmee even when the lake level is below 52.5 feet. Period of record routings with the new schedule show that Lake Kissimmee will be at elevation 52.5 less than 10 percent of the time during the wet season. Accordingly, the past policy of assuming Lake Kissimmee at the wet season schedule elevation at the start of the design storms, is probably too conservative even for design. A new method of analyses had to be developed so that the flood stage frequency of the two different types of schedules could be compared. However, profiles showing the UNET results for the 51.0 existing and 52.5 proposed starting water levels are shown in the report. They are shown in part because they represent a worst case scenario for each storm frequency; but, mostly because the new method of analysis does not produce a flood profiles.

Flood stage frequency on Lake Kissimmee is a combination of the probabilities of both rainfall and antecedent lake stage. The probability that the lake will reach a given stage in any year is the sum of the probabilities of all the possible combinations of rainfall and beginning lake stages that could produce that stage. This relationship can be determined stochastically, or by numerical integration. In this study Lakes Kissimmee, Hatchineha, and Cypress were analyzed by both methods and the results compared. Both methods produced essentially the same results. The results obtained by integration were selected because the computations produce repeatable results. The results of the Stochastic method varied ± 0.1 feet depending on the initial seed value.

b. Stochastic Method. Daily period of record routings were made for Lake Kissimmee using the existing schedule and each of the alternative regulation schedules. Each routing produced a tabulation of daily stages from 1 January 1970 to 1 January 1988. From this output the percent of time the lake level exceeded a specific stage could be determined. Multiple HEC-1 runoff and UNET routing model runs were made for the 5-, 10-, 25-, 50-, 100-year, and SPF floods from all possible starting water surface elevations on Lake Kissimmee at one-half (1/2) foot increments. This produces a set of parallel frequency curves depicting stage rise in feet versus storm frequencies for various starting water surface elevations. From this data, the height the lake would rise for a storm of any frequency at any SWSEL within the modeled range can be obtained by interpolation.

The stochastic approach is to compute an annual maximum stage for a theoretical year by selecting a random lake stage and a random storm frequency for each year. The annual maximum stage for each year is derived by adding the corresponding stage rise obtained from the UNET data to the randomly selected stage. Annual maximum stages are derived for a large number of years and total stage frequency is determined by statistical analysis of the data.

For this study a day during the wet season, June through September, was selected randomly between 1970 and 1988. The stage of Lake Kissimmee corresponding to that day was obtained from the period of record UKISS routings. The random flood frequency was selected by randomly selecting a number between zero and one. For this random frequency and this random initial water surface elevation, a stage rise was obtained from the UNET flood routing model results. The annual maximum stage for each year was recorded as the algebraic sum of the beginning stage and the stage rise. This was repeated 10,000 times for each of the alternative regulation schedules and frequency analysis performed on the results.

c. Integration by Segmenting the Stage-Duration Curve. In the past, this has been the most common solution to joint probability of hydrologic data. A direct solution is obtained by segmenting the variables into a finite number of intervals. Daily Wet season stages obtained from the period of record routings from 1970 to 1988 were ordered and then segmented into 1/2 foot increment groups. The percentage of time that the lake level was within each segment was determined by dividing the number of days in that segment by 2196, the total wet season days from 1970 to 1988. Each segment of the stage duration curve represented a possible starting water surface level.

UNET model results showing stage rise for various flood frequencies were used to obtain the probability of experiencing a storm that would raise the lake a specific height above each of the segmented levels. The total probability of reaching any given flood stage is the sum of the products of the probability of reaching that stage from each segment, multiplied by the percent of time the lake level is within those segments. Perhaps it is easier visualized in terms of a hypothetical stage-duration curve and a given flood stage to compute the total probability. Figure A-22 is a sample calculation of the annual probability of the Lake Kissimmee stage exceeding 55.3 feet by joint probability.

d. Stage-Frequency. Stage-frequency curves generated from the joint probability approach comprise the analytical basis for evaluating different design alternatives and their relative performance to the existing condition. The four design alternatives analyzed in an attempt to satisfy the governing flood control criteria for the Middle Basin, that is, limiting flood stage impacts to less than elevation 54 feet, are discussed below:

Alternative 1 (With backfill and new regulation schedule) is the condition of restoration of the Kissimmee River and installation of the new schedule without any other structural modifications.

Alternative 2 (With backfill, new schedule, and enlarged canals) is the same as Alternative 1 but with enlargement to the canals C-36 and C-37 connecting Lakes Kissimmee, Hatchineha, and Cypress.

Alternative 3 (Plan 2) is the same as Alternative 2 but with an increase of 33 percent in the Lake Kissimmee outlet capacity by enlarging S-65 from a 3-bay to a 4-bay structure.

Alternative 4 (Plan 1) is the same as Alternative 2 but with an increase of 67 percent in the Lake Kissimmee outlet capacity by enlarging S-65 from a 3-bay to a 5-bay structure.

For each of the six middle basin locations (Kissimmee, Tiger, Hatchineha, Cypress, S-61 tailwater, S-63A tailwater) shown to be affected by the regulation change, stage frequency curves are presented based on:

a) a coincident frequency analysis approach

b) a UNET computation with the top of the wet season schedule as the initial condition

Although the S-65 enlargement and canal improvements were designed based on the coincident frequency approach, the latter values are plotted for comparison purposes only. Figures A-10 through A-21 show plots of the stage-frequency curves for existing conditions and the four alternatives using the proposed regulation schedule.

Review of the stage-frequency curves leads to several conclusions:

1. Alternative 1 satisfied the stage-frequency criteria for Lake Kissimmee, however, the increased stages at the upstream locations made it necessary to improve downstream conveyance by enlarging canals C-36 and C-37.

2. Alternative 2 satisfied the stage-frequency criteria for Lakes Cypress and Hatchineha,but the improved downstream conveyance increased stages in Lake Kissimmee above acceptable levels.

3. Alternative 3 (S-65: 4-bay) is unacceptable when compared to Alternative 4 (S-65: 5-bay) because the former does not restrict stage impacts on Lake Kissimmee to below elevation 54 feet.

4. Alternative 4 (S-65: 5-bay) is the recommended plan because it limits stage impacts at all six locations to elevation 54 feet or below (see 5. below).

5. Although the S-61 and S-63A tailwater locations show minor stage impacts (0.1 feet) above elevation 54 for the recommended plan, maintenance dredging of Canals 35 and 34 to their as-built templates will remedy the situation.

9. Stage-Duration. Although stage and flow-duration curves under a variety of conditions and alternative schedules are presented in Appendix F, two of the more general and informative graphs are presented in this appendix. Figure A-23 compares the Lake Kissimmee stage-duration for the pre-flood control project period of 1929-1960 with the existing project period of 1970-1988. The curves, based on actual daily gage values over the period, reflect a wider fluctuation in lake stage for the pre-project or unregulated period. The larger variation in the natural system was due primarily to a less efficient outlet from Lake Kissimmee in the form of the meandering Kissimmee River and the absence of the S-65 control structure operating in conjunction with an established regulation schedule. Flood and wet season stages are now reduced because of the improved outlet capacity at S-65 and the downstream conveyance of C-38 while dry season stages tend to be higher because releases from S-65 are curtailed when the lake is below schedule. It should be noted that the extreme drawdown of Lake Kissimmee in 1977 inappropriately skews the post-project data on the low end of the curve. A graphical comparison of the Lake Kissimmee stage-duration when routed by the UKISS model under the existing and proposed regulation schedules is shown in Figure A-24. Although the proposed schedule results in a wider variation in stage, the increase in stage at the upper end of the curve (above elevation 52 feet) is appreciably less than the proposed 1.5 foot increase in the schedule. At stages below elevation 51.85 feet the proposed schedule results in stages on the average about 0.5 feet lower than the existing schedule. These reductions can be attributed to the near continual release nature of the proposed operating criteria which specifies a stage-discharge relationship be maintained even when the lake falls below schedule.

10. Hydraulic Design Criteria.

a. General. The hydraulic designs of recommended improvements for the Kissimmee River Restoration are based on approved design practices and applicable criteria set forth in EM 1110-2-1601, Hydraulic Design of Flood Control Channels and EM 1110-2-1603, Hydraulic Design of Spillways. Hydraulic analyses and designs were accomplished with HEC-2, a one-dimensional steady flow modeling computer program supported by the Hydrologic Engineering Center (HEC), Davis, California. The primary objective of these improvements was to maintain existing flood control while increasing environmental benefits to the Kissimmee chain of lakes via a wider and more natural fluctuation of water stages. Erosion protection measures were included to ensure stability in areas where high flow velocities are expected (e.g., bridges, alignment curves, etc.).

b. Existing Hydraulic Conditions.

(1) Topographic Data. Due to the vast size of the project area, numerous surveys were conducted to obtain adequate topographical coverage. Topographic data used in construction of the hydologic and hydraulic models for analyses of existing hydraulic conditions and development of hydraulic designs were obtained from surveys in 1979, 1991, and 1993-1994 and USGS quadrangle maps. These data included cross-sections for the project area canals and principal tributaries connecting the major lakes of the Middle Basin. Additional topographic data were obtained in cross-sectional format at 500-foot intervals for Canals 34, 35, 36, and 37. Designs for modifications to S-65 were based on spot elevations on a 50- to 80-foot grid.

(2) Canal Characteristics. Existing canals in the project area are shown on Plates A-1 and A-2 and are described as follows:

C-34(Canoe Creek) begins at the south side of Lake Gentry and ends at the east side of Lake Cypress. Two spillway structures, S-63 and S-63A, drop the water surface elevation from a design headwater peak stage of 62.8 feet at S-63 to a design tailwater peak stage of 53.8 feet at S-63A. Canal side slopes are 1 vertical to 2 horizontal (1V:2H). Bottom widths range from 20 feet at S-63 to 70 feet at its southern terminus. Total length of the canal is about 5.7 miles. Photo A-4 shows C-34 looking downstream from S-63A.

C-35(South Port Canal) begins at Structure 61 on the south side of Lake Tohopekaliga and ends at the northwest side of Lake Cypress. The water surface elevation for the design tailwater peak stage is 54.3 feet at S-61. The canal has side slopes of 1V:2H, a constant invert elevation of 30.6 feet, and a bottom width of 20 feet. Total length of the canal is about 4.1 miles. Photo A-2 shows C-35 looking downstream from S-61.

C-36 connects Lake Cypress with Lake Hatchineha. C-36 has side slopes of 1V:2H, a constant invert elevation of 31.3 feet, and a bottom width of 48 feet. Total length of the canal is about 2.8 miles. Photo A-5 shows C-36 looking downstream along the east disposal bank.

C-37 connects Lake Hatchineha with Lake Kissimmee. The canal has side slopes of 1V:2H and a bottom width of 70 feet. Invert elevations range from 27.6 feet at Lake Hatchineha to 26.6 feet at Lake Kissimmee. Total length of the canal is about 3.9 miles. Photo A-6 shows C-37 looking downstream along the east disposal bank.

C-38 is the outlet for Lake Kissimmee flows to Lake Okeechobee. Stages are regulated along the canal by six water control structures, S-65, S-65A, S-65B, S-65C, S-65D, and S-65E. These structures are designed to step down the 36-foot fall of the canal in six-foot increments. Bottom widths range from 90 feet at S-65 to 425 feet at S-65E. Side slopes are 1V:2H. Invert elevations range from 19.0 feet to -14.0 feet over the canal length of about 56 miles.

(3) Tributaries. Middle Basin tributaries typically have well defined channels with sinuous flow paths. Bed slopes are mild, ranging from about 2.0 to 2.5 feet per mile. Tributaries are generally in a natural condition with no evidence of man-made channelization. Overbank areas are low-lying and heavily vegetated with dense brush. Major Middle Basin tributaries are shown on Plate A-1. Photos A-12 and A-13 are views of Reedy Creek looking upstream from C.R. 531 and looking upstream from the CSX Railroad Bridge at U.S. 92, respectively.

c. Design Canal Characteristics.

(1) Design Water Surface in Canals. The design water surface elevation would be based on the flood level at which flood damages and other adverse effects are considered relatively minor. The initial design constraint limited canal widening to one side of the canals to minimize impacts to existing cypress trees adjacent to the canals.

(2) Maximum Permissible Velocities. Based on canal bed material found in the project areas the maximum non-erosive velocities for Canals 34, 35, 36, 37, and 38 would be 2.0 feet per second.

(3) Side Slopes. Based on geotechnical investigations of slope stability, a maximum side slope of 1 vertical to 2.5 horizontal would be used for modifications to project canals.

(4) Cross-Sections. Canal cross-sections are based on the most economical section that would carry the design discharge at the design water surface and slope.

(5) Roughness Coefficients. Roughness coefficients for Manning's equation were based on several site visits between 1992 and 1994 and reference to Chow's Open Channel Hydraulics (1959) and Barnes' Roughness Characteristics of Natural Channels (1967).

(6) Transitions. Smooth transitions would be provided at all changes in canal geometry or slope. Transitions of about 100 feet in length are recommended wherever dimensions of the canal are changed.

(7) Freeboard. No freeboard was considered in the canal designs.

d. Existing Bridges. There are numerous bridges that cross the study area's canals. C-34 is crossed by two privately owned farm road bridges, S.R. 523, and the Florida's Parkway. C-35 is crossed by a farm road immediately downstream of S-61. There are no bridges over C-36. C-37 is crossed by the privately owned Zipperer Bridge. S.R. 60 crosses the outlet of Lake Kissimmee about 380 feet upstream of S-65. Locations of major roads are shown on Plate A-1.

e. Existing Water Control Structures. Existing structures in the project area are shown on Plate A-1 and are described as follows:

S-61 is a one-bay spillway located on C-35 at the outlet of Lake Tohopekaliga. The structure is constructed of reinforced concrete and discharge is controlled by a cable operated vertical lift slide gate. The structure also consist of a reinforced concrete lock structure with two pairs of sector gates. Photo A-1 shows the downstream side of S-61.

S-63A is a two-bay spillway located on C-34 about 500 feet upstream from S.R. 523 and about 2.5 miles upstream from Lake Cypress. The structure is constructed of reinforced concrete and discharge is controlled by cable operated vertical lift slide gates. The structure also consist of a reinforced concrete lock structure with two pairs of sector gates. Photo A-3 shows the downstream side of S-63A.

S-65 is a three-bay spillway located at the outlet of Lake Kissimmee about 380 feet downstream from S.R. 60 on the Kissimmee River. The structure is constructed of reinforced concrete and discharge is controlled by cable operated vertical lift slide gates. The structure also consist of a reinforced concrete lock structure with two pairs of sector gates. Plate A-3 shows a detailed plan view of S-65. Photo A-7 is an aerial view from the southwest of the S-65 spillway, lock, and lock operator's residence with the S.R. 60 bridge in the foreground.

f. Disposal Areas. All disposal material would be placed in areas that would not adversely impact the current flow path.

g. Sediment Potential. Existing and project canals within the project area are typically very flat and were designed with very little hydraulic slope. Velocities under design discharges and low frequency flood events are generally less than 2.5 feet per second. Therefore, it is not anticipated that appreciable shoaling and scouring will occur during design discharges.

11. Hydraulic Analyses of Existing Conditions.

a. Model Development. HEC-2 models were developed to analyze flows immediately upstream and downstream of S-65. The models were developed from spot elevations spaced about 50 feet to 80 feet on center and surveyed in 1991. Cross-sections were spaced at 20-foot intervals near the structure and increased to 100-foot intervals at the farthest cross-sections from the structure. The downstream model(getaway channel) extends from about 840 feet downstream of the structure to the structure's end sill. The upstream model(approach channel) extends from the upstream apron of the structure to about 100 feet upstream of the S.R. 60 bridge, a distance of about 480 feet. S.R. 60 bridge piers and abutments were included in the model.

The starting water surface elevations corresponded to various flow conditions. The following starting water surface elevations at the upstream side of S-65 are shown for respective flow conditions. The same starting water surface elevations were used for both existing and with-project conditions with the exception of the optimum range of water surface elevations.

FLOW CONDITION	STARTING WATER SURFACE ELEV.
Design	51.5 feet, NGVD
SPF	58.0
Critical	58.0
Optimum(Existing)	48.5 to 52.5
Optimum(With-Project)	48.5 to 54.0
Minimum	46.7

The following starting water surface elevations at the downstream side of S-65 are shown for respective flow conditions. The same starting water surface elevations were used for both existing and with-project conditions.

FLOW CONDITION	STARTING WATER SURFACE ELEV.
Design	49.0 feet, NGVD
SPF	53.1
Critical	48.2
Optimum	46.3
Minimum	44.0

Roughness coefficients for Manning's equation were based on several site visits in summer, 1994 and reference to Chow's <u>Open Channel Hydraulics</u> (1959) and Barnes' <u>Roughness Characteristics of Natural Channels</u> (1967).

In attempting to calibrate the HEC-2 models, data correlating stages with known discharges at specific locations were not available. Cross-section geometry, hydraulic input data, and resulting HEC-2 water surface profiles were compared as a relative check.

b. <u>Tributaries</u>. Major tributaries in the Middle Basin were modeled with the UNET models. These tributaries included Reedy Creek, Dead Creek, Rosalie Creek, and Tiger Creek. Cross-sections for the UNET models were based on topographic surveys obtained in 1991, USGS quadrangle interpolations, and field observations.

c. <u>Conclusions</u>. The HEC-2 models were used to compute water surface profiles and channel velocities at the immediate location of S-65 for an array of flow conditions under existing conditions. These data were used for determining the effects of increased discharges and/or stages for the with-project conditions. Comparison of the model results revealed negligible changes in water surface profile elevations and channel velocities.

Comparison of the existing and with-project conditions for the UNET models showed that the with-project's starting water surface elevations were higher at the mouth of Dead and Reedy Creeks. However, the peak stages for the existing condition were higher at those same locations. This is because of the widening of C-36 and C-37 and the increased outlet capacity at S-65. Therefore, no adverse impacts beyond those that currently exist are anticipated for the with-project condition.

12. <u>Hydraulic Designs</u>.

a. <u>General</u>. Hydraulic designs for the plan of improvement to the Middle Basin canals were performed with use of the UNET models. Hydraulic designs of the approach and getaway channels as part of the S-65 modification were performed with use of the HEC-2 models.

b. <u>Recommended Plan</u>.

Several alternative plans were evaluated. Alternatives consisted of: "no action", which would leave the existing Middle Basin works in place and operating with existing schedules; modification of the regulation schedules for various combinations of the Middle Basin Lakes; and various combinations of land acquisition and structural modifications, such as canal dredging, to control effects of changed water levels. These alternatives were formulated and evaluated in detail, including hydrologic modeling and environmental analyses.

Based on the performance of the alternatives, the recommended plan for the Headwaters Revitalization Project includes the following features:

Modification of Existing Lake Kissimmee Regulation Schedule. Modification of the regulation schedule is necessary for the restoration of the Kissimmee River and to expand the upper Kissimmee lake littoral zones. The proposed regulation schedule is shown in Appendix B, Figure B-9.

Land Acquisition. Acquisition of approximately 20,800 acres of land bordering the affected lakes, Lake Hatchineha, Lake Kissimmee, Lake Cypress and Lake Tiger. See Plate 8-1 in the main report.

Widening of Flood Control Canals. Because of the increased tailwater flood stages at S-65 resulting from the modified regulation schedule, the flood control canals connecting Lake Kissimmee to Lake Hatchineha, C-37, and Lake Hatchineha to Lake Cypress, C-36 will have to be enlarged to flatten the flood profile through the upper lakes and prevent increasing flood stages.

Degradation of Local Levees. Breaching of five local levees is recommended for obtaining additional water storage in the Middle Basin and to expand the range of Middle Basin restoration. See Plate 8-1 in the main report for locations of local levees.

Increase Outlet Capacity of S-65. Modifications to the existing S-65 will be needed to provide a greater discharge capacity. If a low-frequency storm event coincides with the top of the regulation schedule water will need to be discharged from S-65 at a greater rate to prevent adverse impacts. As part of the increased outlet capacity of S-65, modification to C-38 at the immediate location of the structure is required. The canal would be widened to accommodate the additional two-bay structure and to provide an even flow distribution to the five bays.

Level of Protection. The level of protection for the recommended plan will be equal to or greater than the flood protection of the existing project at elevations of 54 feet and higher. The existing project design specifies protection for the 30% SPF event.

c. Canals. The recommended plan of improvement does not require modifications to Canals 34 and 35.

C-36 would be widened from its original bottom width of 48 feet to 60 feet. Widening would be performed on the canal's west side only. Maintenance dredging of C-36 would restore the invert elevation to 31.3 feet. Canal widening would increase the canal's discharge capacity by about 15 percent for a 10-year event.

C-37 would be widened from its original bottom width of 70 feet to 90 feet. Canal widening would be performed on the canal's east side only. Maintenance dredging would restore the invert elevation to 27.6 feet at Lake Hatchineha and transition to 26.6 feet at Lake Kissimmee. Canal widening and maintenance dredging would not be performed at the location of the Zipperer Bridge. Transition reaches of about 100 feet in length would be provided upstream and downstream of the bridge. Canal widening would increase the canal's discharge capacity by about 20 percent for a 10-year event.

Modifications for C-38 would be limited to excavations required for construction of the new two-bay structure and approach and getaway channels. Canal modifications would extend about 700 feet downstream and about 350 feet upstream of the structure.

d. Tributaries. Because of the limited backwater effects in the tributaries due to the recommended plan, no modifications are recommended.

e. Levees. The recommended plan does not require construction of any levees. Breaching of local levees is recommended for obtaining additional water storage in the Middle Basin and to expand the basin's range of restoration. Approximately one mile of levee sections or about 60,000 cubic yards will be degraded by backfilling nearby borrow ditches. The five local levees are Bronson Levee located along Lake Cypress, Overstreet and Oasis Levees located along Lake Kissimmee, and Rolling Meadows and Sparks Candler Levees located along Lake Hatchineha.

Levees will be degraded by pushing the mounded fill back into the adjacent borrow source ditches. The earth will be graded to the extent necessary to restore the area to its natural ground elevation. No offsite disposal areas will be required for the operation. The levees will be breached in a series of 100-foot gaps and will substantially impede the flow of flood waters landward of the levees. Gaps will be spaced at about 1,000-foot intervals. Gap spacing will be optimized to correspond with degrading low lying areas first and to avoid areas presently overgrown with substantial trees. Tree lined areas will remain intact to provide a source of alternative upland habitat.

f. Bridges. The recommended plan does not require modifications to any bridges in the project area.

The recommended canal design for C-37 would not require canal widening and maintenance dredging at the location of the Zipperer Bridge. Canal improvements would be done to within about 100 feet upstream and downstream of the bridge.

Canal modifications as part of the new structure at S-65 would have a northern limit just downstream of the S.R. 60 bridge and would have no adverse impacts on the bridge.

g. Structures.

(1) General. The S-65 Expansion is a two-bay spillway structure located at the outlet of Lake Kissimmee along the Kissimmee River. Each bay would consist of a reinforced concrete ogee weir with vertical lift slide gate controls. The structure would lie 24 feet to the east of the existing three-bay spillway structure. The 24-foot offset is required such that the foundation of the existing structure does not interfere with construction of the new structure. Plates A-3 and A-4 show plan views of the existing S-65 and recommended S-65 Expansion, respectively. Typical section views of the additional structure are shown on Plate S-3. A summary of hydraulic design data for the structures are given on Tables A-26 through A-28.

(2) Crest. The crest is a ogee weir and was designed in accordance with guidelines and equations set forth in EM 1110-2-1603. The design head (H_d) is the maximum head differential on the weir that would occur during the standard project flood.

(3) Gates. The vertical lift slide gates of S-65 and S-65 Expansion would be operated symmetrically.

(4) Tieback Levee. The S-65 Expansion would be constructed along the existing tieback levee/access road to S-65. Therefore, construction of an additional tieback levee would not be required.

(5) Energy Dissipation. Adequate energy dissipation to prevent downstream erosion would be accomplished with two rows of baffle blocks and an end-sill. Baffle blocks designs are based on physical modeling conducted for S-65B, S-65D, and S-65E in 1979 by the Waterways Experiment Station, Vicksburg, Mississippi. Results of physical modeling for S-65B were considered applicable for S-65 because of their similar structural configuration and range of hydraulic parameters. Baffle block and end-sill designs were verified with guidelines and equations set forth in EM 1110-2-1603. Plate S-2 shows baffle block layout and details and end-sill.

(6) Riprap. Riprap protection for high discharge events would be required for the approach and getaway channels. Limits of riprap placement are shown on Plate S-1.

(7) Discharge Rating Curves. Discharge rating curves were developed for the expected headwater and tailwater extremes. Headwater and tailwater elevations at the structures are expected to range from elevation 45.0 feet to 58.0 feet and 44.0 feet to 55.0 feet, respectively. Discharge rating curves and applicable derivations, formulas, and coefficients for controlled and uncontrolled discharges of the structures are shown on Figures A-25 through A-33.

(8) Water Level Recorders. Automatic water level recorders and staff gages would not be required for the additional S-65 since these items are currently located at the existing S-65. An automatic gate position recorder would be installed for the additional structure.

h. Disposal Areas. The recommended plan of improvement calls for the excavated material to be placed on existing spoil mounds adjacent to the canals. Placement of the material on the spoil mounds would not adversely impact the current flow path.

i. Project Performance/Water Surface Profiles. The level of protection for the recommended plan will be equal to or greater than the flood protection of the existing project at elevations of 54 feet and higher. The existing project design specifies protection for the 30% SPF event. Examination of the stage-frequency curves, Figures A-10 through A-21, for the recommended plan (Plan 1) reflect that depending on the location, a stage of 54 feet will be reached with varying frequency events. This occurs because unlike previous analyses when a level pool was assumed for Lakes Kissimmee, Hatchineha, and Cypress, headloss between the lakes results in the requirement of a less severe flood to reach a given stage as one progresses upstream. For example, a stage of 54 feet would represent approximately a 4, 4.5, 7.5, 10, and 20 percent chance of exceedence event for Lakes Kissimmee, Tiger, Hatchineha, Cypress, and S-61 tailwater locations, respectively. It should be noted that with C-35 restored to its original as-built template the chance of exceeding a stage of 54 feet would be reduced to about 14 percent for the S-61 tailwater location. Although guidance requires that flood events now be measured in percent chance of exceedence, an approximation to return frequency in years can be estimated as 100 percent divided by percent chance of exceedence, thus 14 percent chance of exceedence is about a 7.4-year event. This minimum level of protection agrees with the common assertion that a 30 percent SPF flood represents between a 5- and 10-year event for the Middle Kissimmee Basin. The above percent chance of exceedences are based on a coincident frequency analysis; the chance of exceeding elevation 54 feet would increase if a top of wet season schedule was selected as the initial condition to begin the analyses.

13. Sediment Assessment. A limited sediment assessment showed that a small amount of shoaling has occurred over the project life to date. The project canals were built in the early to middle 1960's. Since their construction, about 3.0 to 3.5 feet (approximately 14-16% of total depth) of shoaling has occurred in C-36 and about 3.5 to 4.0 feet (approximately 14-16% of total depth) in C-37. Plate A-5 shows typical cross-sections for the canals with existing cross-sections based on the 1991 surveys overlaying the original design templates.

Comparison of 10-year existing and with-project conditions showed similar velocities for C-36 and C-37. Velocities for the 10-year event under these conditions were about 2.3 feet per second for both canals. Bottom material found in C-36 and C-37 consisted mostly of fine to medium sands with a d_{50} ranging from 0.177 to 0.354 mm. Using Figure A-34, bed material movement would not occur for velocities less than about 4.0 feet per second. Therefore, an increased rate of shoaling is not anticipated for the with-project condition.

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT
Appendix A
Hydrology and Hydraulic Analyses

TABLES

TABLE A-10

MIDDLE BASIN HYDROLOGIC PARAMETERS

SUB-BASIN NO.	SUB-BASIN NAME	DRAINAGE AREA (SQ. MI.)	CURVE NUMBER	HEC-1 LAG (HOURS)
168, 167 166, 165 164, 163	REEDY CREEK IMPROVEMENT DISTRICT @ S-40	184.25	44	16
162	REEDY CREEK	36.91	74	40
162A	REEDY SWAMP	14.59	74	25
162B	LOWER LOUGHMAN	6.87	40	12
161A	LAKE RUSSELL	4.17	74	7.8
	(lake)	1.15	100	
161B	LOWER REEDY	19.26	74	20
152	HORSE CREEK	27.33	52	34.6
151A	LAKE PIERCE	44.88	52	38
	(lake)	5.96	100	
151B	CATFISH CREEK	15.56	63	13.7
142	MARIAN	49.12	74	33.6
	(lake)	10	100	
141	JACKSON	33.53	74	36.6
	(lake)	2.4	100	
133	WEOHYAKAPKA	35.09	74	13.7
	(lake)	11.8	100	
133A	TIGER CREEK	37.14	52	33.6
132	TIGER	9.03	74	8
	(lake)	5.3	100	
131	ROSALIE	28.55	74	8
	(lake)	10.4	100	
121	CANOE CREEK	6.7	73	16
113	CYPRESS	16.8	73	11.1
	(lake)	8.59	100	
112A	LAKE MARION	28.1	52	10.8
	(lake)	4.74	100	
112B	LAKE MARION CREEK	35.19	63	34.6
112C	LONDON CREEK	10.41	63	10
112D	HATCHINEHA	32.27	74	12.8
	(lake)	13.59	100	
111	KISSIMMEE	131.71	73.5	16.8
	(lake)	63.67	100	
	TOTALS	945.06 SQ. MILES		

TABLE A-11

COMPARISON OF 1994 HEC-1 RESULTS WITH 1991 FEASIBILITYREPORT

	LAKE KISSIMMEE PEAK STAGE, EL. FT.					
	5-YEAR	10-YEAR	25-YEAR	50-YEAR	100-YEAR	SPF
1994 HEC-1 EXISTING CONDITIONS	53.13	53.53	54.57	55.10	55.61	57.06
1991 CHANOP EXISTING CONDITIONS	52.81	53.46	N/A	54.93	55.49	56.56
1994 HEC-1 WITH-PROJECT CONDITIONS	53.78	53.86	54.56	54.96	55.37	56.53
1991 CHANOP WITH-PROJECT CONDITIONS	53.81	54.05	N/A	55.03	55.42	56.40

NOTE:

1. 1994 ANALYSES USE A HEC-1 UPPER/MIDDLE BASIN MODEL CONSTRUCTED DOWNSTREAM TO S-65.

2. 1991 ANALYSES USE A CHANOP UPPER/MIDDLE BASIN MODEL CONSTRUCTED TO S-65 IN CONJUNCTION WITH A DWOPER LOWER BASIN MODEL CONSTRUCTED FROM S-65 TO S-65E.

3. EXISTING CONDITIONS ASSUMES A LAKE KISSIMMEE SWSEL OF 51.0 FT, EXISTING CANALS AND S-65 CAPACITY OF 11,000 CFS. S-65 DISCHARGE IS REDUCED TO 3,000 CFS WHEN S-65A HEADWATER EXCEEDS ELEVATION 46.6 FEET.

4. WITH-PROJECT CONDITIONS ASSUMES A LAKE KISSIMMEE SWSEL 0F 52.5 FT, EXISTING CANALS, BACKFILL PLACED IN C-38 AND S-65 CAPACITY OF 11,000 CFS. S-65 DISCHARGE IS RESTRICTED TO 6,000 CFS UNTIL LAKE KISSIMMEE REACHES ELEVATION 53.8 FEET.

TABLE A-12

LOWER BASIN HYDROLOGIC PARAMETERS

POOL	HEC-1 SUB-BASIN NO.	SUB-BASIN NAME	DRAINAGE AREA (SQ. MILES)	CURVE NUMBER	HEC-1 LAG (HOURS)
A	1	UNNAMED	1.52	71	14.8
A	2	BUTTERMILK SLOUGH	33.31	71	22.8
A	3	BLANKET BAY SLOUGH	30.51	71	64.7
A	4	ICE CREAM SLOUGH	13.89	71	30.2
A	5	UNNAMED	2.68	71	24.2
A	6	TICK ISLAND SLOUGH	37.56	71	35.5
A	7	UNNAMED	4.16	71	17.6
A	8	UNNAMED	8.26	71	33.7
A	9	S-65A EAST	17.48	71	37.4
A	18	S-65 EAST	1.00	71	7.4
A	19	UNNAMED	1.34	71	6.1
A	20	LONG HAMMOCK SLOUGH	3.04	71	5.8
A	21	UNNAMED	2.58	71	8.7
A	22	UNNAMED	2.40	71	10.2
A	23	UNNAMED	3.23	71	16.3
A	AREM	A-REMAINDER	12.32	72	20.0
		POOL "A" TOTAL	175.28 SQ. MILES		
B	10A	PINE ISLAND SLOUGH	41.16	72	60.1
B	10B	SEVEN MILE SLOUGH	73.10	72	39.3
B	11	DUCK SLOUGH	14.60	72	68.1
B	24	ORANGE HAMMOCK	3.54	72	17.0
B	25	UNNAMED	1.13	72	9.0
B	26	FORT KISSIMMEE	2.27	72	10.5
B	27	UNNAMED	3.28	72	14.7
B	28	AVON PARK	2.56	72	17.0
B	29	BILL BAY	14.53	72	17.0
B	30	MOSQUITO HAMMOCK	12.09	72	11.7
B	36	UNNAMED	1.92	72	8.1
B	37	SADDLE HAMMOCK	1.85	72	10.0
B	38	McGUIRE HAMMOCK	0.75	72	14.5
B	39	RODGERS HAMMOCK	1.95	72	9.2
B	BREM	B-REMAINDER	17.25	72	24.0
		POOL "B" TOTAL	191.98 SQ. MILES		

TABLE A-12 (continued)

LOWER BASIN HYDROLOGIC PARAMETERS

POOL	HEC-1 SUB-BASIN NO.	SUB-BASIN NAME	DRAINAGE AREA (SQ. MILES)	CURVE NUMBER	HEC-1 LAG (HOURS)
C	12	STARVATION SLOUGH	11.31	74	24.3
C	13	HICKORY HAMMOCK	11.59	74	27.9
C	14	OAK CREEK	29.39	74	52.7
C	31	BLUFF HAMMOCK	2.46	74	4.5
C	32	DINNER BAY	1.30	74	4.8
C	33	HOLE IN THE WALL	1.09	74	4.6
C	34	UNNAMED	2.59	74	14.8
C	35	UNNAMED	1.88	74	8.1
C	40	UNNAMED	0.85	74	5.7
C	41	S-65C EAST	1.26	74	8.5
C	50	ISTOKPOGA	31.55	74	42.8
		POOL "C" TOTAL	95.27 SQ. MILES		
D	15	CHANDLER SLOUGH	101.98	74	64.3
D	42	S-65C EAST	3.54	74	12.2
D	43	UNNAMED	2.38	74	7.9
D	44	UNNAMED	5.05	74	18.2
D	45	UNNAMED	2.13	74	10.3
D	46	CORNWELL	4.65	74	14.8
D	48	FORT BASINGER	2.24	74	8.0
D	DREM	D-REMAINDER	45.34	74	32.0
		POOL "D" TOTAL	167.31 SQ. MILES		
		POOL "A", "B", "C", "D" TOTALS	629.84 SQ. MILES		

TABLE A-13

COMPARISON OF KISSIMMEE LOWER BASIN HYDROLOGIC PARAMETERS BY POOL

	1990 SFWMD / 1985 CORPS REPORTS			1995 CORPS 1135 REPORT		
	DRAINAGE AREA (SQ. MILES)	SCS CURVE NUMBER	LAG (HOURS)	DRAINAGE AREA (SQ. MILES)	SCS CURVE NUMBER	LAG (HOURS)
POOL A	161.32	71	20	175.28	71	N/A
POOL B	202.43	72	24	191.98	72	N/A
POOL C	78.29	74	16	95.27	74	N/A
POOL D	184.55	74	32	167.31	74	N/A
TOTALS	626.6			629.8		

NOTE:

1. THE 1994 CORPS ANALYSES SUBDIVIDE EACH POOL INTO INDIVIDUAL DRAINAGE SUB-BASINS. THE LAG TIMES FOR EACH OF THE SUB-BASINS IS SHOWN IN TABLE A-.

2. POOL E DATA IS NOT SHOWN SINCE THE 1994 CORPS HEC-1 AND UNET MODELS EXTEND ONLY TO THE DOWNSTREAM END OF POOL D AT S-65D.

TABLE A–14

UNET PEAK STAGES (UPPER/MIDDLE BASIN MODEL ONLY)

PEAK STAGES EL., FT.	LAKE KISSIMMEE SWSEL @ EL. 52.5 FT.	
	WITH–PROJECT S–65 6,000 CFS FIRM 11,000 CFS @ EL. 53.8 FT. C–35 20' B.W., C–36 48' B.W. C–37 70' B.W.	FULL CANALS S–65 6,000 CFS FIRM 11,000 CFS @ EL. 53.8 FT. C–35 40' B.W., C–36 80' B.W. C–37 160' B.W.
5–YEAR		
S–61 T.W.	55.22	54.37
CYPRESS	54.96	54.27
HATCHINEHA	54.75	54.08
KISSIMMEE	53.84	53.86
TIGER	53.90	53.93
10–YEAR		
S–61 T.W.	55.64	54.55
CYPRESS	55.38	54.46
HATCHINEHA	55.11	54.24
KISSIMMEE	53.86	53.93
TIGER	54.01	54.04
25–YEAR		
S–61 T.W.	56.33	55.50
CYPRESS	56.08	55.38
HATCHINEHA	55.78	55.28
KISSIMMEE	54.14	54.98
TIGER	54.33	55.00
50–YEAR		
S–61 T.W.	56.86	56.06
CYPRESS	56.64	55.96
HATCHINEHA	56.42	55.89
KISSIMMEE	54.78	55.63
TIGER	54.79	55.64
100–YEAR		
S–61 T.W.	57.24	56.54
CYPRESS	57.04	56.46
HATCHINEHA	56.90	56.42
KISSIMMEE	55.60	56.19
TIGER	55.61	56.20
SPF		
S–61 T.W.	58.44	58.11
CYPRESS	58.27	58.05
HATCHINEHA	58.27	58.04
KISSIMMEE	58.00	57.95
TIGER	58.00	57.95

TABLE A-15

UNET PEAK STAGES

(BASED ON COINCIDENT FREQUENCY ANALYSIS)

	L. KISS SWSEL 49.0 TO 51.0 FT.	L. KISSIMMEE SWSEL VARIES BETWEEN EL. 48.5 TO 52.5 FEET BASED ON PERIOD OF RECORD ROUTINGS									
PEAK STAGE (EL., FT.)	EXISTING CONDITIONS S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	WITH BACKFILL S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	VS. EX.	DESIGN CANALS S-65 11,000 CFS C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 2 (B/F "n" = 0.3) S-65: 4-BAY CAP. C-35,20' C-36, 60' C-37, 90'		PLAN 1 ("n"=0.15/0.30/0.15) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 1 (B/F "n" = 0.3) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.
5-YEAR											
S-61 T.W.	53.91	54.53	0.6	54.11	0.2	54.05	0.1	53.96	0.0	54.01	0.1
S-63A T.W.	53.85	54.49	0.6	54.03	0.2	54.01	0.2	53.94	0.1	53.98	0.1
CYPRESS	53.47	54.15	0.7	53.67	0.2	53.63	0.2	53.52	0.0	53.58	0.1
HATCHINEHA	52.87	53.82	1.0	53.39	0.5	53.35	0.5	53.23	0.4	53.3	0.4
KISSIMMEE	51.77	52.73	1.0	52.83	1.1	52.83	1.1	52.69	0.9	52.77	1.0
TIGER	52.39	52.99	0.6	53.03	0.6	52.99	0.6	52.96	0.6	52.99	0.6
JACKSON	56.8	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0
ROSALIE	56.1	56.1	0.0	56.1	0.0	56.1	0.0	56.1	0.0	56.1	0.0
MARIAN	61.4	61.4	0.0	61.4	0.0	61.4	0.0	61.4	0.0	61.4	0.0
S-65 T.W.	49.66							51.15	1.5	51.9	2.2
S-65A H.W.	48.04							50.31	2.3	51.27	3.2
S-65A T.W.	44.18							49.96	5.8	50.99	6.8
@ BACKFILL	43.93							49.65	5.7	50.71	6.8
S-65B H.W.	42.86							44.27	1.4	44.75	1.9
S-65B T.W.	35.4										
S-65C H.W.	34.35							38.52	4.2	39.39	5.0

TABLE A-15 (continued)

UNET PEAK STAGES

(BASED ON COINCIDENT FREQUENCY ANALYSIS)

PEAK STAGE (EL., FT.)	L. KISS SWSEL 49.0 TO 51.0FT.	L. KISSIMMEE SWSEL VARIES BETWEEN EL. 48.5 TO 52.5 FEET BASED ON UKISS PERIOD OF RECORD ROUTINGS									
	EXISTING CONDITIONS S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	WITH BACKFILL S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	VS. EX.	DESIGN CANALS S-65 11,000 CFS C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 2 (B/F "n" = 0.3) S-65: 4-BAY CAP. C-35,20' C-36, 60' C-37, 90'		PLAN 1 ("n"=0.15/0.30/0.15) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 1 (B/F "n" = 0.3) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.
10-YEAR											
S-61 T.W.	54.53	54.96	0.4	54.47	-0.1	54.47	-0.1	54.26	-0.3	54.38	-0.1
S-63A T.W.	54.53	54.94	0.4	54.5	-0.0	54.49	-0.0	54.33	-0.2	54.43	-0.1
CYPRESS	54.16	54.62	0.5	54.09	-0.1	54.09	-0.1	53.86	-0.3	53.99	-0.2
HATCHINEHA	53.69	54.29	0.6	53.85	0.2	53.85	0.2	53.57	-0.1	53.74	0.1
KISSIMMEE	52.41	53.09	0.7	53.29	0.9	53.29	0.9	52.97	0.6	53.17	0.8
TIGER	52.93	53.35	0.4	53.46	0.5	53.44	0.5	53.26	0.3	53.37	0.4
JACKSON	57.4	57.4	0.0	57.4	0.0	57.4	0.0	57.4	0.0	57.4	0.0
ROSALIE	56.3	56.3	0.0	56.3	0.0	56.3	0.0	56.3	0.0	56.3	0.0
MARIAN	61.7	61.7	0.0	61.7	0.0	61.7	0.0	61.7	0.0	61.7	0.0
S-65 T.W.	49.51							52.03	2.5	52.41	2.9
S-65A H.W.	48.14							51.22	3.1	51.82	3.7
S-65A T.W.	44.55							50.83	6.3	51.54	7.0
@ BACKFILL	44.27							50.45	6.2	51.37	7.1
S-65B H.W.	43.16							45.06	1.9	45.27	2.1
S-65B T.W.	35.92										
S-65C H.W.	34.85							39.37	4.5	40.01	5.2

TABLE A-15 (continued)

UNET PEAK STAGES

(BASED ON COINCIDENT FREQUENCY ANALYSIS)

PEAK STAGE (EL., FT.)	L. KISS SWSEL 49.0 TO 51.0 FT.	L. KISSIMMEE SWSEL VARIES BETWEEN EL. 48.5 TO 52.5 FEET BASED ON UKISS PERIOD OF RECORD ROUTINGS									
	EXISTING CONDITIONS S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	WITH BACKFILL S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	VS. EX.	DESIGN CANALS S-65 11,000 CFS C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 2 (B/F "n" = 0.3) S-65: 4-BAY CAP. C-35,20' C-36, 60' C-37, 90'		PLAN 1 ("n"=0.15/0.30/0.15) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 1 (B/F "n" = 0.3) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.
25-YEAR											
S-61 T.W.	55.96	55.91	-0.0	55.35	-0.6	55.33	-0.6	55.02	-0.9	55.22	-0.7
S-63A T.W.	56.01	55.92	-0.1	55.37	-0.6	55.36	-0.6	55.09	-0.9	55.27	-0.7
CYPRESS	55.71	55.59	-0.1	55	-0.7	54.98	-0.7	54.65	-1.1	54.88	-0.8
HATCHINEHA	55.42	55.3	-0.1	54.85	-0.6	54.82	-0.6	54.39	-1.0	54.68	-0.7
KISSIMMEE	53.96	53.79	-0.2	54.21	0.3	54.14	0.2	53.6	-0.4	53.95	-0.0
TIGER	54.08	53.96	-0.1	54.25	0.2	54.2	0.1	53.8	-0.3	54.05	-0.0
JACKSON	58.1	58.1	0.0	58.1	0.0	58.1	0.0	58.1	0.0	58.1	0.0
ROSALIE	56.6	56.6	0.0	56.6	0.0	56.6	0.0	56.6	0.0	56.6	0.0
MARIAN	62.1	62.1	0.0	62.1	0.0	62.1	0.0	61.7	-0.4	62.1	0.0
S-65 T.W.	49.83							52.62	2.8	53.04	3.2
S-65A H.W.	48.59							51.85	3.3	52.43	3.8
S-65A T.W.	45.47							51.45	6.0	52.13	6.7
@ BACKFILL	45.3							51.01	5.7	51.86	6.6
S-65B H.W.	44.51							45.64	1.1	45.8	1.3
S-65B T.W.	36.06										
S-65C H.W.	35.12							40.02	4.9	40.64	5.5

TABLE A−15 (continued)

UNET PEAK STAGES

(BASED ON COINCIDENT FREQUENCY ANALYSIS)

	L. KISS SWSEL 49.0 TO 51.0 FT.	L. KISSIMMEE SWSEL VARIES BETWEEN EL. 48.5 TO 52.5 FEET BASED ON UKISS PERIOD OF RECORD ROUTINGS									
PEAK STAGE (EL., FT.)	EXISTING CONDITIONS S−65 11,000 CFS C−35,20' C−36, 48' C−37, 70'	WITH BACKFILL S−65 11,000 CFS C−35,20' C−36, 48' C−37, 70'	VS. EX.	DESIGN CANALS S−65 11,000 CFS C−35,20' C−36, 60' C−37, 90'	VS. EX.	PLAN 2 (B/F "n" = 0.3) S−65: 4−BAY CAP. C−35,20' C−36, 60' C−37, 90'	VS. EX.	PLAN 1 ("n"=0.15/0.30/0.15) S−65: 5−BAY CAP. C−35,20' C−36, 60' C−37, 90'	VS. EX.	PLAN 1 (B/F "n" = 0.3) S−65: 5−BAY CAP. C−35,20' C−36, 60' C−37, 90'	VS. EX.
50−YEAR											
S−61 T.W.	56.77	56.45	−0.3	55.88	−0.9	55.79	−1.0	55.44	−1.3	55.68	−1.1
S−63A T.W.	56.84	56.45	−0.4	55.89	−1.0	55.82	−1.0	55.5	−1.3	55.71	−1.1
CYPRESS	56.56	56.19	−0.4	55.58	−1.0	55.5	−1.1	55.12	−1.4	55.37	−1.2
HATCHINEHA	56.41	55.94	−0.5	55.49	−0.9	55.39	−1.0	54.93	−1.5	55.23	−1.2
KISSIMMEE	55.13	54.34	−0.8	54.88	−0.3	54.68	−0.5	54.08	−1.0	54.46	−0.7
TIGER	55.15	54.44	−0.7	54.88	−0.3	54.71	−0.4	54.23	−0.9	54.53	−0.6
JACKSON	58.4	58.4	0.0	58.4	0.0	58.4	0.0	58.4	0.0	58.4	0.0
ROSALIE	56.8	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0
MARIAN	62.4	62.4	0.0	62.4	0.0	62.4	0.0	62.4	0.0	62.4	0.0
S−65 T.W.	49.99							53.02	3.0	53.45	3.5
S−65A H.W.	49.02							52.28	3.3	52.87	3.8
S−65A T.W.	46.22							51.87	5.6	52.57	6.3
@ BACKFILL	46.08							51.4	5.3	52.27	6.2
S−65B H.W.	45.43							46.01	0.6	46.2	0.8
S−65B T.W.	36.47										
S−65C H.W.	35.61							40.45	4.8	41.1	5.5

TABLE A-15 (continued)

UNET PEAK STAGES

(BASED ON COINCIDENT FREQUENCY ANALYSIS)

PEAK STAGE (EL., FT.)	L. KISS SWSEL 49.0 TO 51.0 FT.	L. KISSIMMEE SWSEL VARIES BETWEEN EL. 48.5 TO 52.5 FEET BASED ON UKISS PERIOD OF RECORD ROUTINGS									
	EXISTING CONDITIONS S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	WITH BACKFILL S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	VS. EX.	DESIGN CANALS S-65 11,000 CFS C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 2 (B/F "n" = 0.3) S-65: 4-BAY CAP. C-35,20' C-36, 60' C-37, 90'		PLAN 1 ("n"=0.15/0.30/0.15) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 1 (B/F "n" = 0.3) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.
100-YEAR											
S-61 T.W.	57.22	56.9	-0.3	56.37	-0.9	56.22	-1.0	55.86	-1.4	56.09	-1.1
S-63A T.W.	57.46	56.88	-0.6	56.36	-1.1	56.24	-1.2	55.89	-1.6	56.12	-1.3
CYPRESS	57.04	56.67	-0.4	56.11	-0.9	55.96	-1.1	55.57	-1.5	55.82	-1.2
HATCHINEHA	56.99	56.48	-0.5	56.05	-0.9	55.87	-1.1	55.44	-1.6	55.71	-1.3
KISSIMMEE	56.18	55.02	-1.2	55.53	-0.7	55.19	-1.0	54.58	-1.6	54.96	-1.2
TIGER	56.18	55.05	-1.1	55.54	-0.6	55.22	-1.0	54.69	-1.5	55.01	-1.2
JACKSON	58.7	58.7	0.0	58.7	0.0	58.7	0.0	58.7	0.0	58.7	0.0
ROSALIE	57	57	0.0	57	0.0	57	0.0	57	0.0	57	0.0
MARIAN	62.7	62.7	0.0	62.7	0.0	62.7	0.0	62.7	0.0	62.7	0.0
S-65 T.W.	49.92							53.28	3.4	53.72	3.8
S-65A H.W.	48.87							52.49	3.6	53.07	4.2
S-65A T.W.	46.16							52.05	5.9	52.75	6.6
@ BACKFILL	46.03							51.56	5.5	52.44	6.4
S-65B H.W.	45.36							46.16	0.8	46.37	1.0
S-65B T.W.	36.47										
S-65C H.W.	35.61							40.61	5.0	41.27	5.7

TABLE A-16

C-38 BACKFILL AND LAKE KISSIMMEE SWSEL SENSITIVITY

(SENSITIVITY RUNS)

	VARIATION OF BACKFILL AND LAKE KISSIMMEE SWSEL FOR WITH-PROJECT CONDITION			VARIATION OF BACKFILL AND LAKE KISSIMMEE SWSEL FOR EXISTING CONDITION		
PEAK STAGE (EL., FT.)	WITH-PROJECT SWSEL = 52.5' (B/F @ RM 39.30) S-65 11,000 CFS S65A 11,000 CFS C-35,20' C-36, 48' C-37, 70'	WITH-PROJECT SWSEL = 52.5' (B/F REMOVED) S-65 11,000 CFS S65A 11,000 CFS C-35,20' C-36, 48' C-37, 70'	WITH-PROJECT SWSEL = 51.0' (B/F @ RM 39.30) S-65 11,000 CFS S65A 11,000 CFS C-35,20' C-36, 48' C-37, 70'	EXISTING SWSEL = 51.0' (NO BACKFILL) S-65 11,000 CFS S65A 11,000 CFS C-35,20' C-36, 48' C-37, 70'	EXISTING SWSEL = 51.0' (B/F @ RM 39.30) S-65 11,000 CFS S65A 11,000 CFS C-35,20' C-36, 48' C-37, 70'	EXISTING SWSEL = 52.5' (NO BACKFILL) S-65 11,000 CFS S65A 11,000 CFS C-35,20' C-36, 48' C-37, 70'
5-YEAR						
S-61 T.W.	54.75	54.63	54.11	53.97	55.4	54.84
CYPRESS	54.45	54.31	53.73	53.54	55.13	54.53
HATCHINEHA	54.11	53.97	53.21	52.91	55.01	54.17
KISSIMMEE	53.17	52.95	52.02	51.88	54.64	53.31
TIGER	53.35	53.15	52.52	52.42	54.64	53.46
S-65 T.W.	52.01	50.03	51.12	49.22	50.41	49.18
S-65A H.W.	51.34	48.07	50.63	47.63	50.18	47.55
S-65A T.W.	50.45	42.55	49.97	43.94	49.19	43.94
@ BACKFILL	50.04	39.31	49.59	42.96	48.85	42.96
S-65B H.W.	44.66	35.48	44.18	41.94	44.6	41.94
S-65B T.W.				35.38	43.21	35.38
S-65C H.W.	38.8	33.62	38.35	34.21	37.93	34.21
S-65C T.W.				30.48	36.93	30.48
100-YEAR					50-YEAR	
S-61 T.W.	57.34	57.21	56.78	57.31	58.47	57.94
CYPRESS	57.15	57.01	56.55	57.15	58.33	57.8
HATCHINEHA	57.02	56.84	56.28	57.07	58.33	57.8
KISSIMMEE	55.81	55.51	54.6	56.16	58.29	57.52
TIGER	55.82	55.51	54.62	56.17	58.29	57.52
S-65 T.W.	53.56	51.12	52.85	49.28	52.34	49.27
S-65A H.W.	52.89	48.62	52.28	48.62	52.14	48.6
S-65A T.W.	51.65	45.06	51.23	45.96	50.38	45.96
@ BACKFILL	51.19	42.37	50.83	45.4	50.05	45.4
S-65B H.W.	46.04	37.96	45.67	44.8	46.92	44.79
S-65B T.W.				36.47	44.41	36.47
S-65C H.W.	40.31	35.96	39.96	35.54	40.19	35.54
S-65C T.W.				32.26	38.18	32.27

TABLE A–17

SENSITIVITY RUNS FOR C–38 BACKFILL MANNINGS "N" AND LAKE KISSIMMEE HEC–1 LAG

PEAK STAGE (EL., FT.)	VARIATION OF MANNINGS "N" VALUE FOR C–38 BACKFILL SECTION		
	PLAN 1 "N" VALUE = 0.1 SWSEL = 52.5 FT. S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'	PLAN 1 "N" VALUE = 0.3 SWSEL = 52.5 FT. S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'	PLAN 1 "N" VALUE = 0.5 SWSEL = 52.5 FT. S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'
25–YEAR			
S–63A T.W.	55.28	55.64	56.11
S–61 T.W.	55.07	55.56	56.1
CYPRESS	54.72	55.25	55.83
HATCHINEHA	54.48	55.11	55.76
KISSIMMEE	53.62	54.41	55.26
TIGER	53.9	54.49	55.27
S–65 T.W.	52.39	53.42	54.44
S–65A H.W.	50.93	52.89	54.03
S–65A T.W.	50.28	52.58	53.65
@ BACKFILL	49.24	52.28	53.5
S–65B	43.35	46.22	47.52
S–65C	38.15	41.13	42.51

PEAK STAGE (EL., FT.)	VARIATION OF HEC–1 LAG FOR LAKE KISSIMMEE DRAINAGE BASIN		
	PLAN 1 LAG = 16.8 HOURS SWSEL = 52.5 FT. S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'	PLAN 1 LAG = 33.6 HOURS SWSEL = 52.5 FT. S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'	PLAN 1 LAG = 50.8 HOURS SWSEL = 52.5 FT. S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'
25–YEAR			
S–63A T.W.			
S–61 T.W.	55.69	55.69	55.67
CYPRESS	55.39	55.39	55.36
HATCHINEHA	55.25	55.25	55.23
KISSIMMEE	54.47	54.47	54.46
TIGER	54.55	54.55	54.53
S–65 T.W.	53.41	53.41	53.25
S–65A H.W.	52.7	52.7	52.53
S–65A T.W.	51.47	51.47	51.36
@ BACKFILL	51.02	51.02	50.92
S–65B	45.85	45.85	45.75
S–65C	40.08	40.08	39.99

TABLE A-18

SENSITIVITY RUNS FOR EARLY - MONTH AND MID - MONTH RAINFALL DISTRIBUTION

UNET PEAK STAGE (EL., FT.)	EARLY - MONTH DISTRIBUTION (used in 1985 and 1991 reports) PLAN 1 SWSEL = 52.5 FT. S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'	MID - MONTH DISTRIBUTION (used in 1995 report) PLAN 1 SWSEL = 52.5 FT. S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'
25-YEAR		
S-61 T.W.	54.92	55.33
S-63A T.W.	55.05	55.43
CYPRESS	54.50	55.00
HATCHINEHA	54.22	54.83
KISSIMMEE	53.47	54.04
TIGER	53.70	54.19
JACKSON	57.95	58.39
ROSALIE	56.32	56.56
MARIAN	61.71	62.05
S-65 T.W.	52.54	53.01
S-65A H.W.	51.72	52.23
S-65A T.W.	51.31	51.80
@ BACKFILL	50.88	51.33
S-65B	45.53	45.96
S-65C	39.88	40.40

TABLE A-19

IMPACT OF VARYING LOWER BASIN FLOOD FOR GIVEN MIDDLE BASIN FLOOD

(EXISTING CONDITION SENSITIVITY RUNS)

PEAK STAGE (EL., FT.)	EXISTING CONDITION: LAKE KISSIMMEE SWSEL 51.0 FT.; S-65 11,000 CFS, S-65A 11,000 CFS NO BACKFILL IN C-38; EXISTING CANALS WITH C-35, 20' B.W.; C-36, 48' B.W.; C-37, 70' B.W.					
	5-YEAR		10-YEAR		25-YEAR	
	WITH 5-YEAR LOWER BASIN FLOOD	WITH 10-YEAR LOWER BASIN FLOOD	WITH 10-YEAR LOWER BASIN FLOOD	WITH 100-YEAR LOWER BASIN FLOOD	WITH 25-YEAR LOWER BASIN FLOOD	WITH 10-YEAR LOWER BASIN FLOOD
S-61 T.W.	53.97	54.02	54.52	54.86	55.93	55.74
CYPRESS	53.54	53.6	54.2	54.56	55.67	55.44
HATCHINEHA	52.91	52.96	53.7	54.14	55.37	55.13
KISSIMMEE	51.88	52.03	52.46	53.08	53.81	53.43
TIGER	52.42	52.48	52.94	53.3	53.96	53.63
S-65 T.W.	49.22	49.1	49.19	49.23	48.78	48.95
S-65A H.W.	47.63	47.67	47.69	48.57	47.97	47.67
S-65A T.W.	43.94	44.58	44.58	45.93	45.28	44.59
@ BACKFILL	42.96	43.73	43.74	45.37	44.61	43.75
S-65B H.W.	41.94	42.87	42.89	44.76	43.89	42.89
S-65B T.W.	35.38	35.42	35.42	36.47	35.91	35.42
S-65C H.W.	34.21	34.21	34.21	35.54	34.88	34.21
S-65C T.W.	30.48	30.87	30.88	32.26	31.61	30

PEAK STAGE (EL., FT.)	EXISTING CONDITION: LAKE KISSIMMEE SWSEL 51.0 FT.; S-65 11,000 CFS, S-65A 11,000 CFS NO BACKFILL IN C-38; EXISTING CANALS WITH C-35, 20' B.W.; C-36, 48' B.W.; C-37, 70' B.W.					
	50-YEAR		100-YEAR		SPF	
	WITH 50-YEAR LOWER BASIN FLOOD	WITH 10-YEAR LOWER BASIN FLOOD	WITH 100-YEAR LOWER BASIN FLOOD	WITH 10-YEAR LOWER BASIN FLOOD	WITH SPF LOWER BASIN FLOOD	WITH 10-YEAR LOWER BASIN FLOOD
S-61 T.W.	56.79	56.52	57.31	57.07	59.18	58.35
CYPRESS	56.6	56.32	57.15	56.89	59.07	58.2
HATCHINEHA	56.42	56.07	57.07	56.74	59.07	58.2
KISSIMMEE	55.08	54.48	56.16	55.45	58.91	57.94
TIGER	55.09	54.5	56.17	55.46	58.91	57.95
S-65 T.W.	49.27	48.93	49.28	49.16	51.85	49.08
S-65A H.W.	48.61	47.67	48.62	47.67	51.49	47.67
S-65A T.W.	45.95	44.59	45.96	44.59	48.83	44.59
@ BACKFILL	45.39	43.75	45.4	43.75	48.51	43.76
S-65B H.W.	44.79	42.9	44.8	42.9	48.17	42.9
S-65B T.W.	36.47	35.42	36.47	35.42	38.32	35.42
S-65C H.W.	35.54	34.21	35.54	34.21	37.67	34.
S-65C T.W.	32.26	30.88	32.26	30.88	34.54	30.88

TABLE A–20

IMPACT OF VARYING LOWER BASIN FLOOD FOR GIVEN MIDDLE BASIN FLOOD

(SENSITIVITY RUNS FOR WITH–PROJECT CONDITION)

PEAK STAGE (EL., FT.)	WITH–DESIGN CANAL CONDITION: LAKE KISSIMMEE SWSEL 52.5 FT.; S–65 11,000 CFS, S–65A 11,000 CFS BACKFILL IN C–38; IMPROVED CANALS WITH C–35, 20' B.W.; C–36, 60' B.W.; C–37, 90' B.W.					
	5–YEAR		10–YEAR		25–YEAR	
	WITH 5–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH 100–YEAR LOWER BASIN FLOOD	WITH 25–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD
S–61 T.W.	54.36	54.4	54.92	55	55.99	55.87
CYPRESS	54.03	54.07	54.63	54.72	55.71	55.58
HATCHINEHA	53.77	53.82	54.42	54.53	55.61	55.48
KISSIMMEE	53.29	53.35	53.82	53.95	54.97	54.81
TIGER	53.44	53.49	53.91	54.03	54.98	54.83
S–65 T.W.	52.02	52.21	52.39	52.8	53.03	52.67
S–65A H.W.	51.34	51.58	51.73	52.27	52.39	51.93
S–65A T.W.	50.46	50.67	50.76	51.26	51.28	50.89
@ BACKFILL	50.04	50.25	50.34	50.84	50.85	50.46
S–65B	44.67	44.96	45.07	45.68	45.68	45.22
S–65C	38.81	39.13	39.23	39.95	39.91	39.41

PEAK STAGE (EL., FT.)	WITH DESIGN CANAL CONDITION: LAKE KISSIMMEE SWSEL 52.5 FT.; S–65 11,000 CFS, S–65A 11,000 CFS BACKFILL IN C–38; IMPROVED CANALS WITH C–35, 20' B.W.; C–36, 60' B.W.; C–37, 90' B.W.					
	50–YEAR		100–YEAR		SPF	
	WITH 50–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH 100–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH SPF LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD
S–61 T.W.	56.45	56.33	56.86	56.76	58.32	58.12
CYPRESS	56.21	56.08	56.64	56.53	58.15	57.94
HATCHINEHA	56.15	56.03	56.6	56.49	58.15	57.94
KISSIMMEE	55.59	55.44	56.14	55.99	58.01	57.78
TIGER	55.6	55.45	56.14	56	58.01	57.78
S–65 T.W.	53.31	52.82	53.49	52.99	54.59	53.34
S–65A H.W.	52.69	52.05	52.84	52.18	54.05	52.47
S–65A T.W.	51.52	50.95	51.62	51.03	52.62	51.2
@ BACKFILL	51.08	50.52	51.17	50.58	52.14	50.74
S–65B	45.93	45.29	46.02	45.37	47.05	45.54
S–65C	40.2	39.48	40.29	39.55	41.54	39.72

TABLE A–21

LAKE ROSALIE ANALYSIS

PEAK LAKE STAGE (EL., FT.)	TOP OF REGULATION SCHEDULE		JOINT PROBABILITY APPROACH	
	EXISTING CONDITIONS (KISS SWSEL @ 51.0') S–65 11,000 CFS C–35,20' C–36, 48' C–37, 70'	PLAN 1 (B/F @ RM 39.30) (KISS SWSEL @ 52.5') S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'	EXISTING CONDITIONS (KISS SWSEL 50.0' – 50.3') S–65 11,000 CFS C–35,20' C–36, 48' C–37, 70'	PLAN 1 (B/F @ RM 39.30) (KISS SWSEL 51.1' – 51.3') S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'
5–YEAR	56.06	56.07	56.06	56.07
10–YEAR	56.26	56.27	56.26	56.27
25–YEAR	56.54	56.56	56.54	56.56
50–YEAR	56.77	56.78	56.77	56.78
100–YEAR	56.94	56.95	56.94	56.95
SPF	58.93	57.37	N/A	N/A

TABLE A–22

ZIPPERER CANAL ANALYSIS

PEAK STAGE ON ZIPPERER CANAL D/S OF G–113 (EL., FT.)	TOP OF REGULATION SCHEDULE		JOINT PROBABILITY APPROACH	
	EXISTING CONDITIONS (KISS SWSEL @ 51.0') S–65 11,000 CFS C–35,20' C–36, 48' C–37, 70'	PLAN 1 (B/F @ RM 39.30) (KISS SWSEL @ 52.5') S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'	EXISTING CONDITIONS (KISS SWSEL @ 50.3') S–65 11,000 CFS C–35,20' C–36, 48' C–37, 70'	PLAN 1 (B/F @ RM 39.30) (KISS SWSEL @ 51.2') S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'
5–YEAR	52.2	53	52.05	52.55
10–YEAR	52.7	53.4	52.7	52.6
25–YEAR	54.1	54.1	54.1	53.8
50–YEAR	55.25	54.6	55.1	54.25
100–YEAR	56.34	54.9	56.22	54.6
SPF	58.93	56.2	N/A	N/A

NOTE:

1. G–113 IS THE WEIR STRUCTURE INSTALLED ON ZIPPERER CANAL BETWEEN LAKE ROSALIE AND LAKE KISSIMMEE. UNET ANALYSES SHOW THERE WILL BE NO ADVERSE STAGE IMPACTS TO LAKE ROSALIE DUE TO THE PROJECT IF THE WEIR IS SET AT A MINIMUM ELEVATION EQUAL TO OR GREATER THAN THE LAKE KISSIMMEE REGULATORY STAGE. FURTHER ANALYSES INDICATE THAT THE PEAK STAGES ON LAKE ROSALIE WOULD BE REDUCED BY 0.2 TO 0.3 FEET IF THE WEIR WERE REMOVED. THE PRIMARY OUTLET FROM LAKE ROSALIE IS ROSALIE CREEK FLOWING TO LAKE TIGER AT A NATURAL SILL ELEVATION OF APPROXIMATELY 50 FEET.

TABLE A-23

LAKE JACKSON WATER CONTROL STRUCTURE (LJWCS), LAKE JACKSON AND LAKE MARIAN ANALYSIS

PEAK STAGE (EL., FEET)	WITH LAKE JACKSON WATER CONTROL STRUCTURE IN-PLACE		
	EXISTING CONDITIONS (KISS SWSEL @ 51.0') S-65 11,000 CFS	PLAN 1 (KISS SWSEL @ 51.0') S-65 (5-BAY CAP.)	PLAN 1 (KISS SWSEL @ 52.5') S-65 (5-BAY CAP.)
5-YEAR			
L. KISSIMMEE	51.9	52.7	52.9
LJWCS (TW/HW)	55.7/56.75	55.75/56.8	55.7/56.8
L. JACKSON	56.8	56.8	56.8
G-103 (TW/HW)	58.5/61.35	58.5/61.35	58.5/61.35
L. MARIAN	61.4	61.4	61.4
10-YEAR			
L. KISSIMMEE	52.5	52.8	53.3
LJWCS (TW/HW)	56.1/57.3	56.2/57.35	56.25/57.3
L. JACKSON	57.4	57.4	57.4
G-103 (TW/HW)	58.8/61.6	58.8/61.6	58.8/61.6
L. MARIAN	61.7	61.7	61.7
25-YEAR			
L. KISSIMMEE	54.1	53.6	54.0
LJWCS (TW/HW)	56.6/58	56.6/58	56.6/58
L. JACKSON	58.1	58.1	58.1
G-103 (TW/HW)	59.2/62.0	59.2/62.0	59.2/62.0
L. MARIAN	62.1	62.1	62.1
50-YEAR			
L. KISSIMMEE	55.2	54.1	54.5
LJWCS (TW/HW)	56.75/58.3	56.7/58.3	56.75/58.3
L. JACKSON	58.4	58.4	58.4
G-103 (TW/HW)	59.25/62.4	59.25/62.4	59.25/62.4
L. MARIAN	62.4	62.4	62.4
100-YEAR			
L. KISSIMMEE	56.3	54.5	54.9
LJWCS (TW/HW)	56.85/58.65	56.8/58.6	56.8/58.6
L. JACKSON	58.7	58.7	58.7
G-103 (TW/HW)	59.35/62.6	59.35/62.6	59.35/62.6
L. MARIAN	62.7	62.6	62.6
SPF			
L. KISSIMMEE	58.9	55.8	56.2
LJWCS (TW/HW)	58.93/59.32	57.0/59.3	57.1/59.25
L. JACKSON	59.4	59.3	59.3
G-103 (TW/HW)	59.4/63.15	59.4/63.15	59.4/63.15
L. MARIAN	63.15	63.1	63.1

TABLE A-24

JACKSON CANAL DOWNSTREAM OF LJWCS ANALYSIS

PEAK STAGE ON JACKSON CANAL AT RIVER MILE __ (EL., FT.)	TOP OF REGULATION SCHEDULE		JOINT PROBABILITY APPROACH	
	EXISTING CONDITIONS (KISS SWSEL @ 51.0') S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	PLAN 1 (KISS SWSEL @ 52.5') S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'	EXISTING CONDITIONS (KISS SWSEL @ 50.3') S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	PLAN 1 (KISS SWSEL @ 51.2') S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'
5-YEAR				
5.25 (KISSIMMEE)	51.88	52.9	51.77	52.68
5.5	52.1	53.05	52	52.8
6.0	54	54.2	53.9	54.1
6.5	55	55.1	55	55.1
7.0	55.55	55.6	55.6	55.6
7.5 (D/S OF LJWCS)	55.7	55.75	55.7	55.75
10-YEAR				
5.25 (KISSIMMEE)	52.48	53.3	52.41	52.98
5.5	52.6	53.4	52.6	53
6.0	54.4	54.6	54.4	54.5
6.5	55.4	55.45	55.4	55.4
7.0	55.9	56	55.9	55.9
7.5 (D/S OF LJWCS)	56.15	56.15	56.1	56.15
25-YEAR				
5.25 (KISSIMMEE)	54.07	54.04	53.96	53.6
5.5	54.1	54.05	54	53.7
6.0	55.1	55.1	55	55
6.5	55.8	55.8	55.8	55.8
7.0	56.3	56.35	56.35	56.4
7.5 (D/S OF LJWCS)	56.6	56.6	56.6	56.6
50-YEAR				
5.25 (KISSIMMEE)	55.24	54.53	55.12	54.08
5.5	55.25	54.55	55.15	54.2
6.0	55.4	55.35	55.35	55.2
6.5	56	56	56	55.95
7.0	56.5	56.5	56.5	56.5
7.5 (D/S OF LJWCS)	56.75	56.75	56.75	56.7
100-YEAR				
5.25 (KISSIMMEE)	56.34	54.89	56.18	54.58
5.5	56.34	54.9	56.2	54.6
6.0	56.34	55.5	56.2	55.4
6.5	56.35	56.15	56.25	56.1
7.0	56.65	56.6	56.6	56.6
7.5 (D/S OF LJWCS)	56.85	56.85	56.85	56.85

Structure 65

Hydraulic Design Data

Type of Structure	Spillway
Location	
Canal	C-38
Station	N/A
Discharge (cfs)	
Design	3,000
SPF	11,000
Critical	11,000
Headwater Elevation	
Design	51.5
SPF	58.0
Critical	58.0
Optimum	48.5 to 52.5
Minimum	46.7
Tailwater Elevation	
Design	49.0
SPF	53.1
Critical	48.2
Optimum	46.3
Minimum	44.0
Crest	
Shape	Ogee
Design Head (ft.)	18.7
Elevation	39.3
Net Length (ft.)	81.0
Gates	
Number	3
Width X Height (ft.)	27.0 X 14.2
Clearance Elevation	53.1
Stilling Basin	
Apron Elevation	34.0
Apron Length	48.0
End Sill Elevation	36.5
Training Wall Elevation	49.0
Channel Section	
Side Slopes (vert. on horiz.)	1 on 2
Upstream Bottom Width & Elev.	210 @ 34.0
Downstream Bottom Width & Elev.	90 @ 19.0
Riprap	
Upstream Channel	
Length (ft.)	80.0
Protection Elev.	54.5
Downstream Channel	
Length (ft.)	180.0
Protection Elev.	52.0
Approximate Ground Elevation at Structure	
Protection Elevation	60.0

Notes: All elevations refer to feet, NGVD.

Table A-25

Structure 65 Expansion

Hydraulic Design Data

Type of Structure	Spillway
Location	
Canal	C-38
Station	N/A
Discharge (cfs)	
Design	2,000
SPF	7,350
Critical	7,350
Headwater Elevation	
Design	51.5
SPF	58.0
Critical	58.0
Optimum	48.5 to 52.5
Minimum	46.7
Tailwater Elevation	
Design	49.0
SPF	53.1
Critical	48.2
Optimum	46.3
Minimum	44.0
Crest	
Shape	Ogee
Design Head (ft.)	18.7
Elevation	39.3
Net Length (ft.)	54.0
Gates	
Number	2
Width X Height (ft.)	27.0 X 14.2
Clearance Elevation	53.1
Stilling Basin	
Apron Elevation	34.0
Apron Length	48.0
End Sill Elevation	36.5
Training Wall Elevation	49.0
Channel Section	
Side Slopes (vert. on horiz.)	1 on 2 to 2.5
Upstream Bottom Width & Elev.	54 @ 34.0
Downstream Bottom Width & Elev.	54 @ 19.0
Riprap	
Upstream Channel	
Length (ft.)	80.0
Protection Elev.	54.5
Downstream Channel	
Length (ft.)	180.0
Protection Elev.	52.0
Approximate Ground Elevation at Structure	
Protection Elevation	60.0

Notes: All elevations refer to feet, NGVD.

Table A-26

Structure 65 Combined

Hydraulic Design Data

Type of Structure	Spillway
Location	
Canal	C-38
Station	N/A
Discharge (cfs)	
Design	5,000
SPF	18,350
Critical	18,350
Headwater Elevation	
Design	51.5
SPF	58.0
Critical	58.0
Optimum	48.5 to 52.5
Minimum	46.7
Tailwater Elevation	
Design	49.0
SPF	53.1
Critical	48.2
Optimum	46.3
Minimum	44.0
Crest	
Shape	Ogee
Design Head (ft.)	18.7
Elevation	39.3
Net Length (ft.)	135
Gates	
Number	5
Width X Height (ft.)	27.0 X 14.2
Clearance Elevation	53.1
Stilling Basin	
Apron Elevation	34.0
Apron Length	48.0
End Sill Elevation	36.5
Training Wall Elevation	49.0
Channel Section	
Side Slopes (vert. on horiz.)	1 on 2 to 2.5
Upstream Bottom Width & Elev.	288 @ 34.0
Downstream Bottom Width & Elev.	168 @ 19.0
Riprap	
Upstream Channel	
Length (ft.)	80.0
Protection Elev.	54.5
Downstream Channel	
Length (ft.)	180.0
Protection Elev.	52.0
Approximate Ground Elevation at Structure	
Protection Elevation	60.0

Notes: All elevations refer to feet, NGVD.

Table A-27

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT
Appendix A
Hydrology and Hydraulic Analyses

PHOTOGRAPHS

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT
Appendix A
Hydrology and Hydraulic Analyses

FIGURES

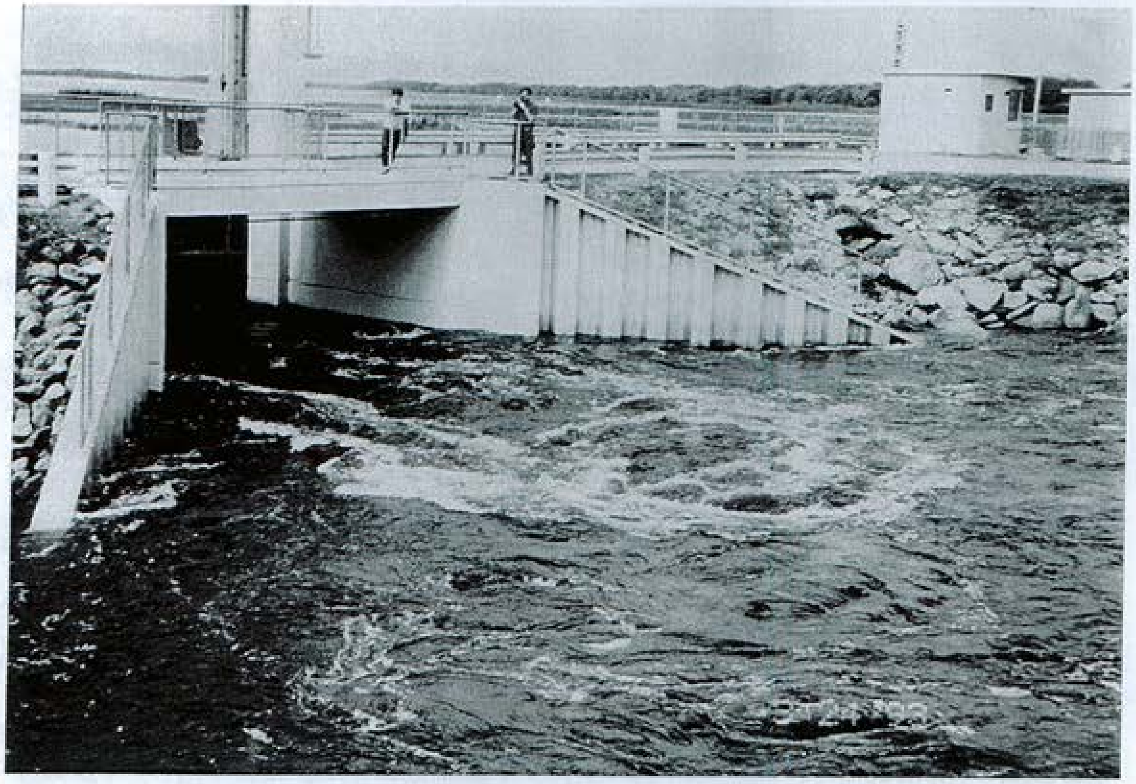


PHOTO A-1
S-61
(Downstream Side)

PHOTO A-2
C-35
(Looking Downstream from S-61)

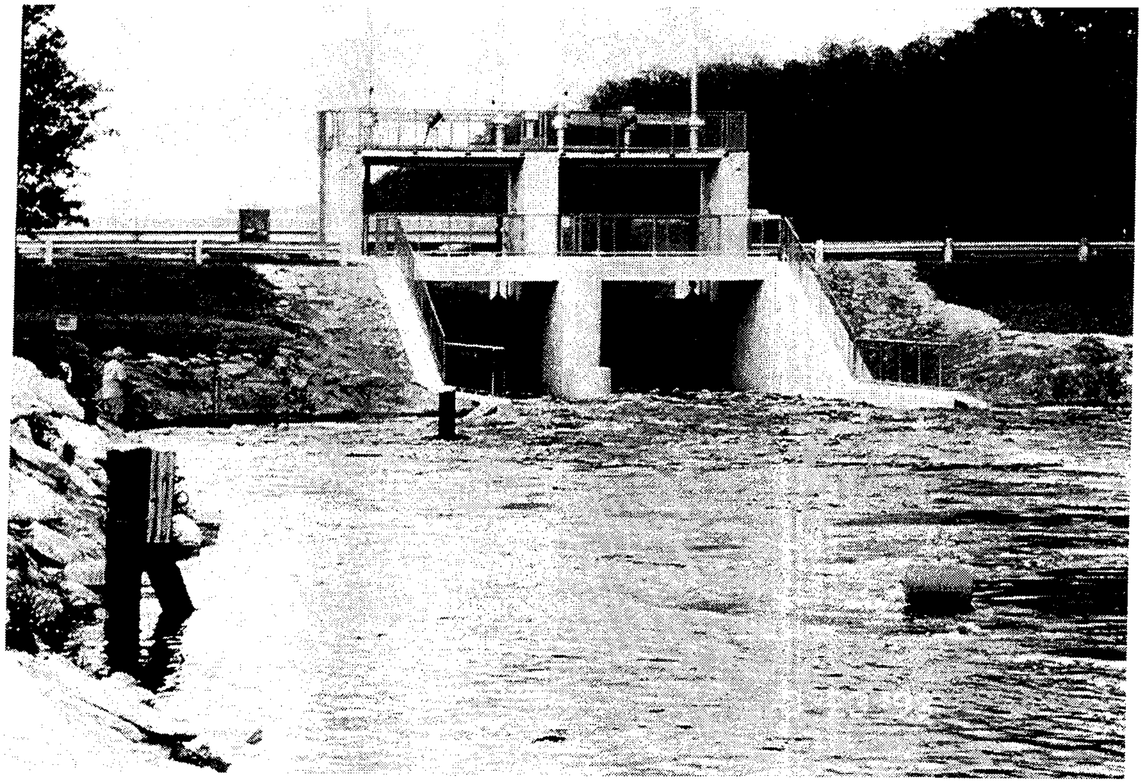


PHOTO A-3
S-63A
(Downstream Side)

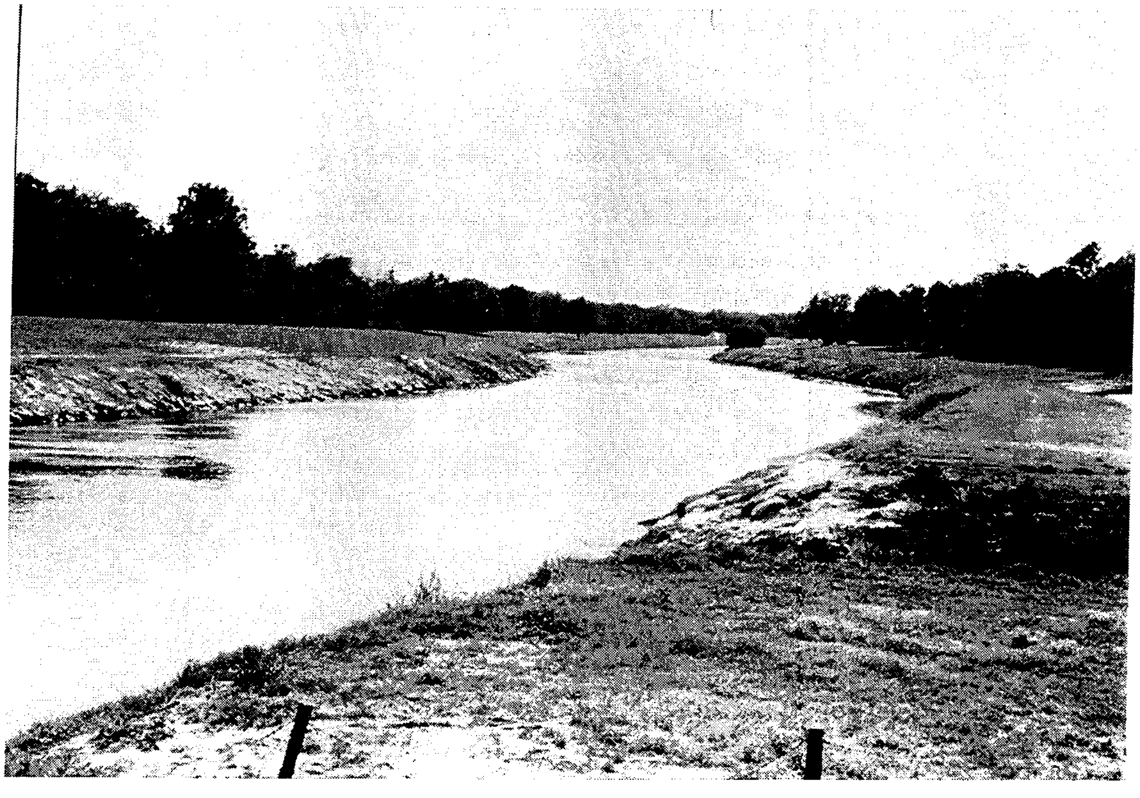


PHOTO A-4
C-34
(Looking Downstream from S-63A)

PHOTO A-5
C-36
(Looking Downstream along East Disposal Bank)

PHOTO A-6
C-37
(Looking Downstream along East Disposal Bank)

PHOTO A-7
S-65, Lock Structure and Operator's Residence
(Looking from southwest towards S.R. 60 Bridge)

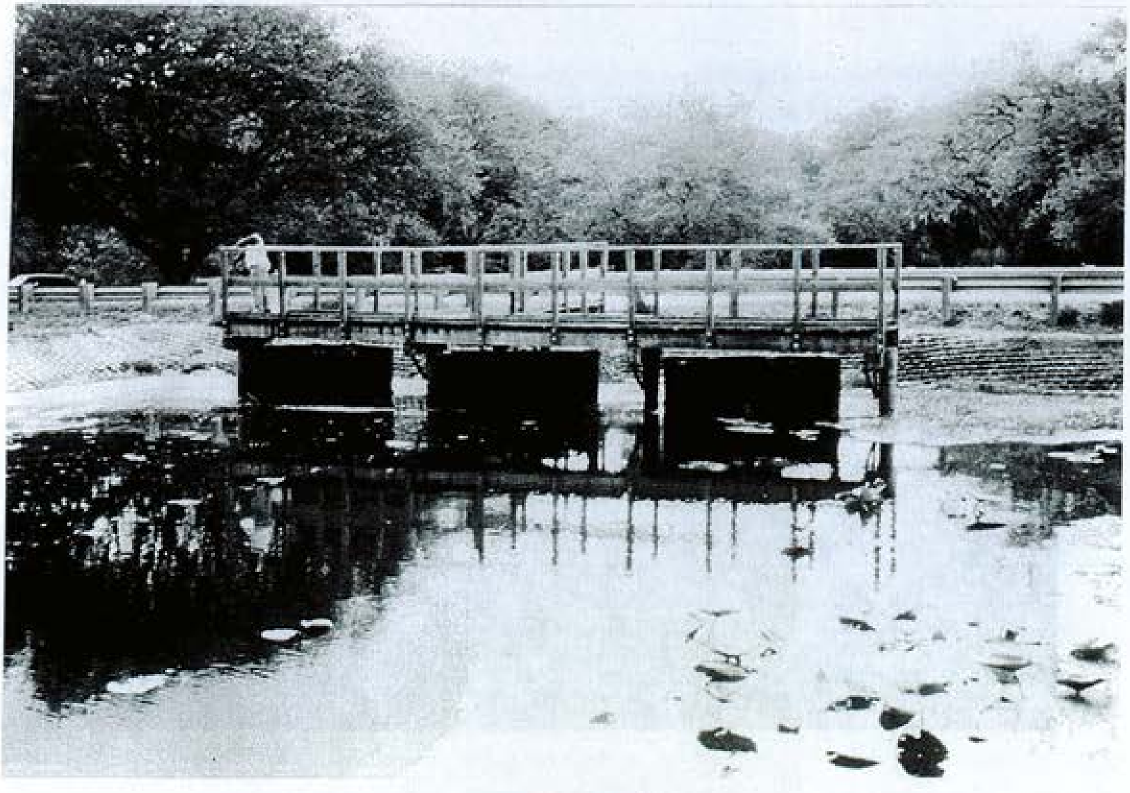


PHOTO A-8
Lake Marian Control Structure, G-113
(Upstream Side)

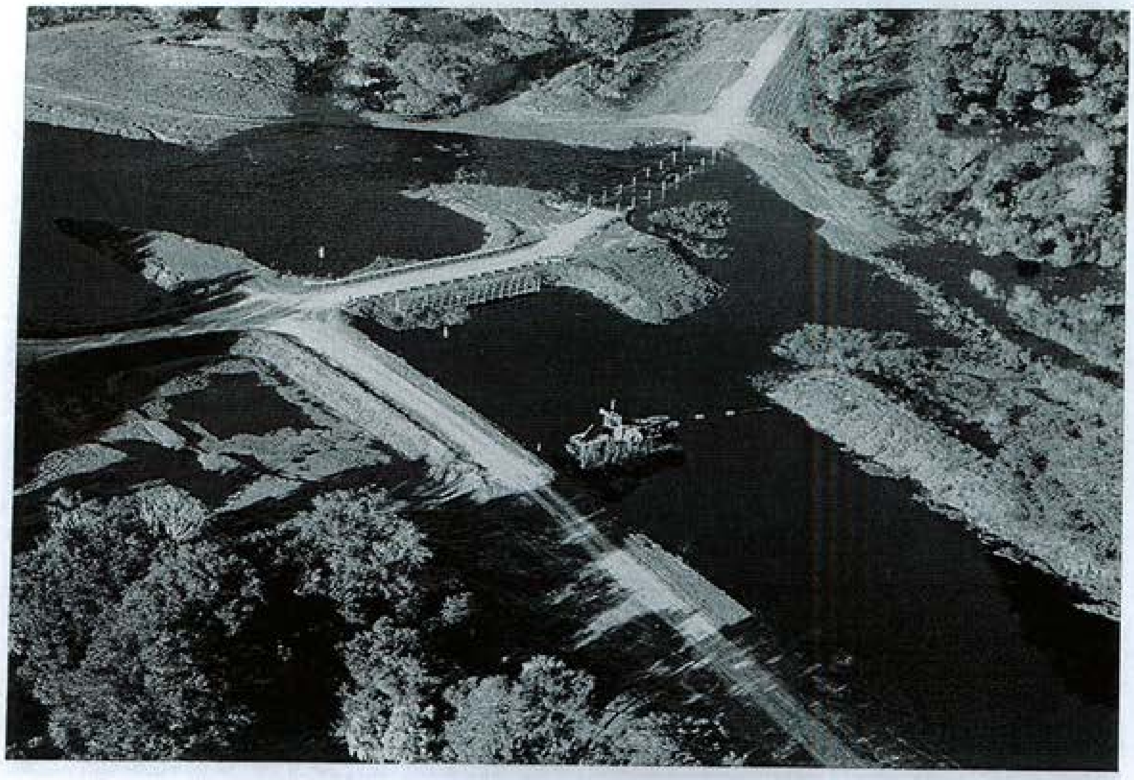


PHOTO A-9
Lake Jackson Water Control Structure
(Upstream Side)

PHOTO A-10
Lake Rosalie Control Structure, G-103
(Downstream Side)

PHOTO A-11
Zipperer Canal
(Looking Downstream from G-103)

PHOTO A-12
Reedy Creek at S.R. 531 near Lake Russell
(Looking Downstream)

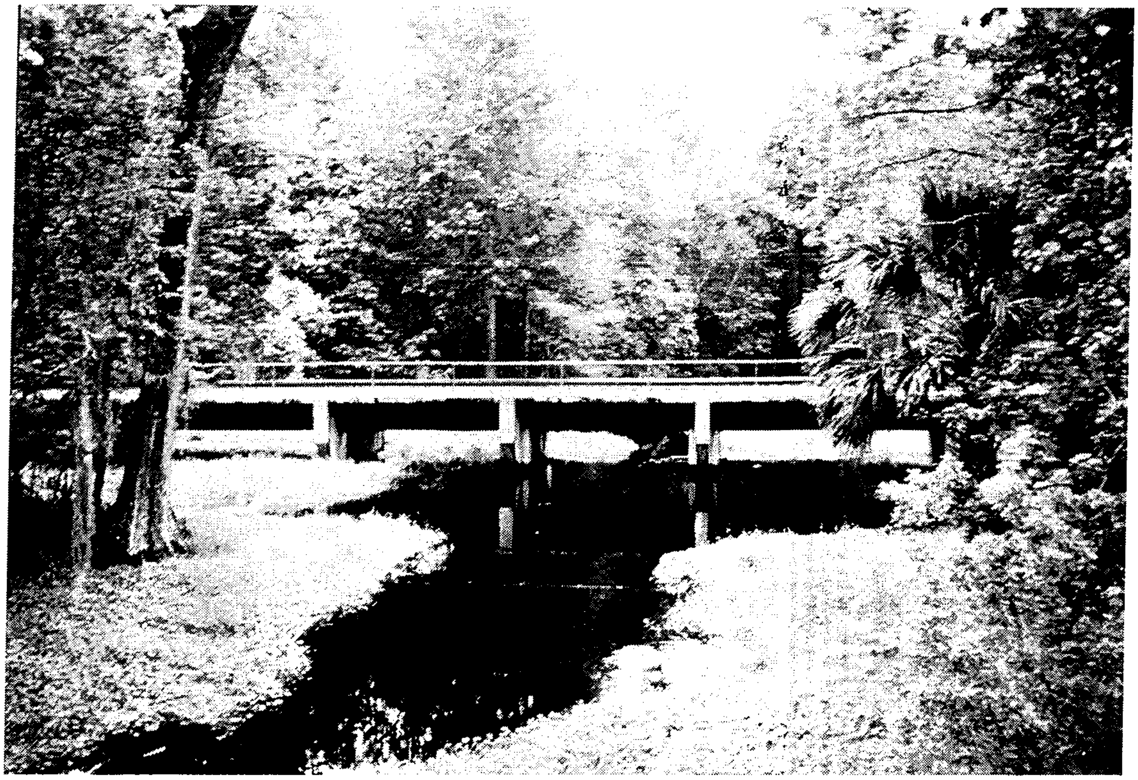
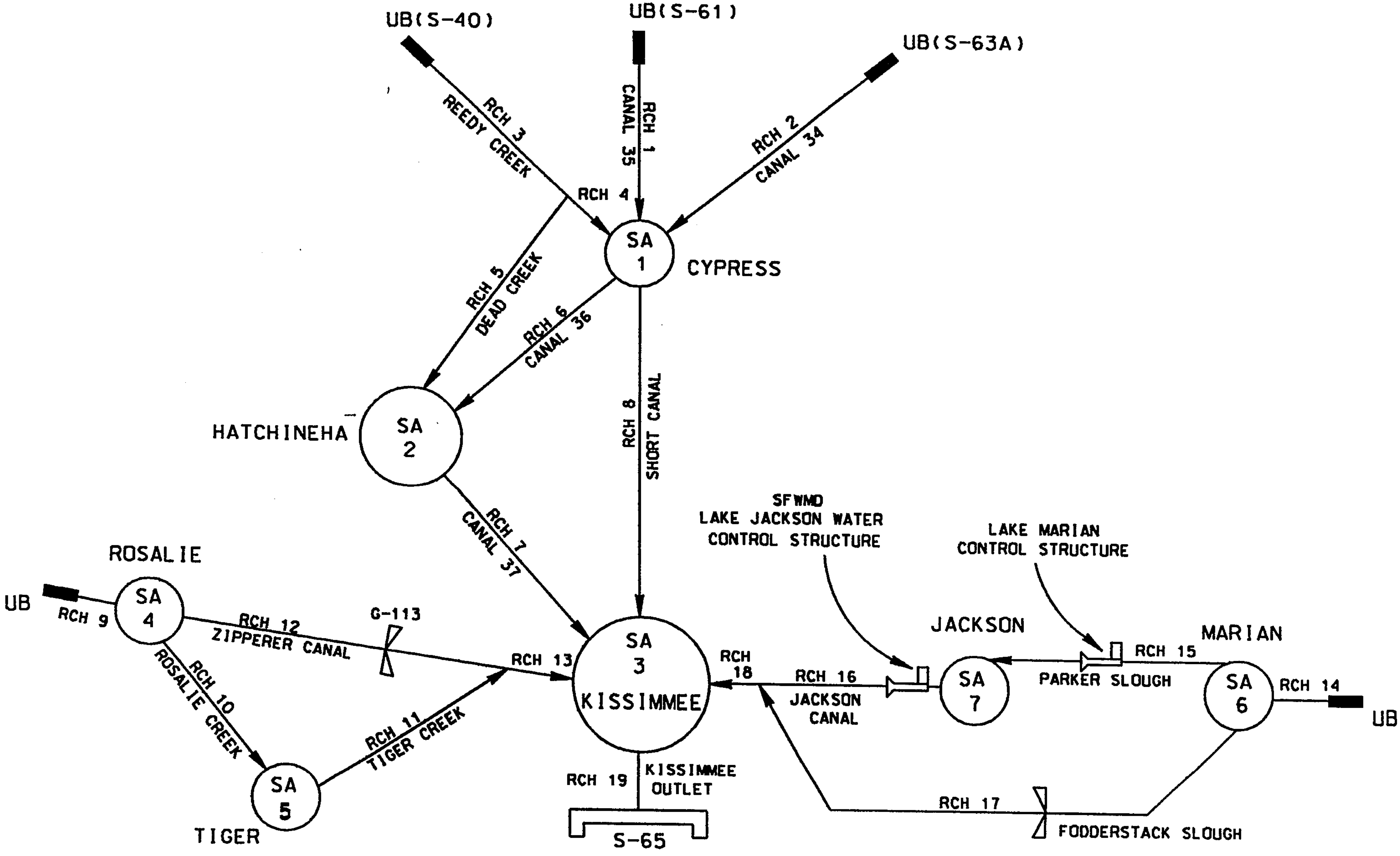


PHOTO A-13
Reedy Creek at U.S. 92 near S-40
(Looking Upstream at CSX Railroad Bridge)

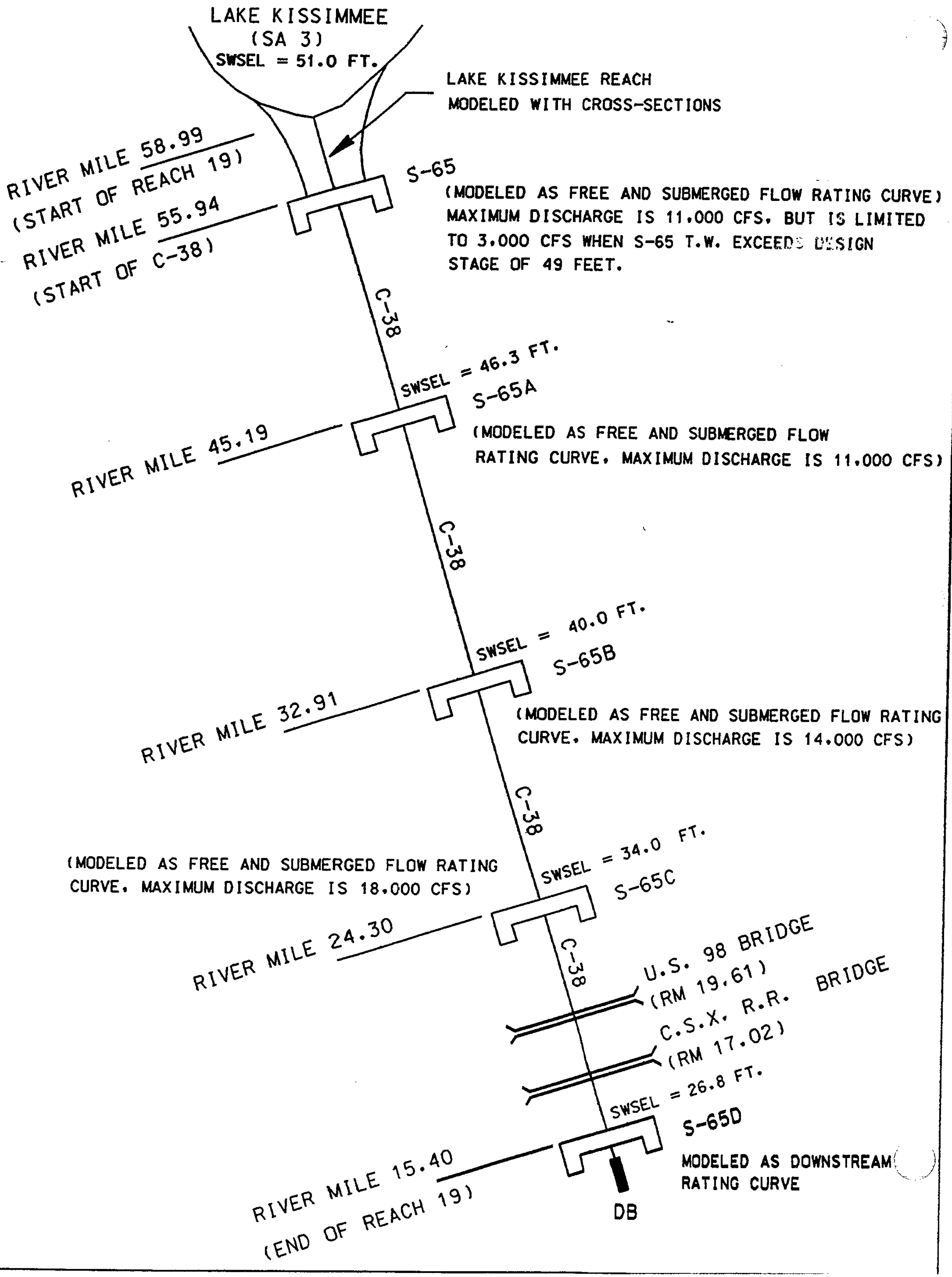
UNET MODEL - MIDDLE BASIN

(EXISTING AND WITH-PROJECT CONDITIONS)



UNET LOWER BASIN MODEL

(EXISTING CONDITIONS)



UNET LOWER BASIN MODEL

(WITH PROJECT CONDITIONS)

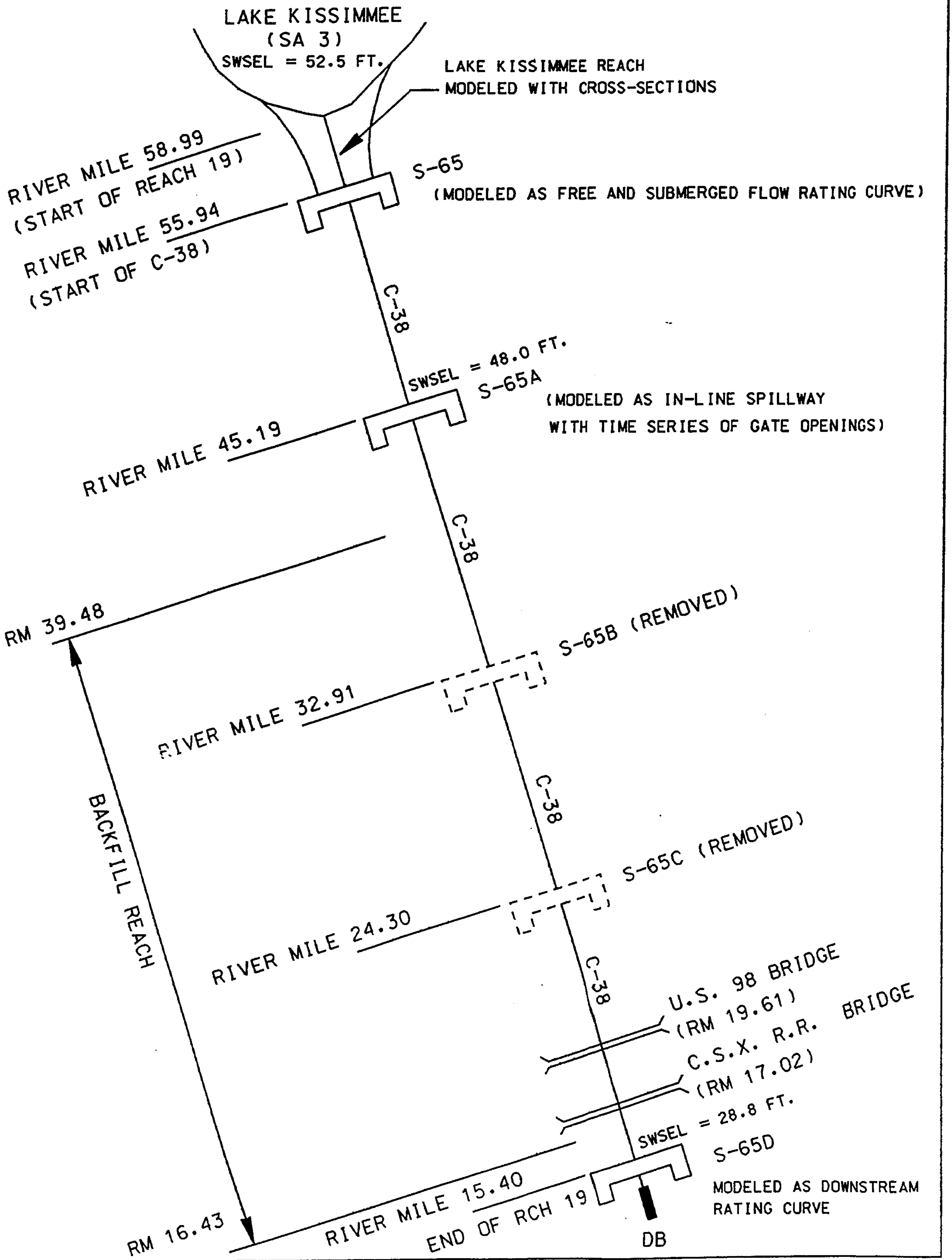


FIGURE A-3

LAKE KISSIMMEE STAGE

(HEC-1 CALIBRATION FOR 1953 FLOOD)

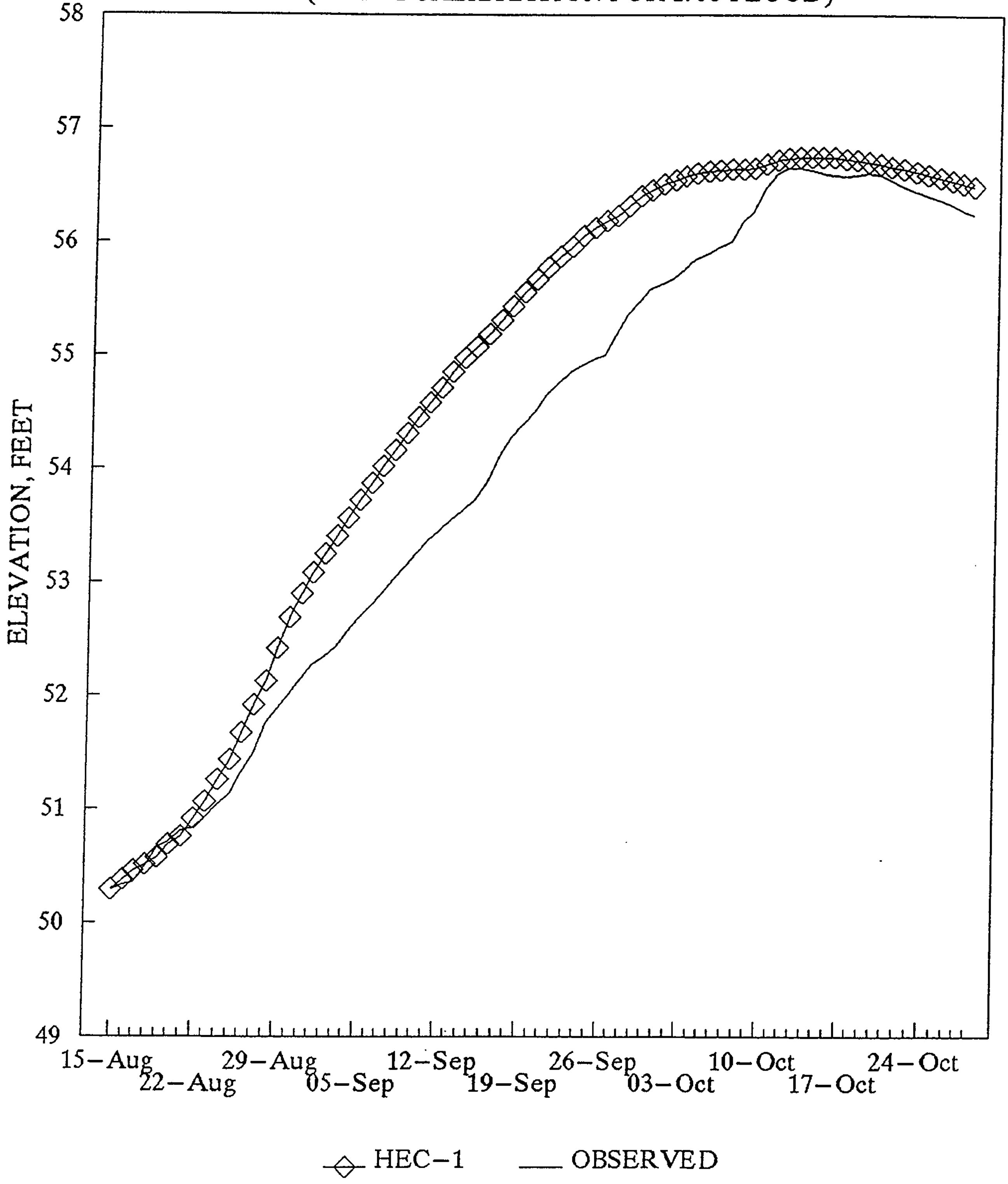


FIGURE A-4

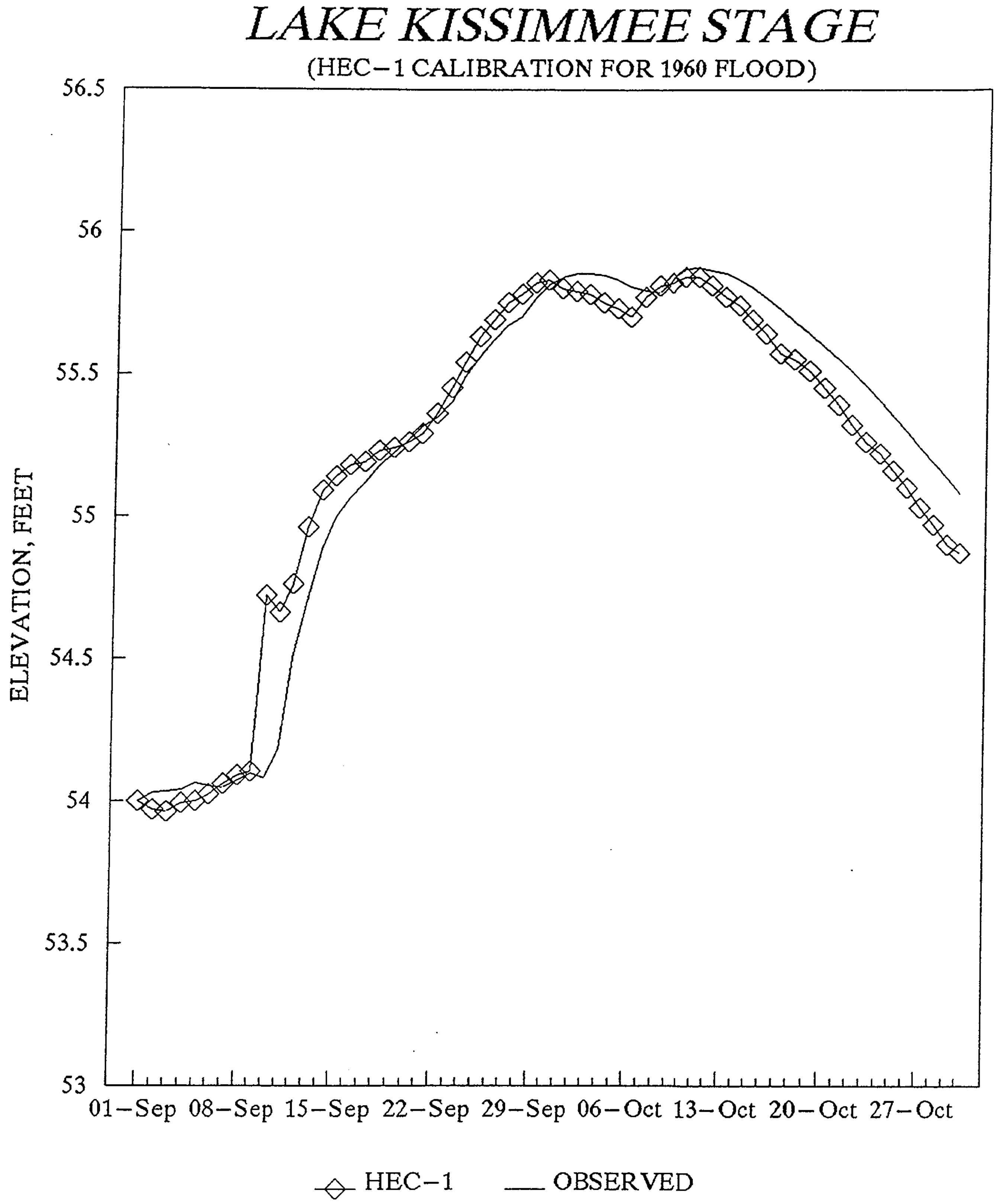

LAKE KISSIMMEE STAGE
(HEC-1 CALIBRATION FOR 1960 FLOOD)
ELEVATION, FEET
56.5
56
55.5
55
54.5
54
53.5
53
01-Sep
08-Sep
15-Sep
22-Sep
29-Sep
06-Oct
13-Oct
20-Oct
27-Oct
HEC-1
OBSERVED

FIGURE A-5

LAKE KISSIMMEE STAGE

(HEC-1 CALIBRATION FOR 1969 FLOOD)

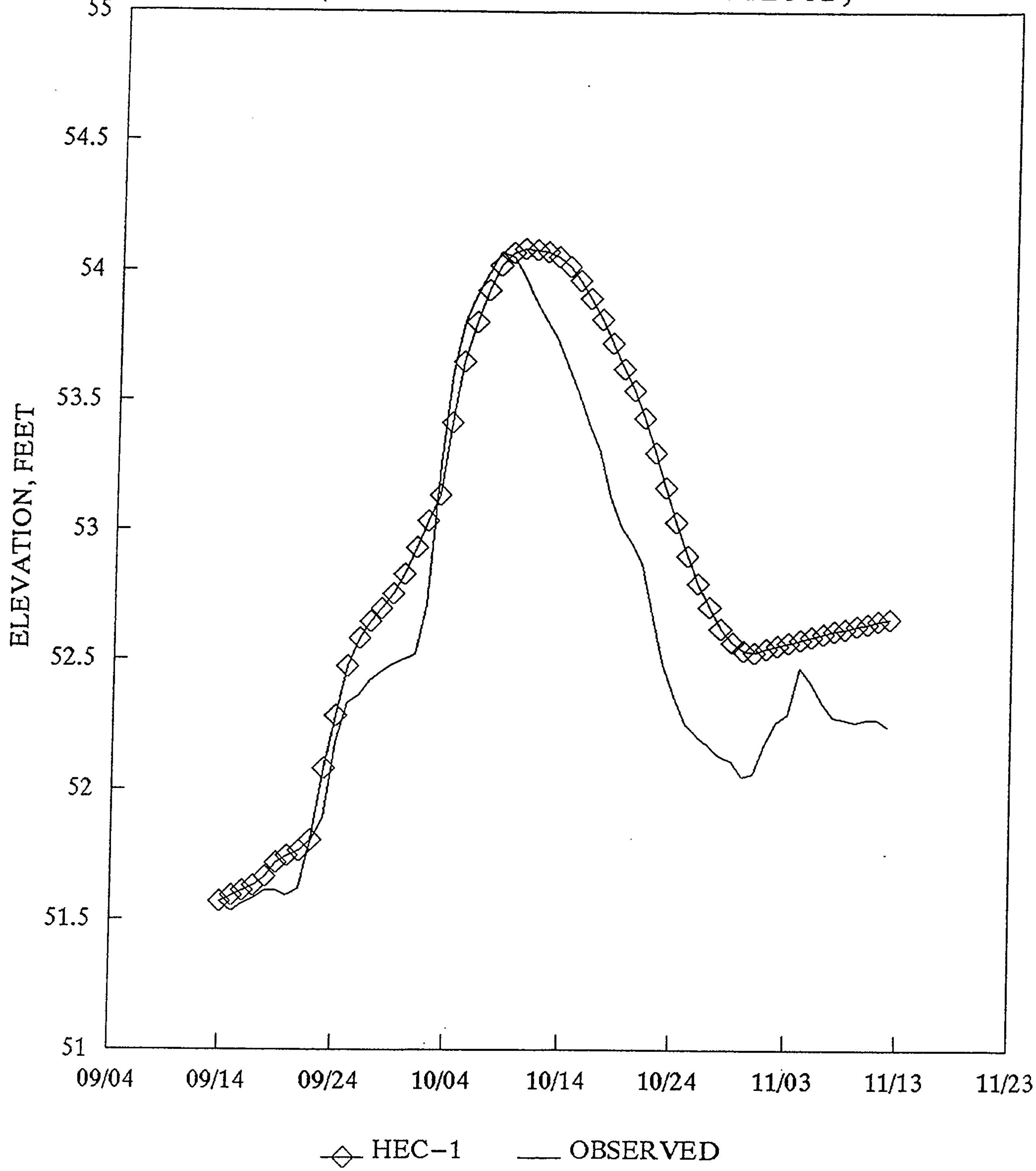
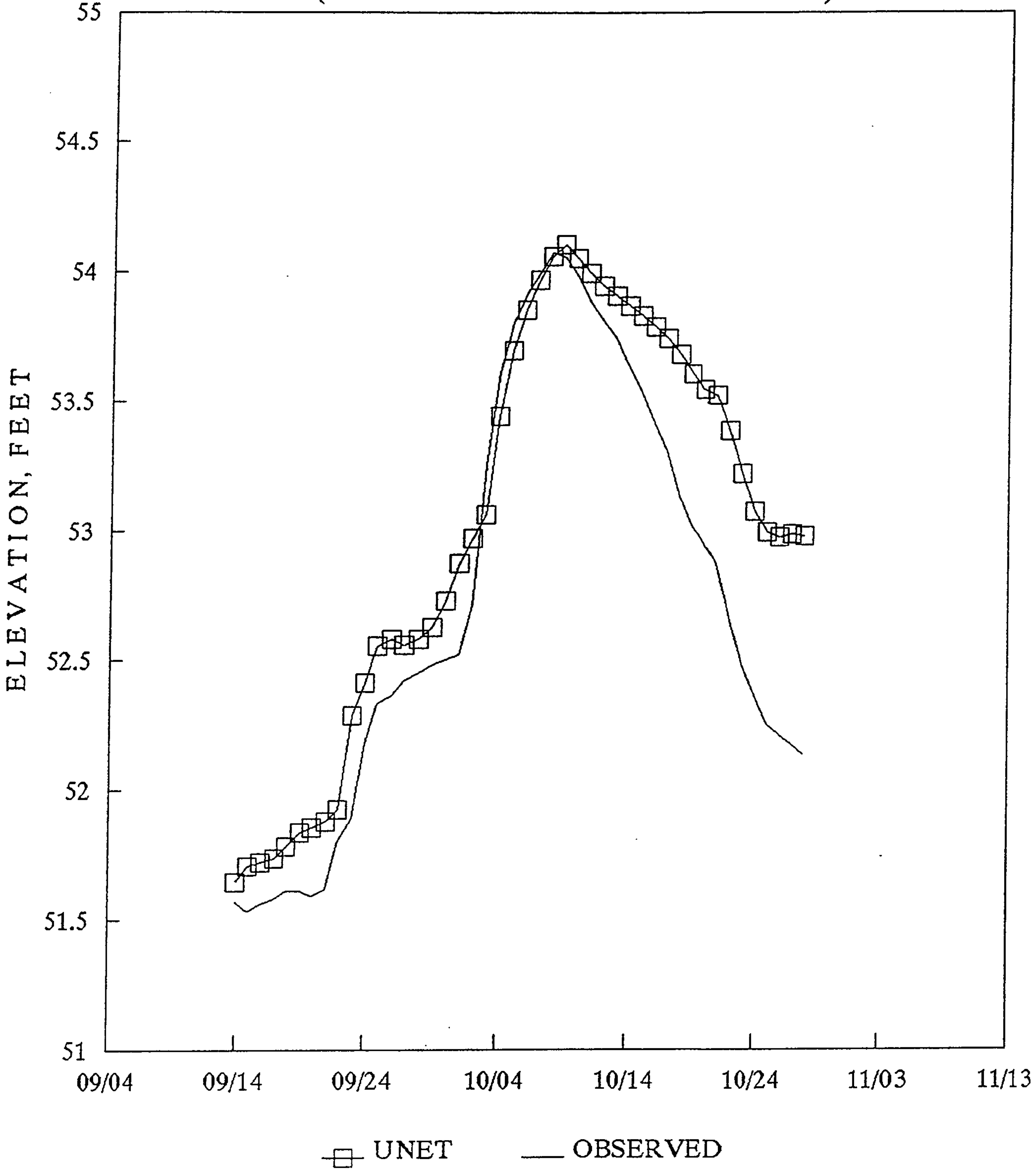


FIGURE A-6



LAKE KISSIMMEE STAGE

(UNET CALIBRATION FOR 1969 FLOOD)

FIGURE A-7

FT. KISSIMMEE RATING CURVE

(10–YR PLAN 1; S–65: 5–BAY CAPACITY; KISS SWSEL 52.5', B/F "N" = 0.15/0.30/0.15)

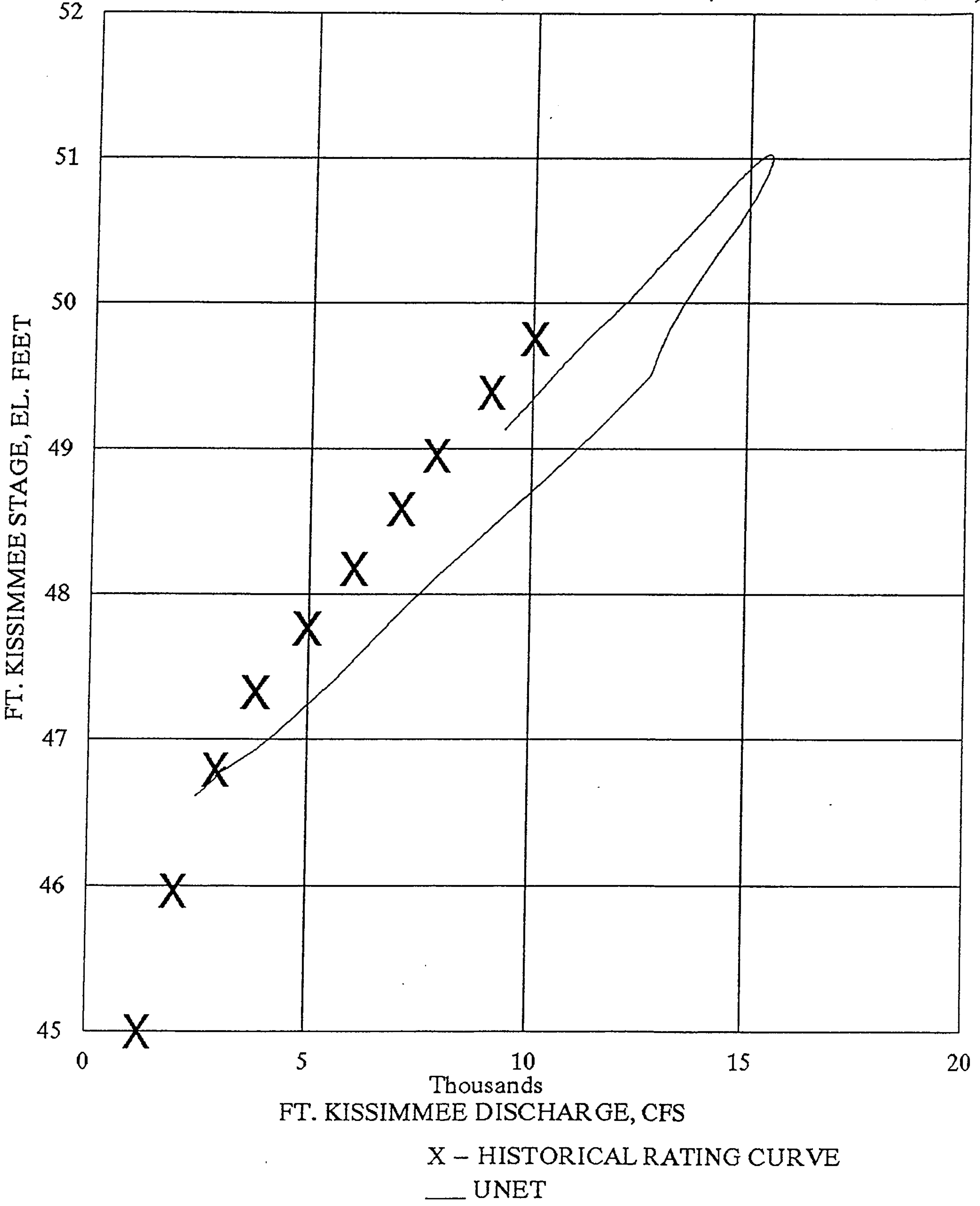


FIGURE A-8

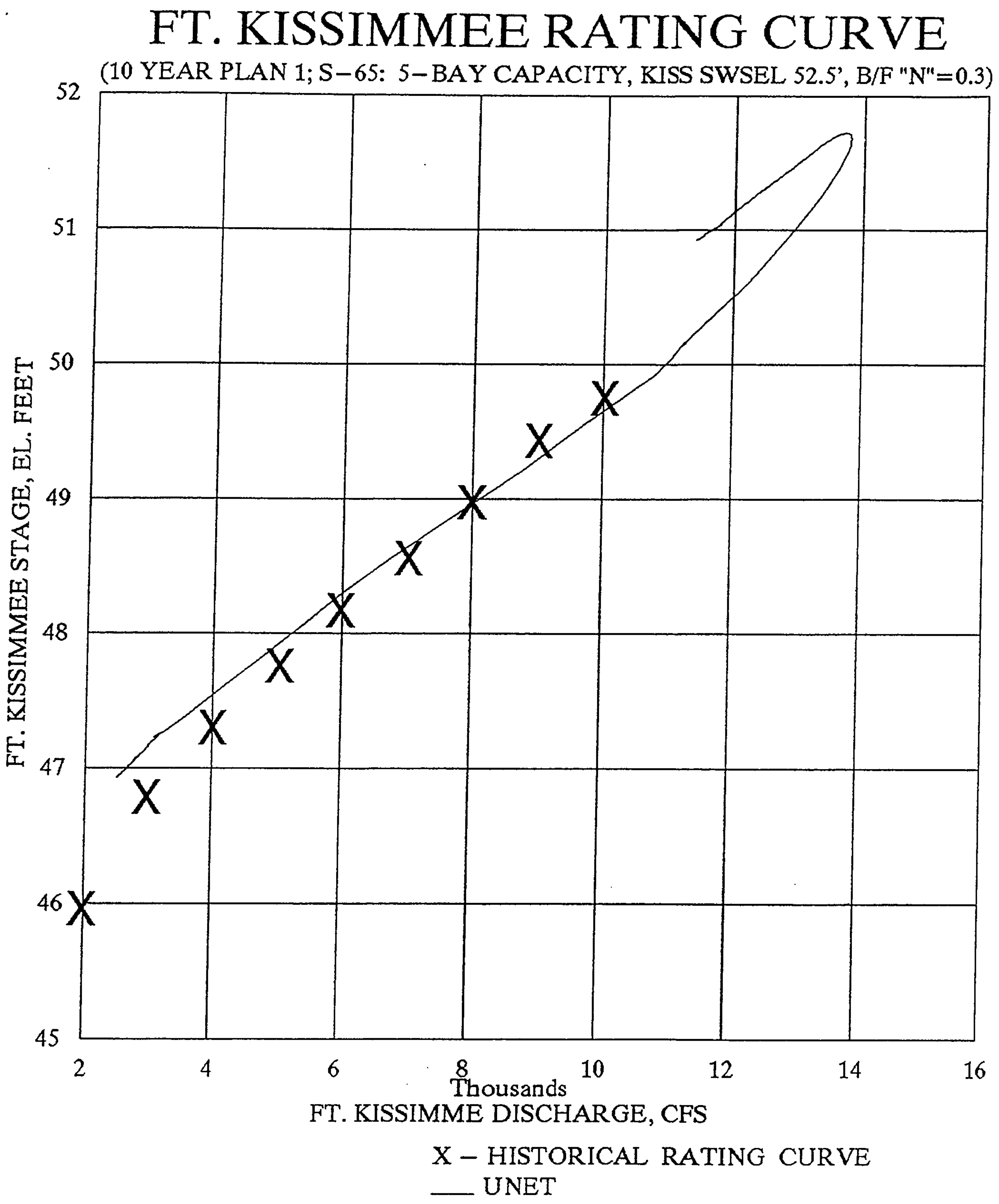
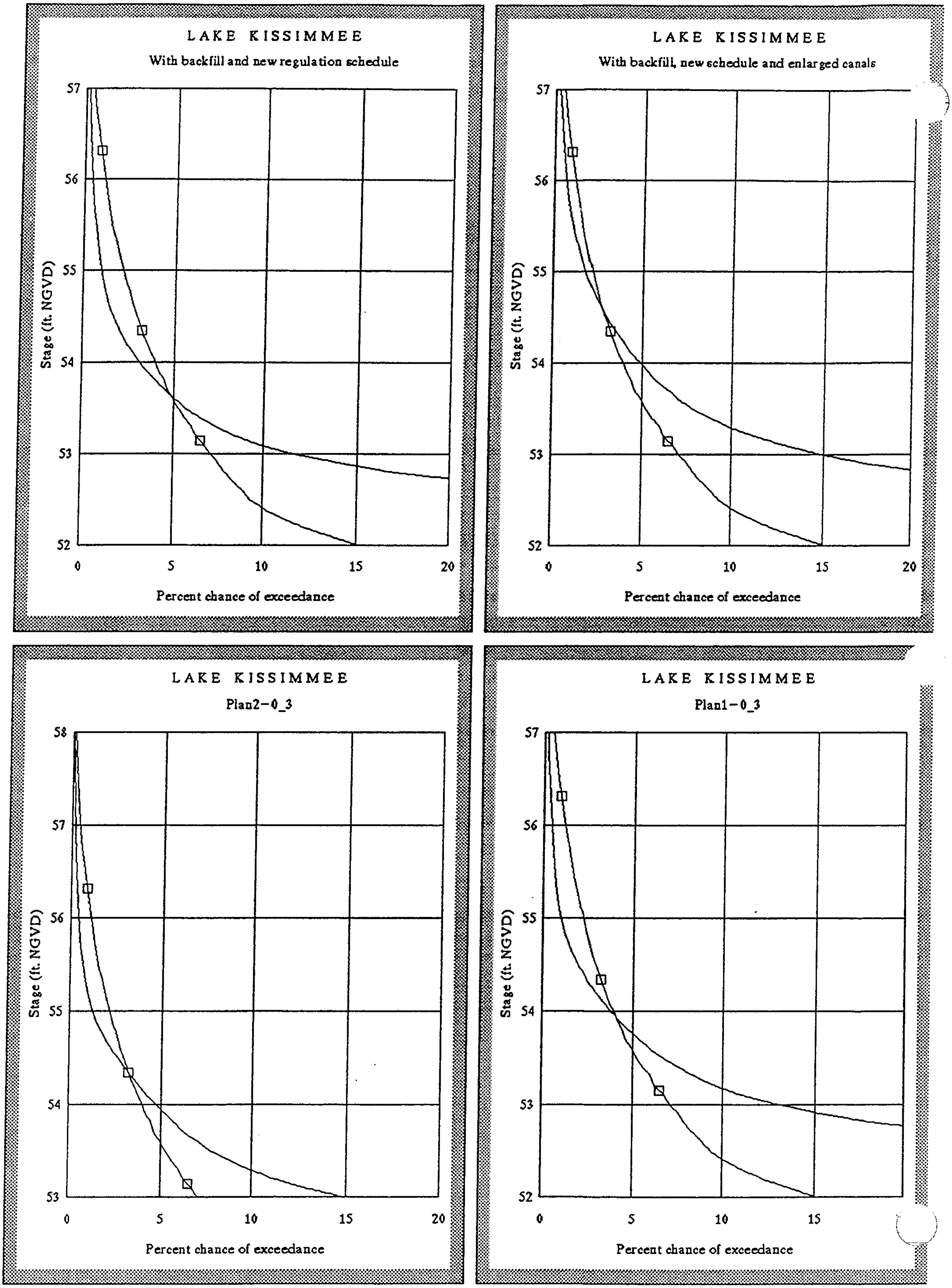
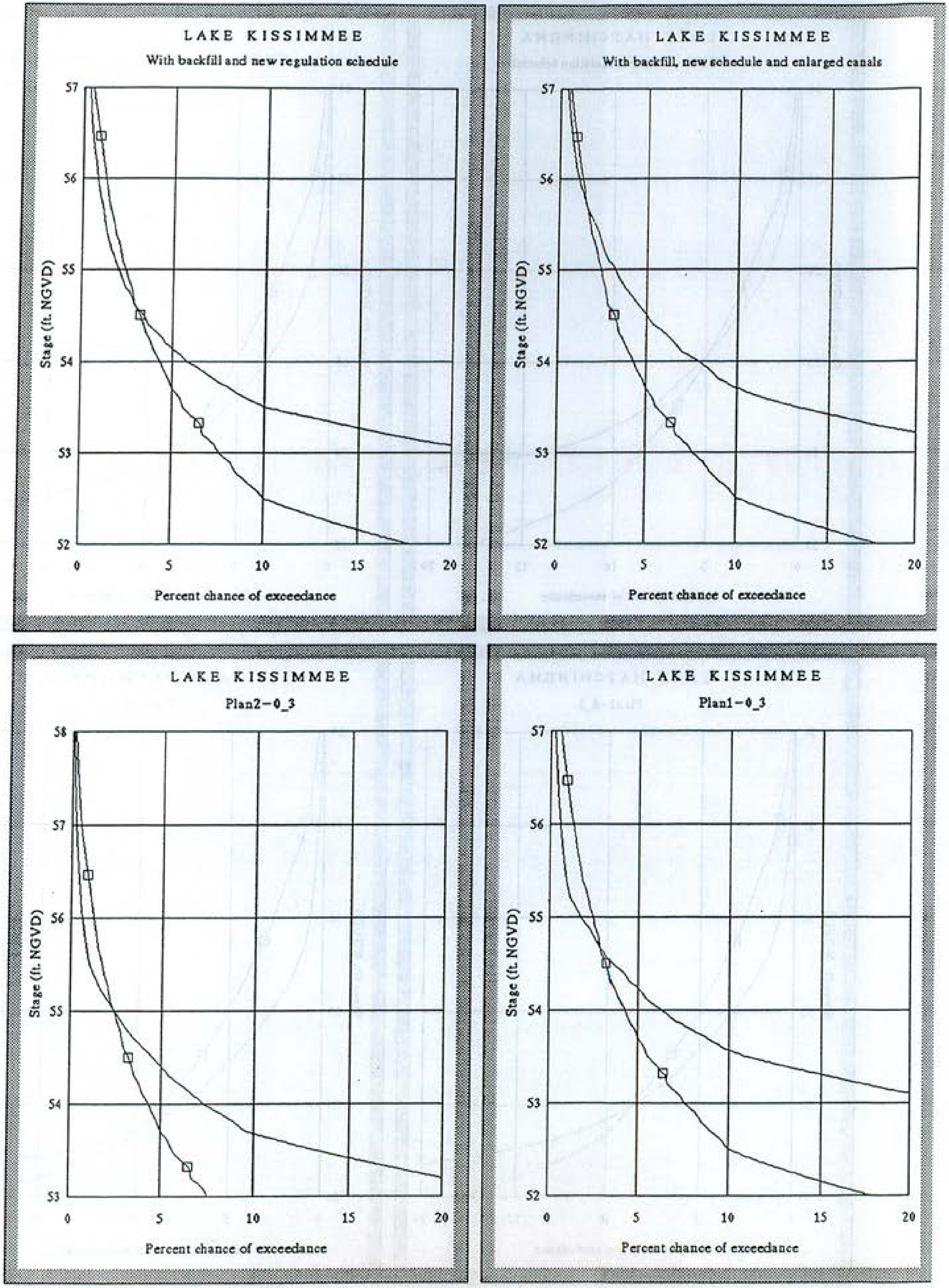

FT. KISSIMMEE RATING CURVE
(10 YEAR PLAN 1; S-65: 5-BAY CAPACITY, KISS SWSEL 52.5', B/F "N"=0.3)
FT. KISSIMMEE STAGE, EL. FEET
52
51
50
49
48
47
46
45
2
4
6
8
10
12
14
16
Thousands
FT. KISSIMME DISCHARGE, CFS
X – HISTORICAL RATING CURVE
___ UNET

FIGURE A-9



☐ Existing stage frequency
Computed by coincident frequency

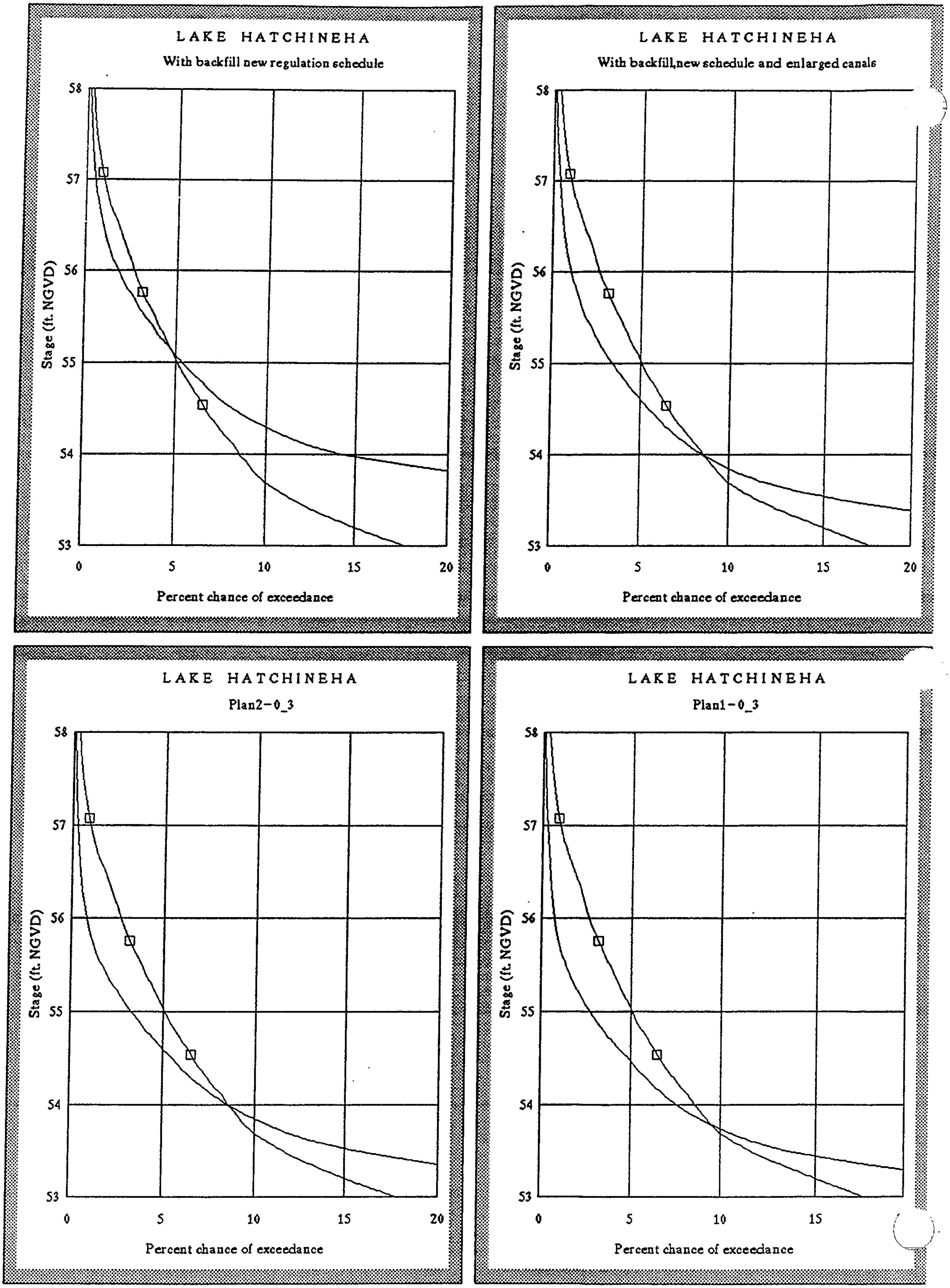
FIGURE A-10



☐ Existing stage frequency

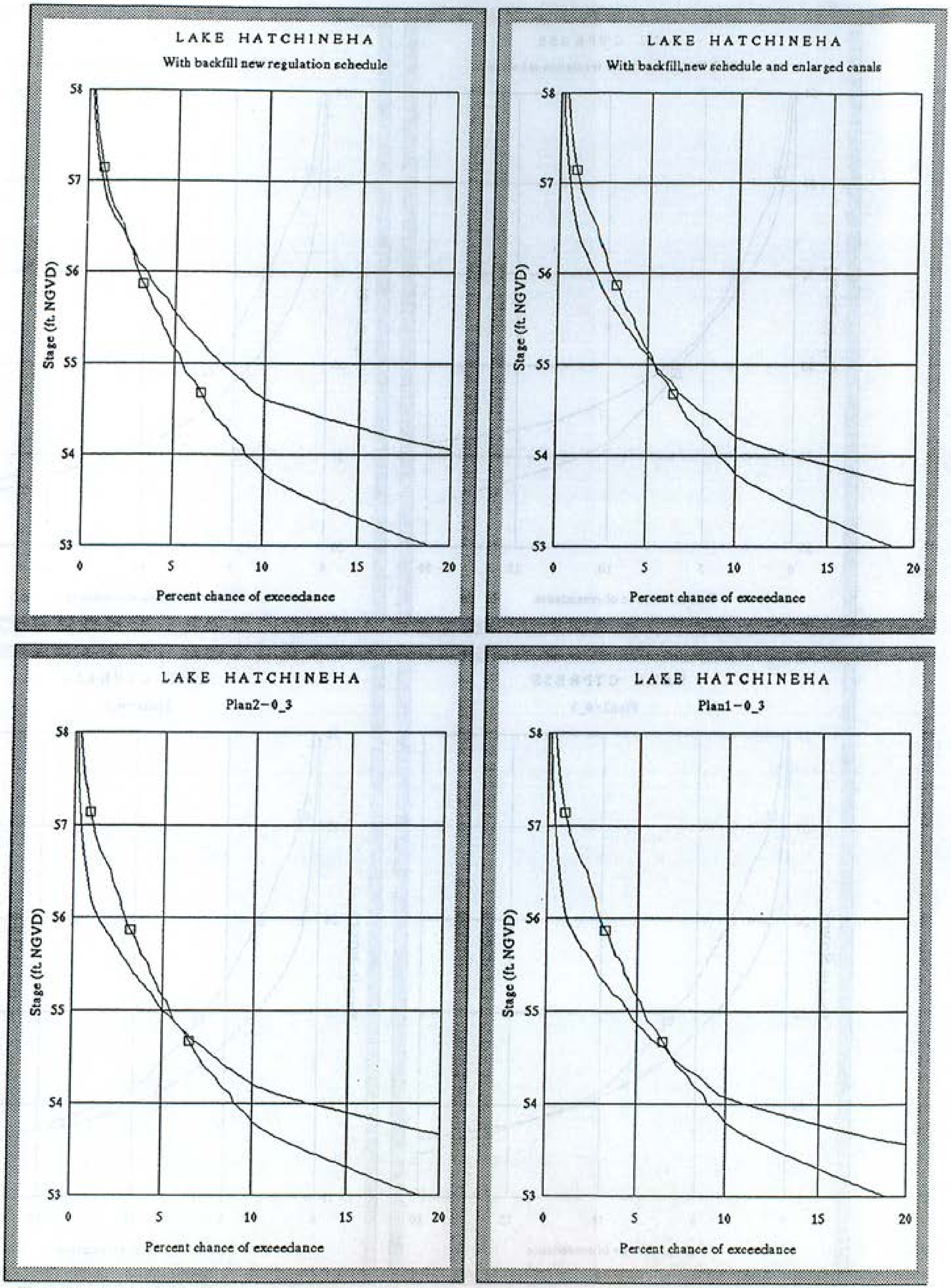
Computed by UNET with top of wet season schedule as the initial condition

FIGURE A-11



☐ Existing stage frequency
Computed by coincident frequency

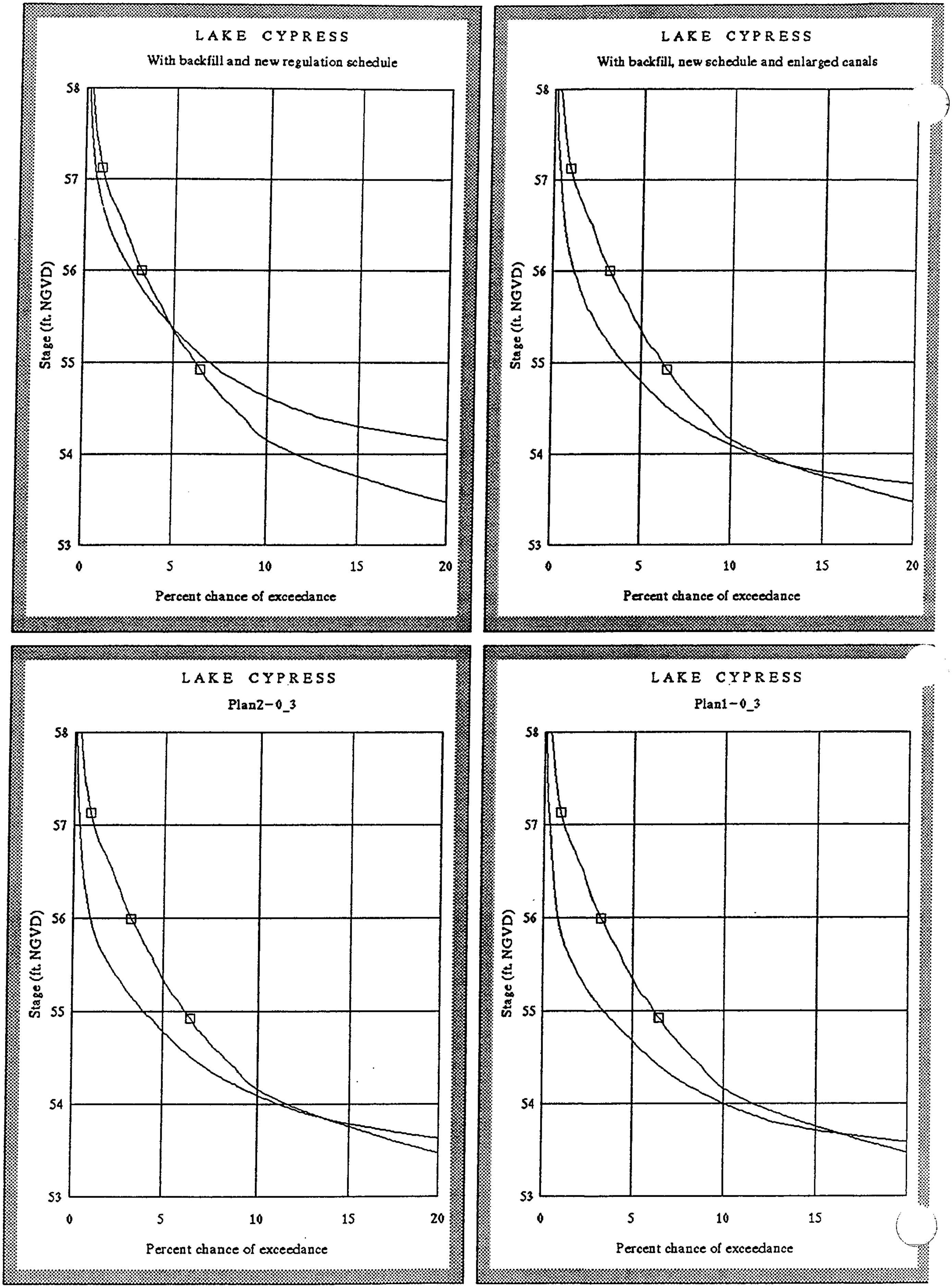
FIGURE A-12



☐ Existing stage frequency

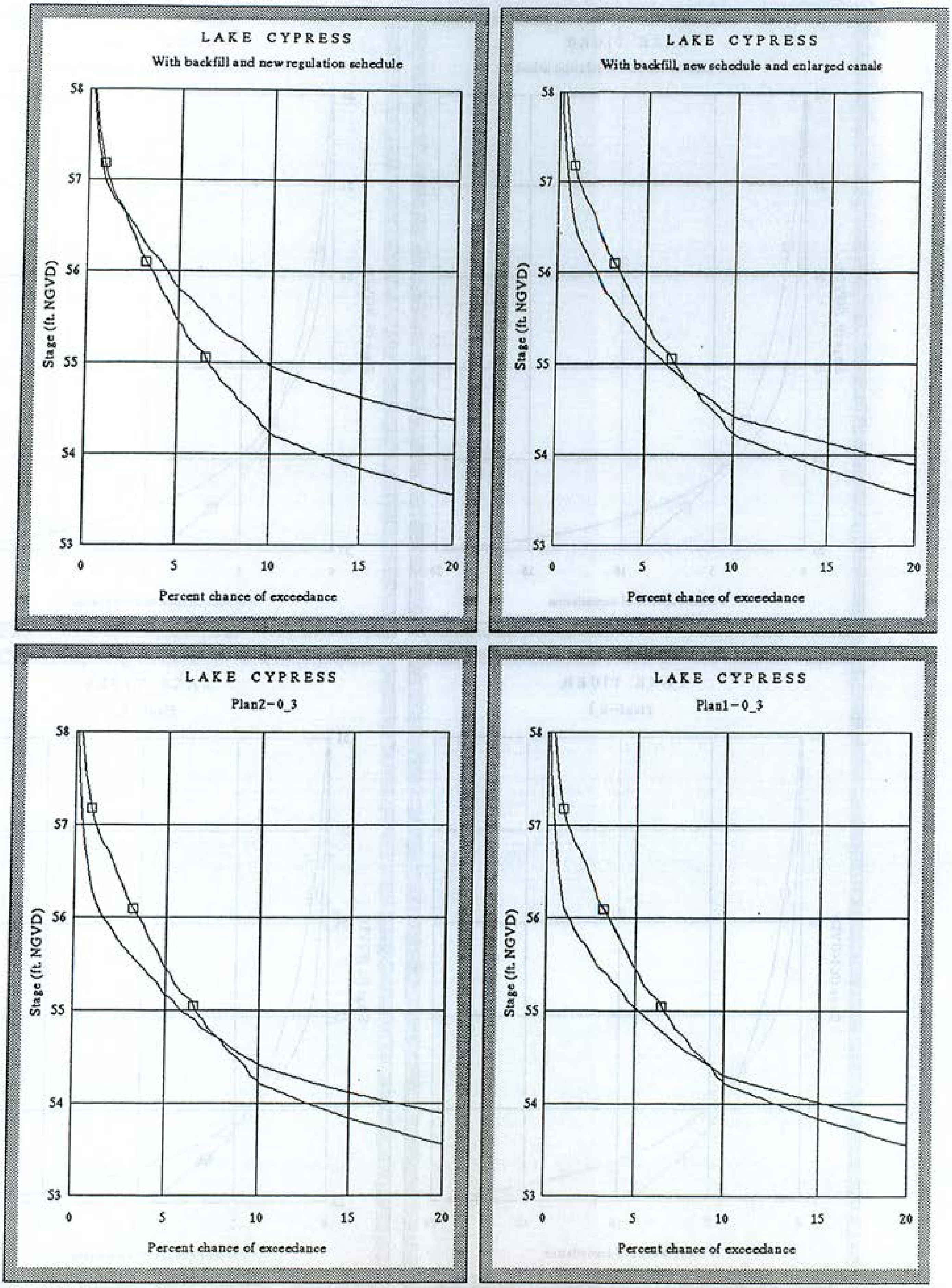
Computed by UNET with top of wet season schedule as the initial condition

FIGURE A-13



☐ Existing stage frequency
Computed by coincident frequency

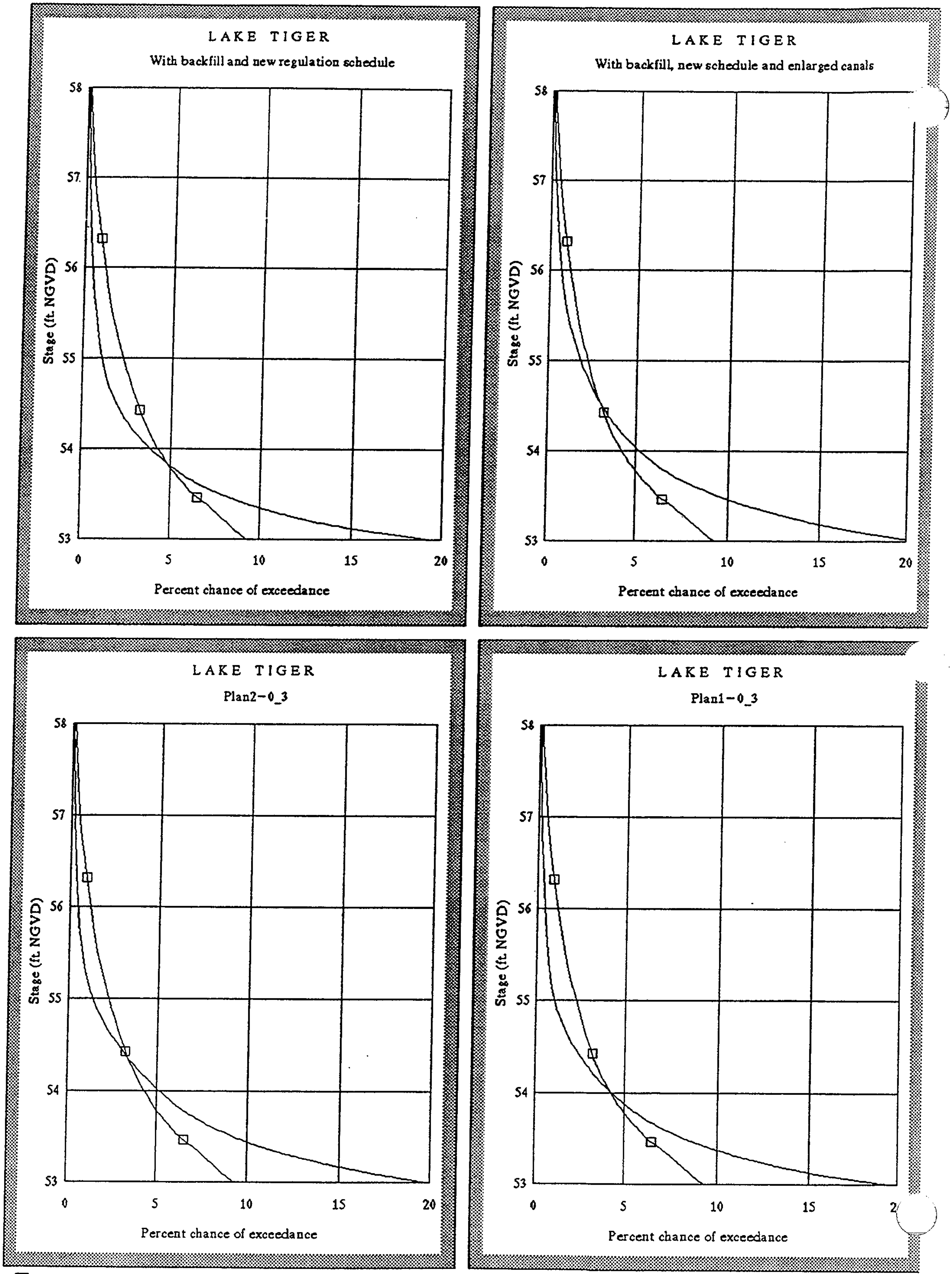
FIGURE A-14



☐ Existing stage frequency

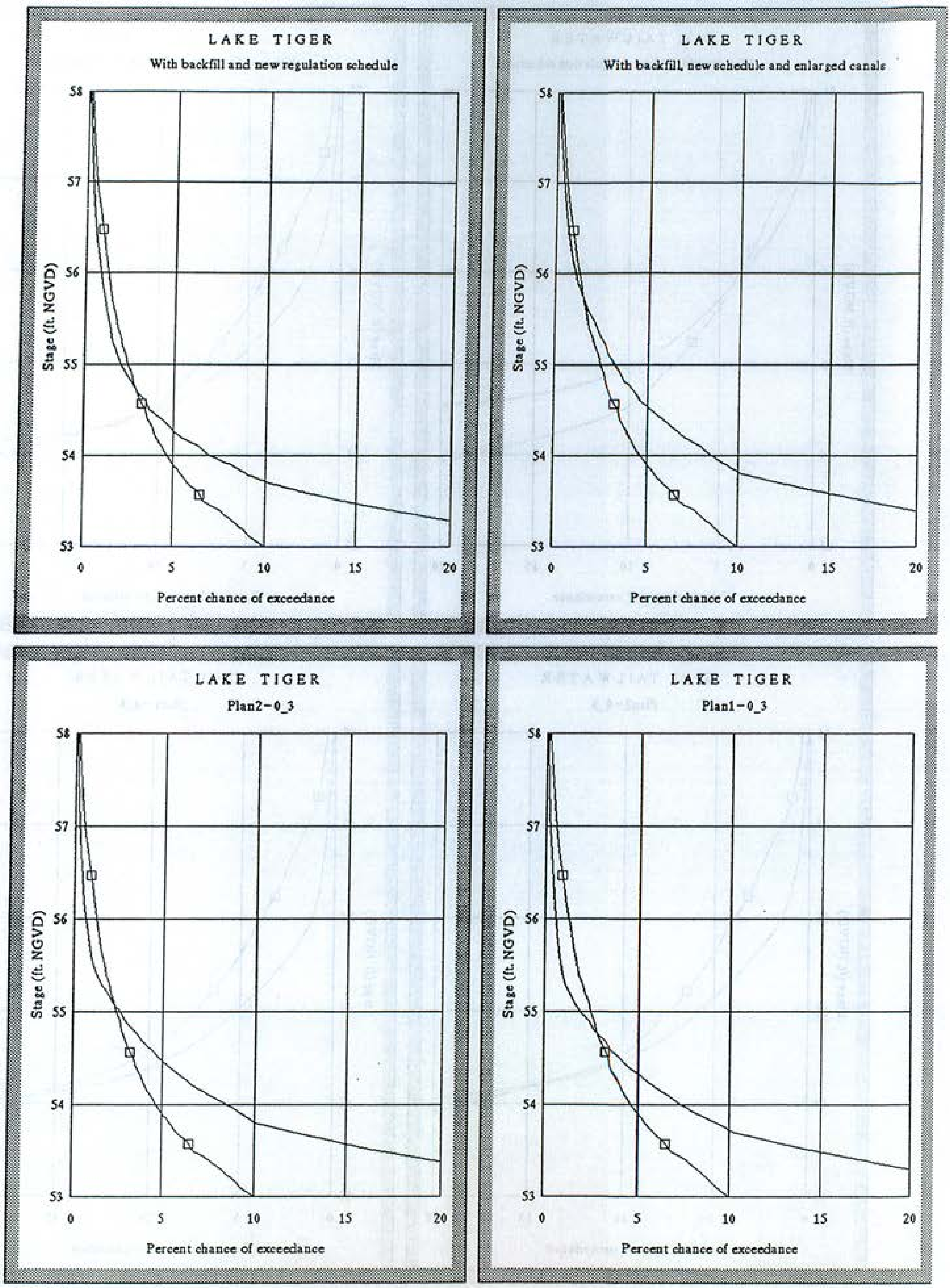
Computed by UNET with top of wet season schedule as the initial condition

FIGURE A-15



☐ Existing stage frequency
Computed by coincident frequency

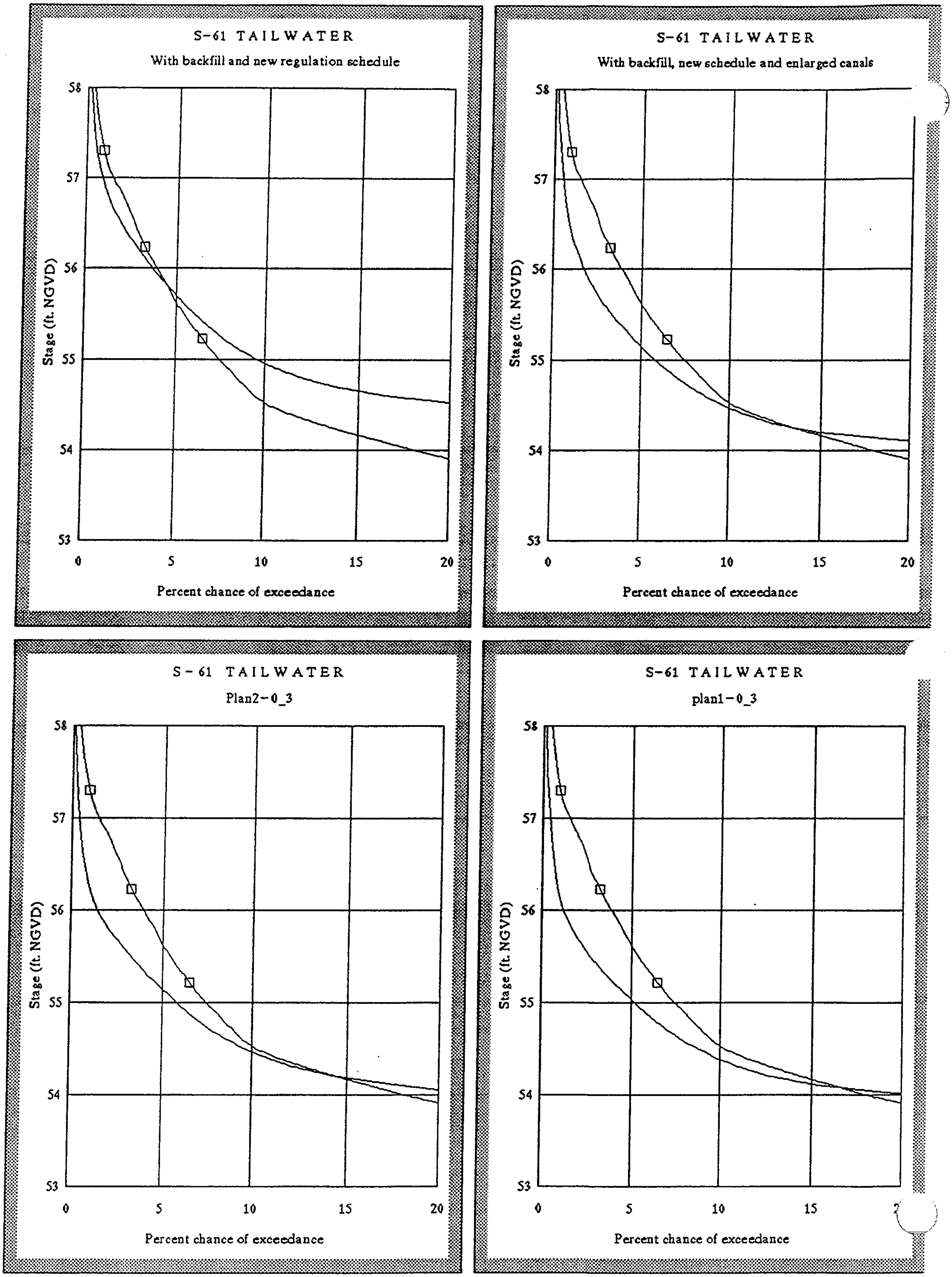
FIGURE A-16



☐ Existing stage frequency

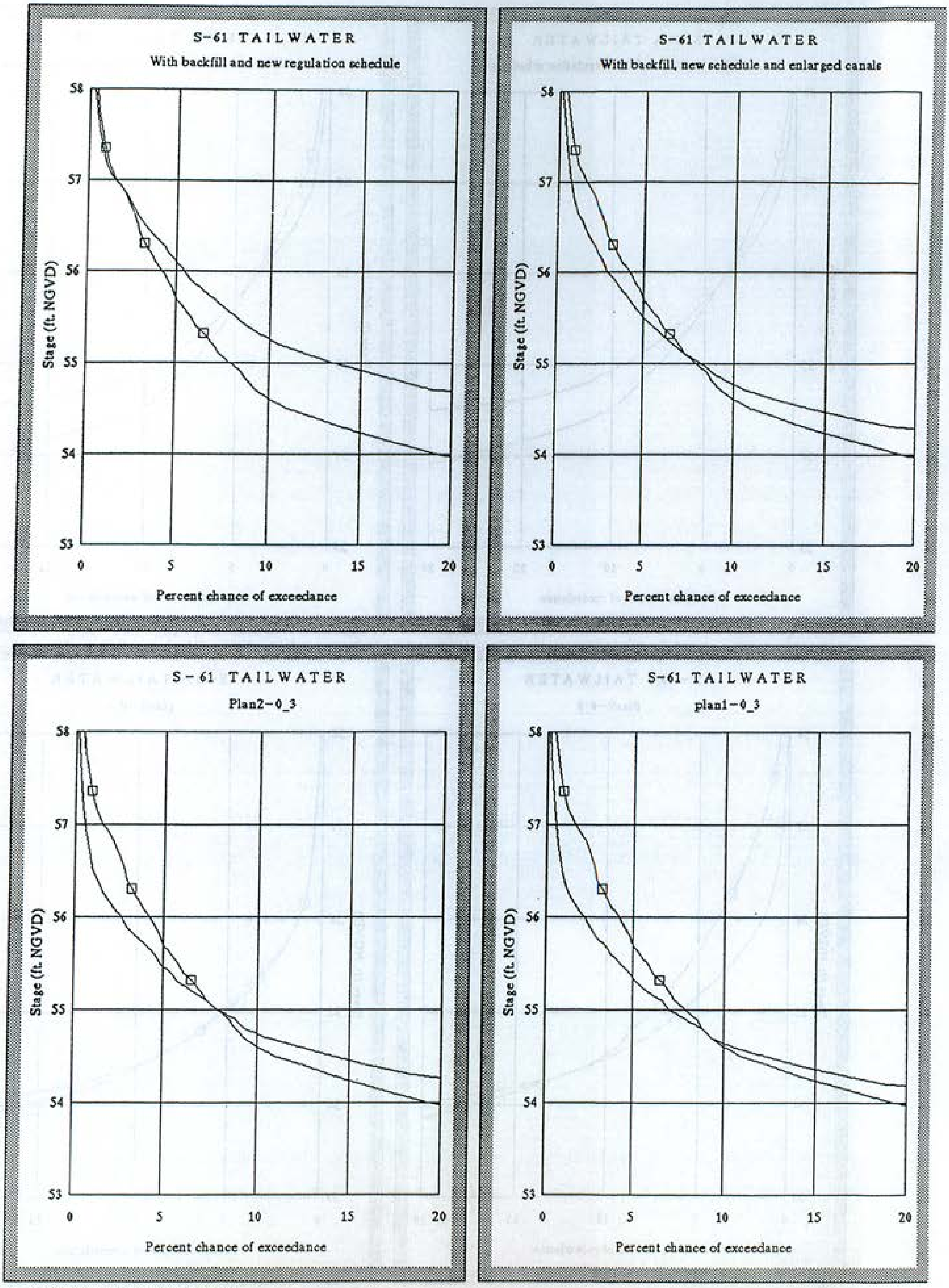
Computed by UNET with top of wet season schedule as the initial condition

FIGURE A-17



☐ Existing stage frequency
Computed by coincident frequency

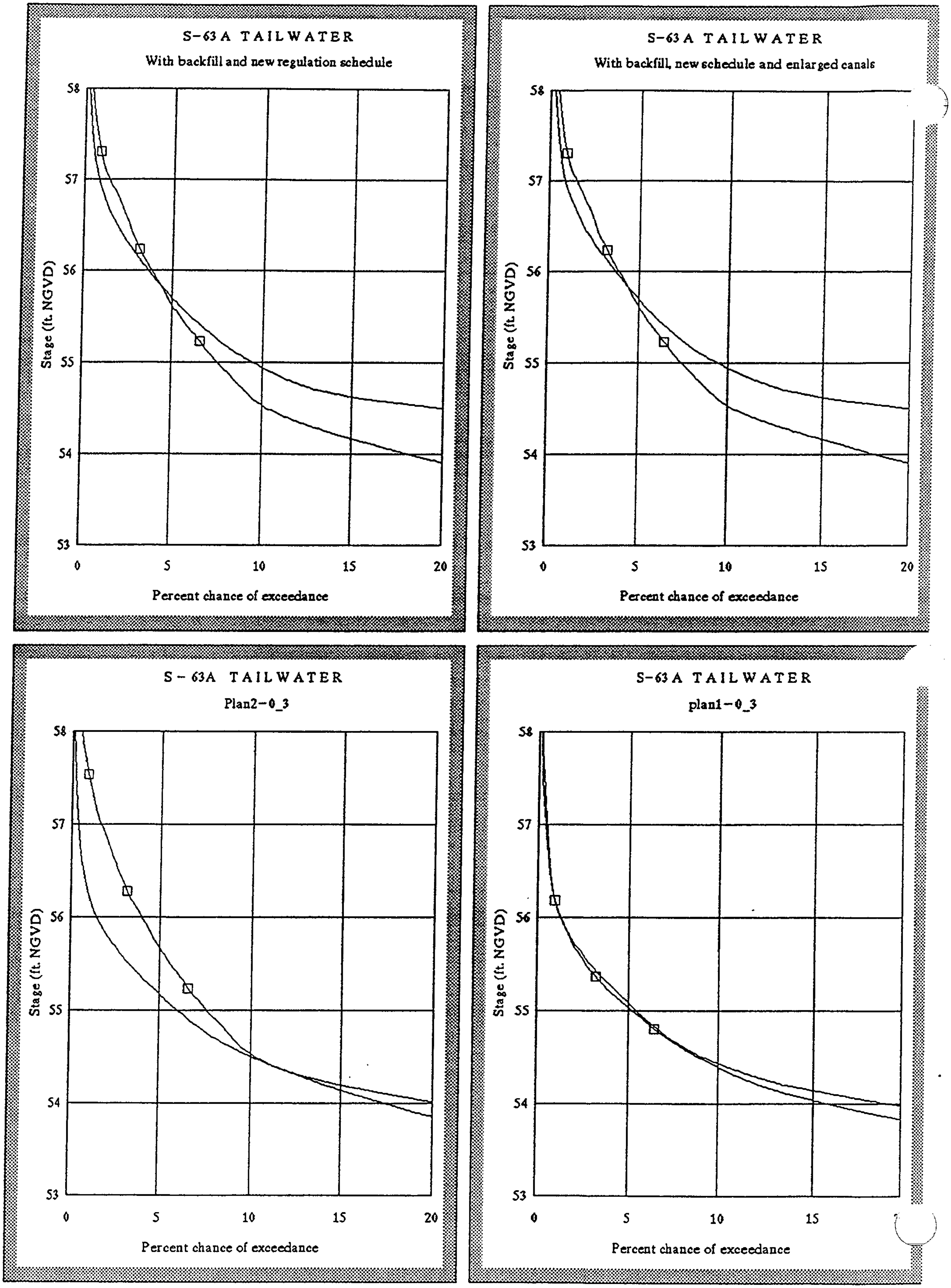
FIGURE A-18



☐ Existing stage frequency

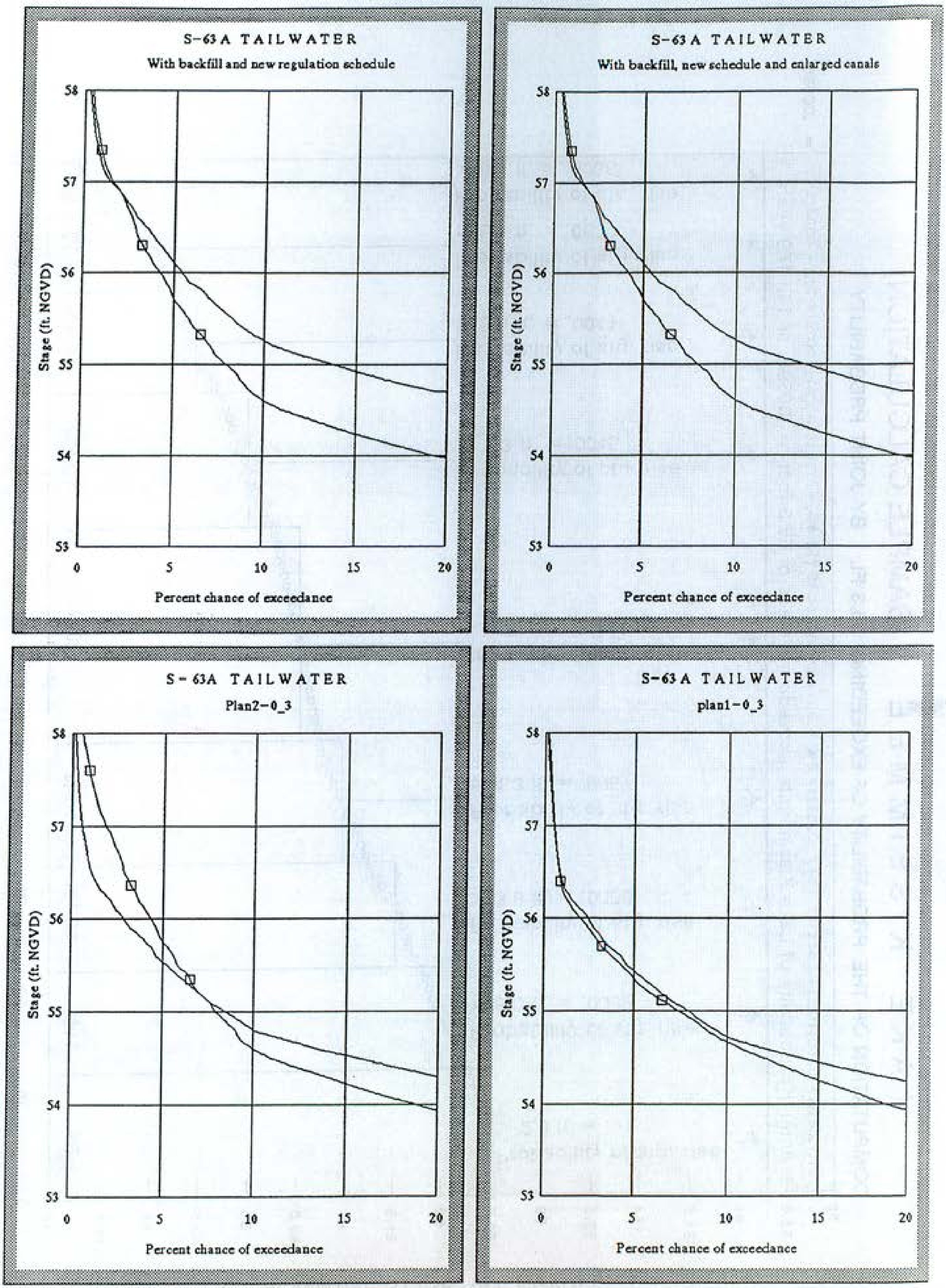
Computed by UNET with top of wet season schedule as the initial condition

FIGURE A–19



☐ Existing stage frequency
Computed by coincident frequency

FIGURE A-20



S-63A TAILWATER
With backfill and new regulation schedule

S-63A TAILWATER
With backfill, new schedule and enlarged canals

S-63A TAILWATER
Plan2-0_3

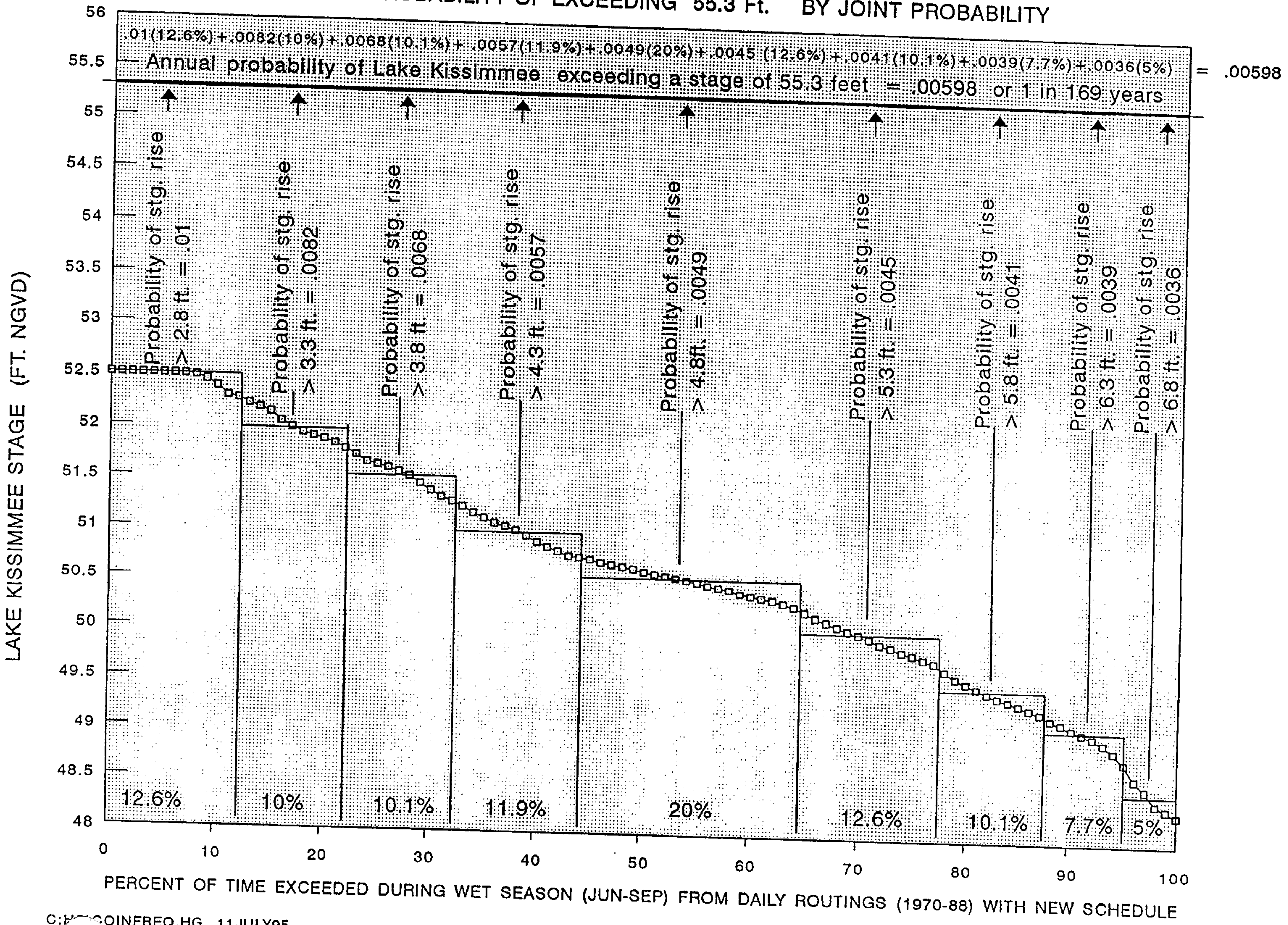
S-63A TAILWATER
plan1-0_3

☐ Existing stage frequency
Computed by UNET with top of wet season schedule as the initial condition

FIGURE A–21

LAKE KISSIMMEE (SAMPLE CALCULATION)

COMPUTATION OF THE PROBABILITY OF EXCEEDING 55.3 Ft. BY JOINT PROBABILITY



C:H COINFREQ.HG 11JULY95

LAKE KISSIMMEE HISTORIC STAGE–DURATION COMPARISONS
(EXISTING VS. PRE–PROJECT)

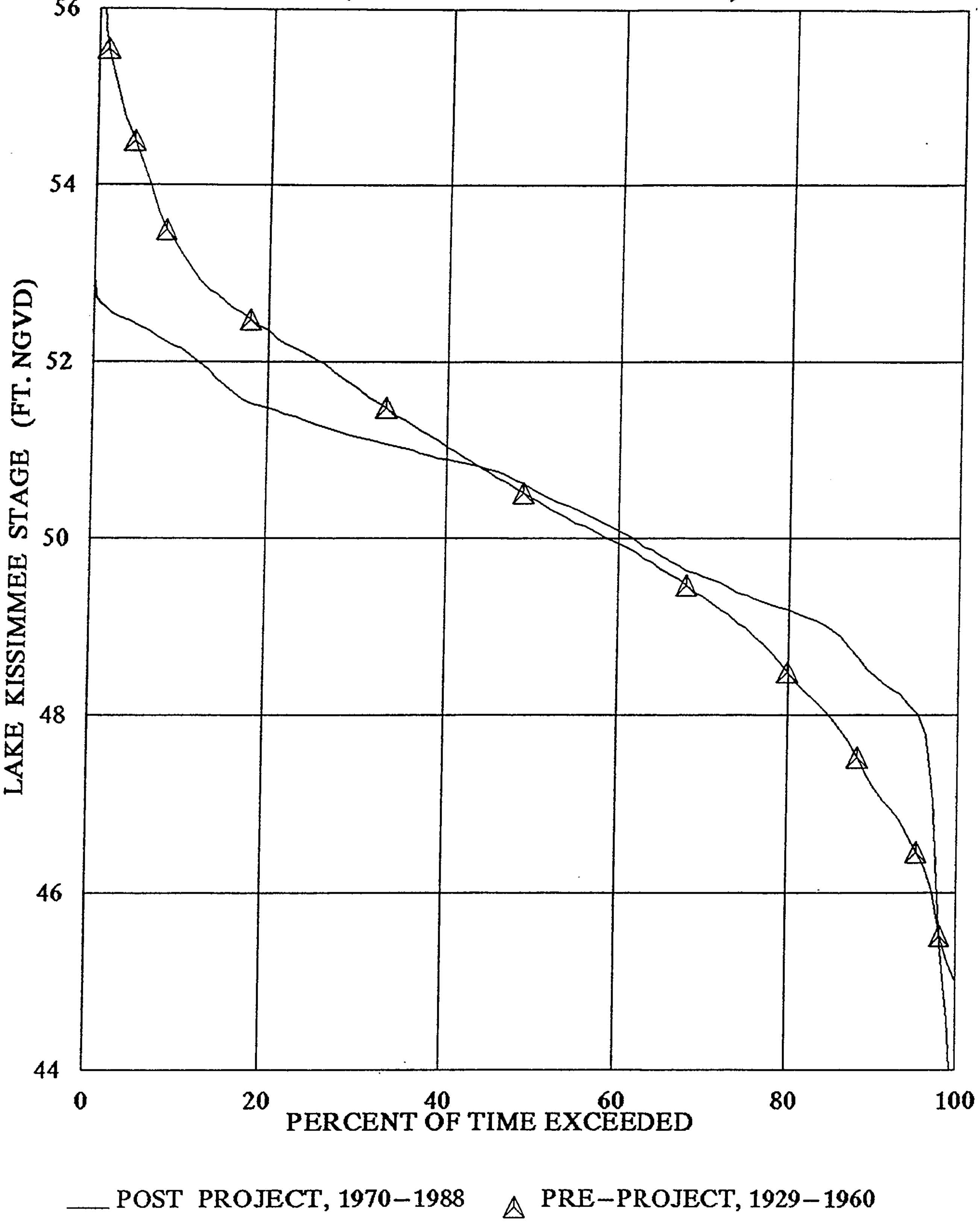


FIGURE A–23

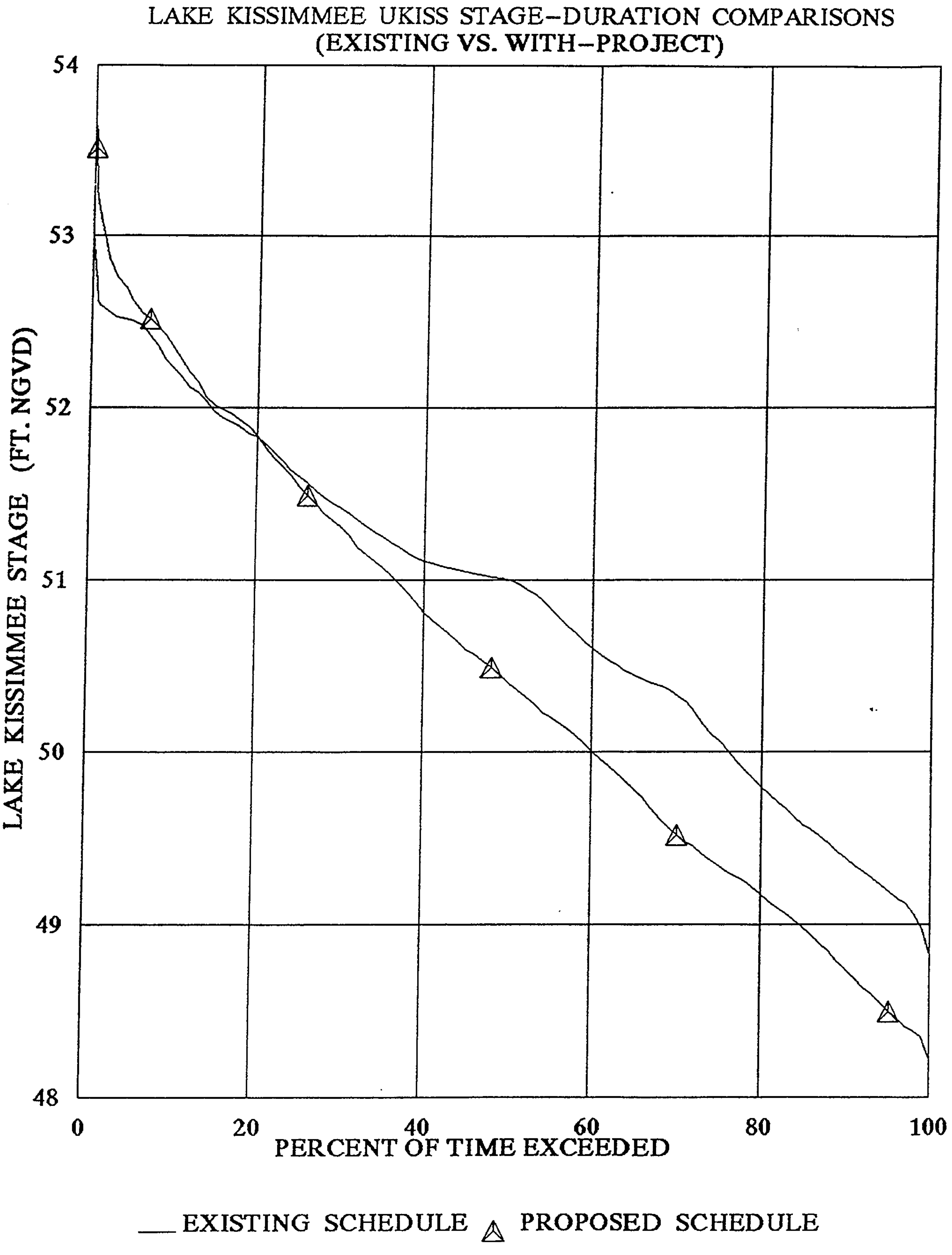

LAKE KISSIMMEE UKISS STAGE–DURATION COMPARISONS
(EXISTING VS. WITH–PROJECT)
LAKE KISSIMMEE STAGE (FT. NGVD)
54
53
52
51
50
49
48
0
20
40
60
80
100
PERCENT OF TIME EXCEEDED
EXISTING SCHEDULE
PROPOSED SCHEDULE

FIGURE A–24

S-65

RATING CURVE FOR SUBMERGED CONTROLLED FLOW

1-27.0′ x 13.7′ GATE (CREST ELEV. 39.3′)

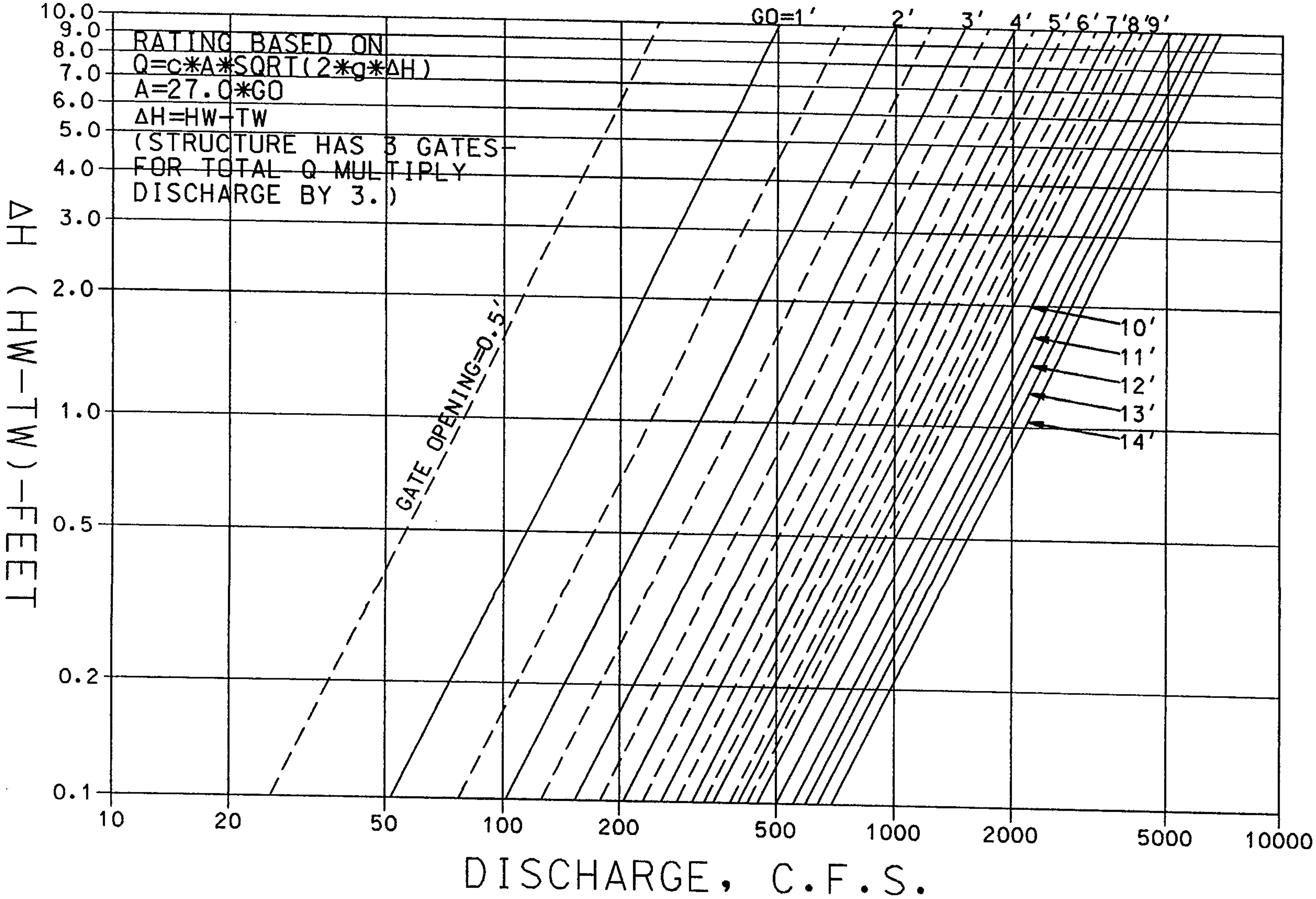
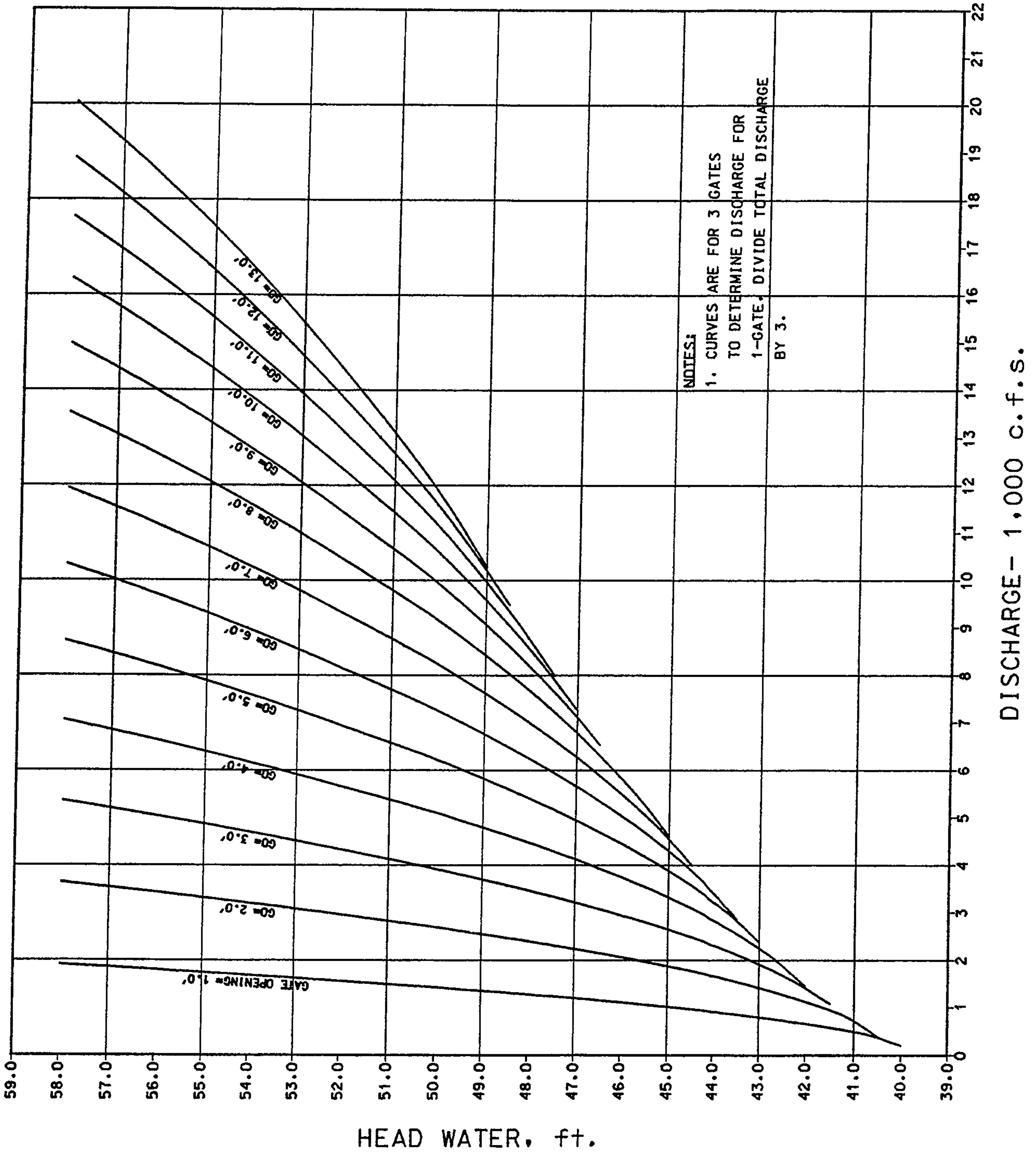


FIGURE A-25

S-65

DISCHARGE RATING CURVE FOR FREE CONTROLLED FLOW

3-27.0' x 13.7' GATE (CREST ELEV. 39.3')



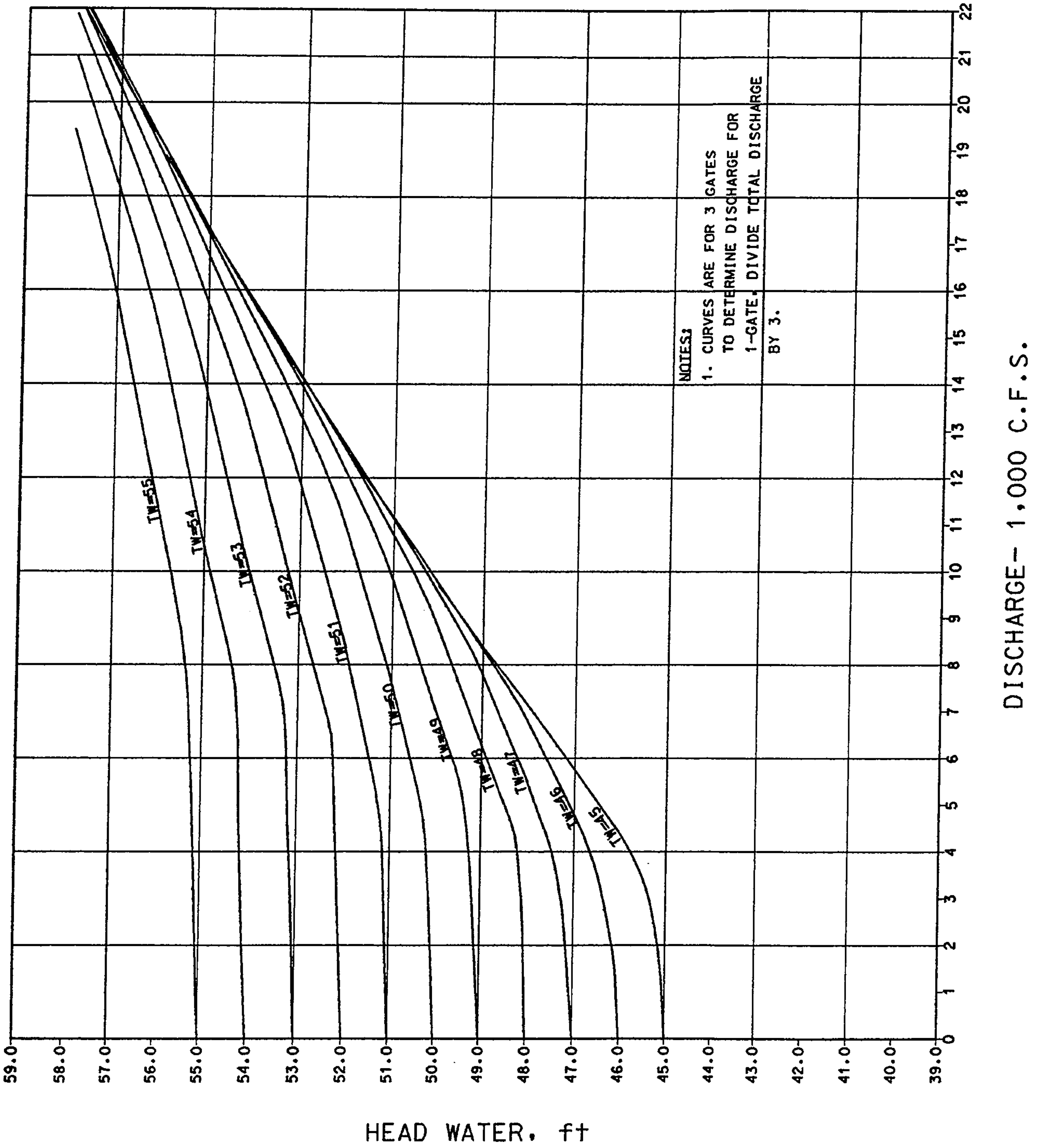
NOTES:
1. CURVES ARE FOR 3 GATES TO DETERMINE DISCHARGE FOR 1-GATE, DIVIDE TOTAL DISCHARGE BY 3.

FIGURE A-26

S-65

DISCHARGE RATING CURVE FOR SUBMERGED UNCONTROLLED FLOW

3-27.0' x 13.7' GATE (CREST ELEV. 39.3')



NOTES:
1. CURVES ARE FOR 3 GATES TO DETERMINE DISCHARGE FOR 1-GATE, DIVIDE TOTAL DISCHARGE BY 3.

FIGURE A-27

S-65 EXPANSION

RATING CURVE FOR SUBMERGED CONTROLLED FLOW

1-27.0′ × 13.7′ GATE (CREST ELEV. 39.3′)

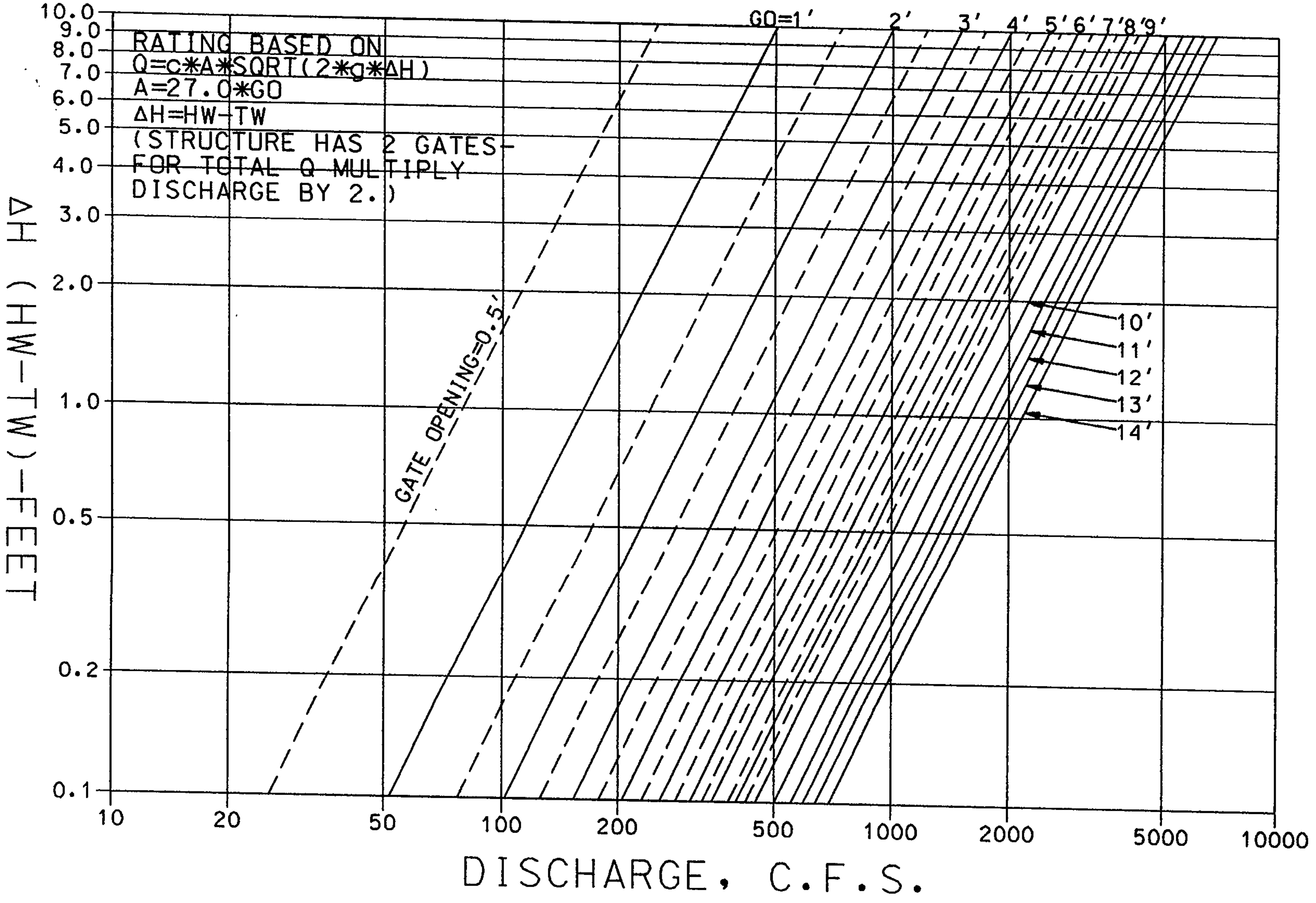


FIGURE A-28

S-65 EXPANSION

DISCHARGE RATING CURVE FOR FREE CONTROLLED FLOW

2-27.0' x 13.7' GATE (CREST ELEV. 39.3')

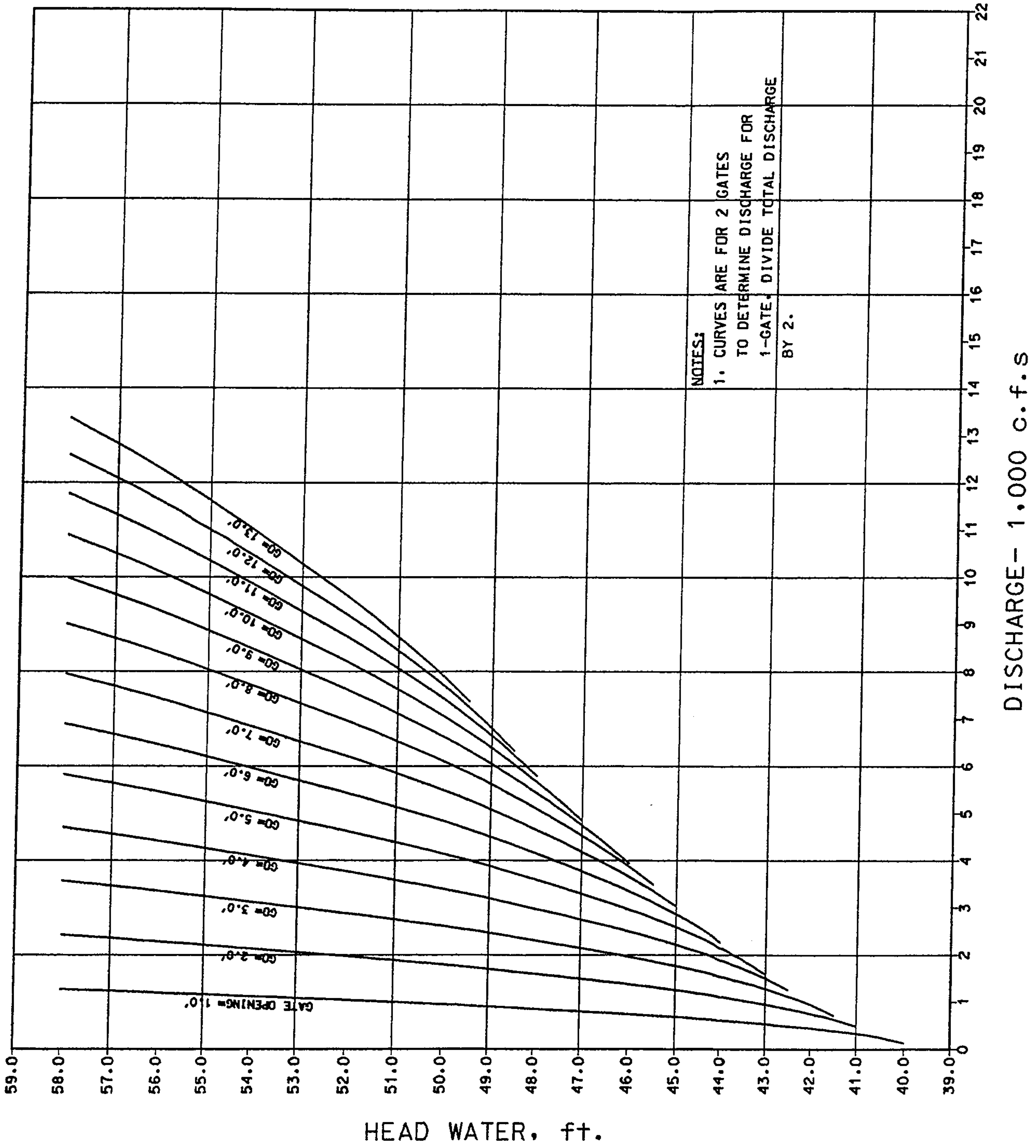
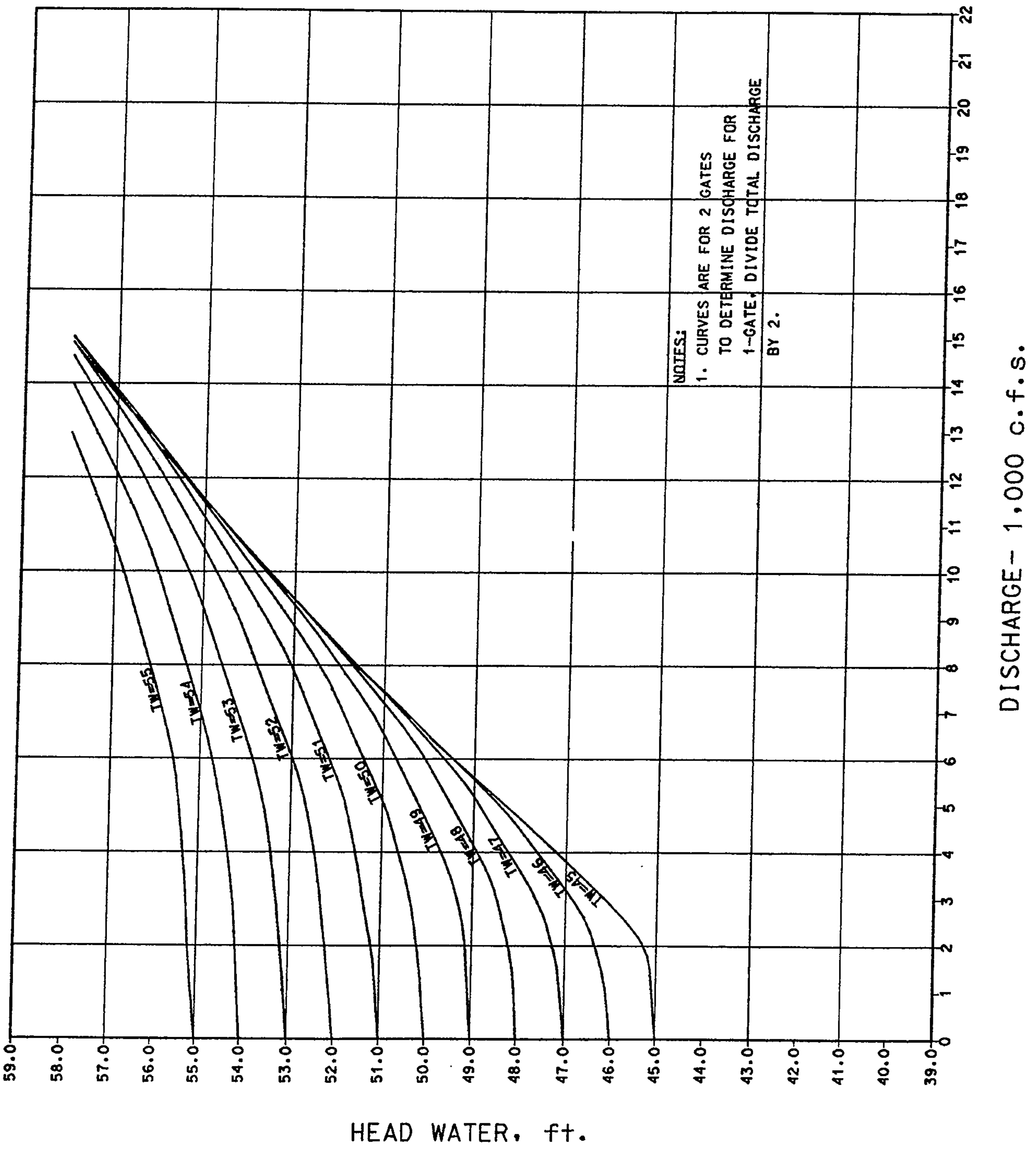


FIGURE A-29

S-65 EXPANSION

DISCHARGE RATING CURVE FOR SUBMERGED UNCONTROLLED FLOW

2-27.0′ x 13.7′ GATE (CREST ELEV. 39.3′)



NOTES:
1. CURVES ARE FOR 2 GATES TO DETERMINE DISCHARGE FOR 1-GATE, DIVIDE TOTAL DISCHARGE BY 2.

FIGURE A-30

COMBINED DISCHARGE FOR S-65 AND S-65 EXPANSION

RATING CURVE FOR SUBMERGED CONTROLLED FLOW

1-27.0′ x 13.7′ GATE (CREST ELEV. 39.3′)

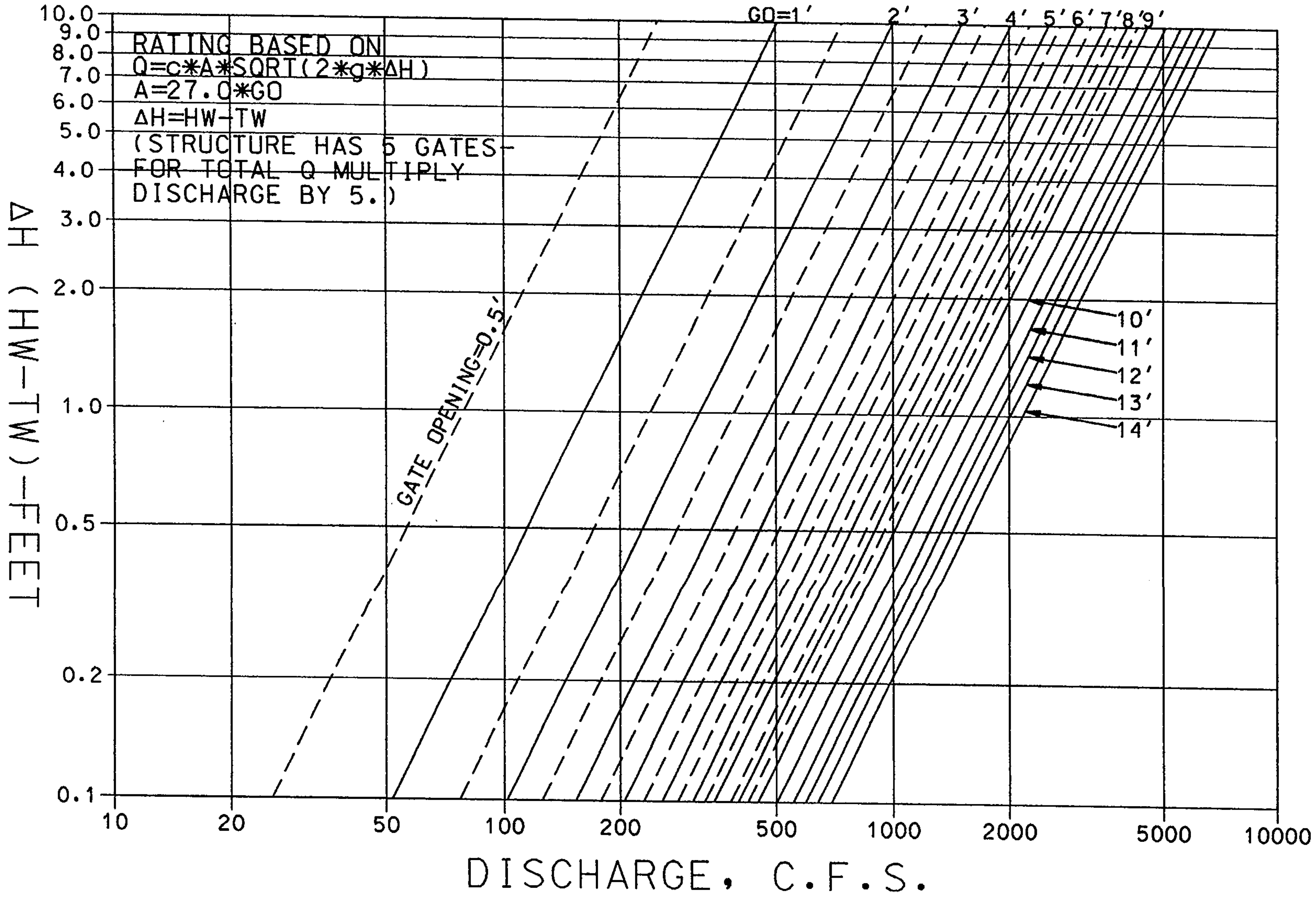
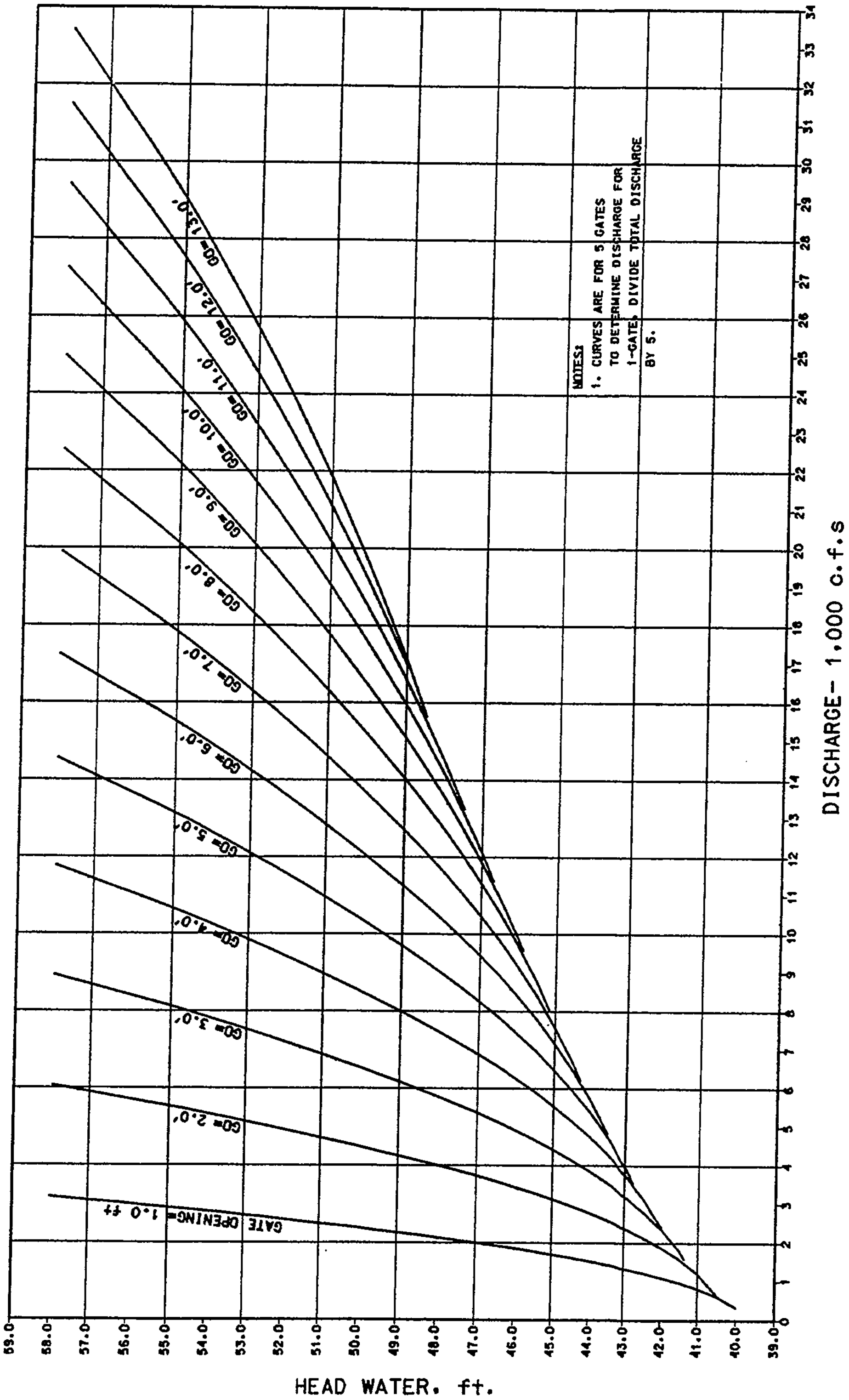


FIGURE A-31

COMBINED DISCHARGE FOR S-65 AND S-65 EXPANSION

DISCHARGE RATING CURVE FOR FREE CONTROLLED FLOW

5-27.0' x 13.7' GATE (CREST ELEV. 39.3')



NOTES:
1. CURVES ARE FOR 5 GATES
TO DETERMINE DISCHARGE FOR
1-GATE, DIVIDE TOTAL DISCHARGE
BY 5.

FIGURE A-32

COMBINED DISCHARGE FOR S-65 AND S-65 EXPANSION

DISCHARGE RATING CURVE FOR SUBMERGED UNCONTROLLED FLOW

5-27.0' x 13.7' GATE (CREST ELEV. 39.3')

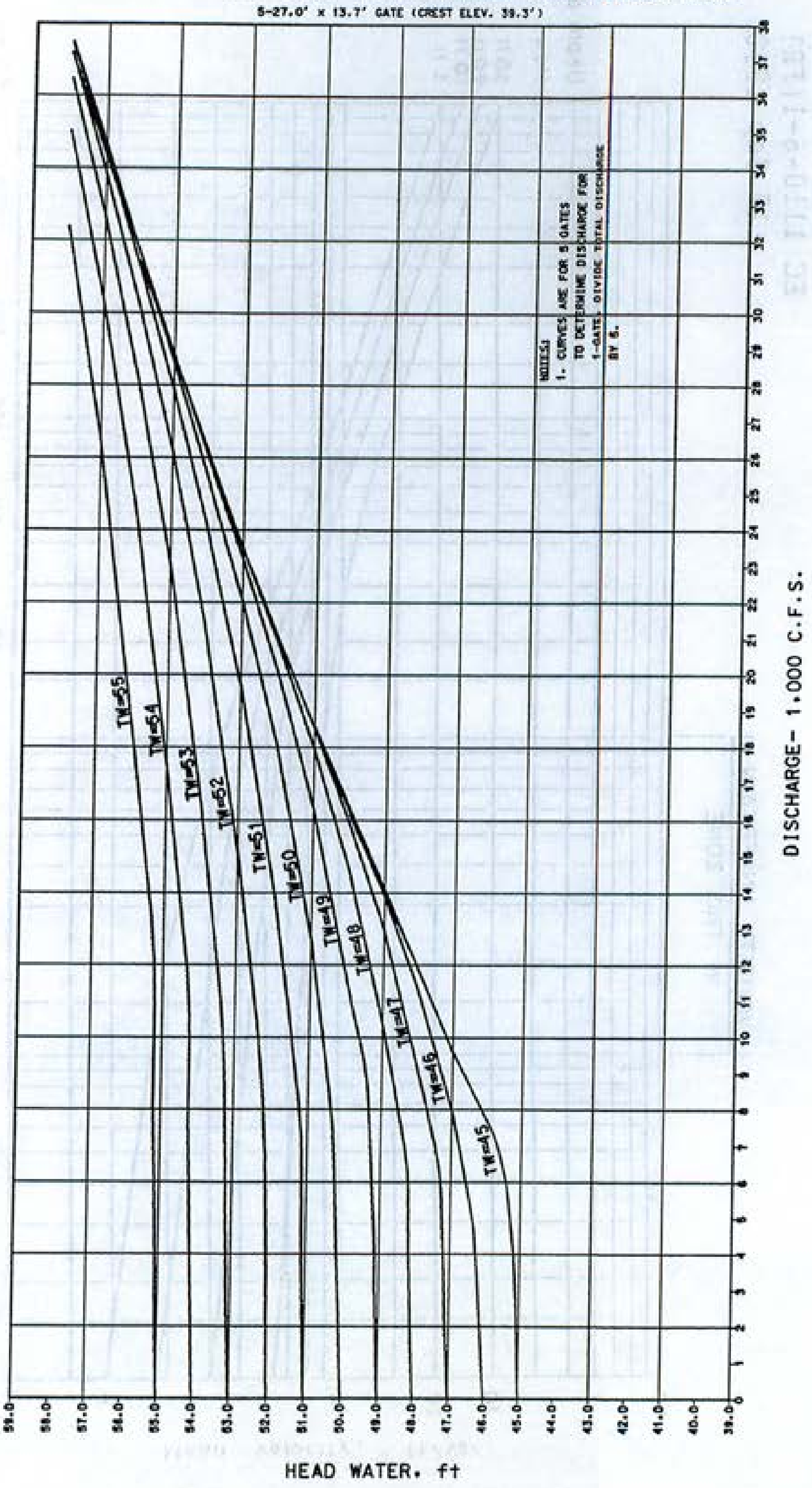


FIGURE A-33

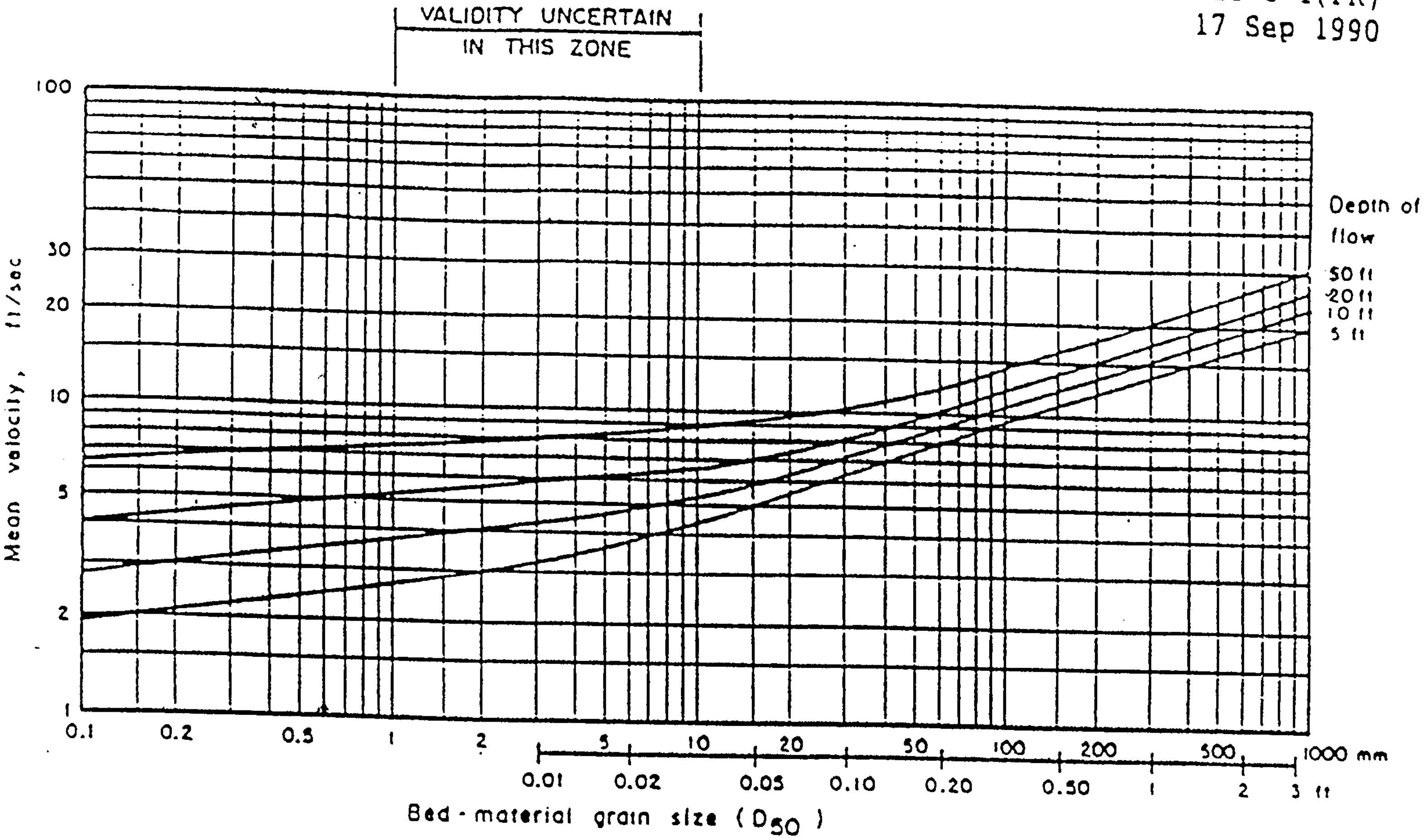
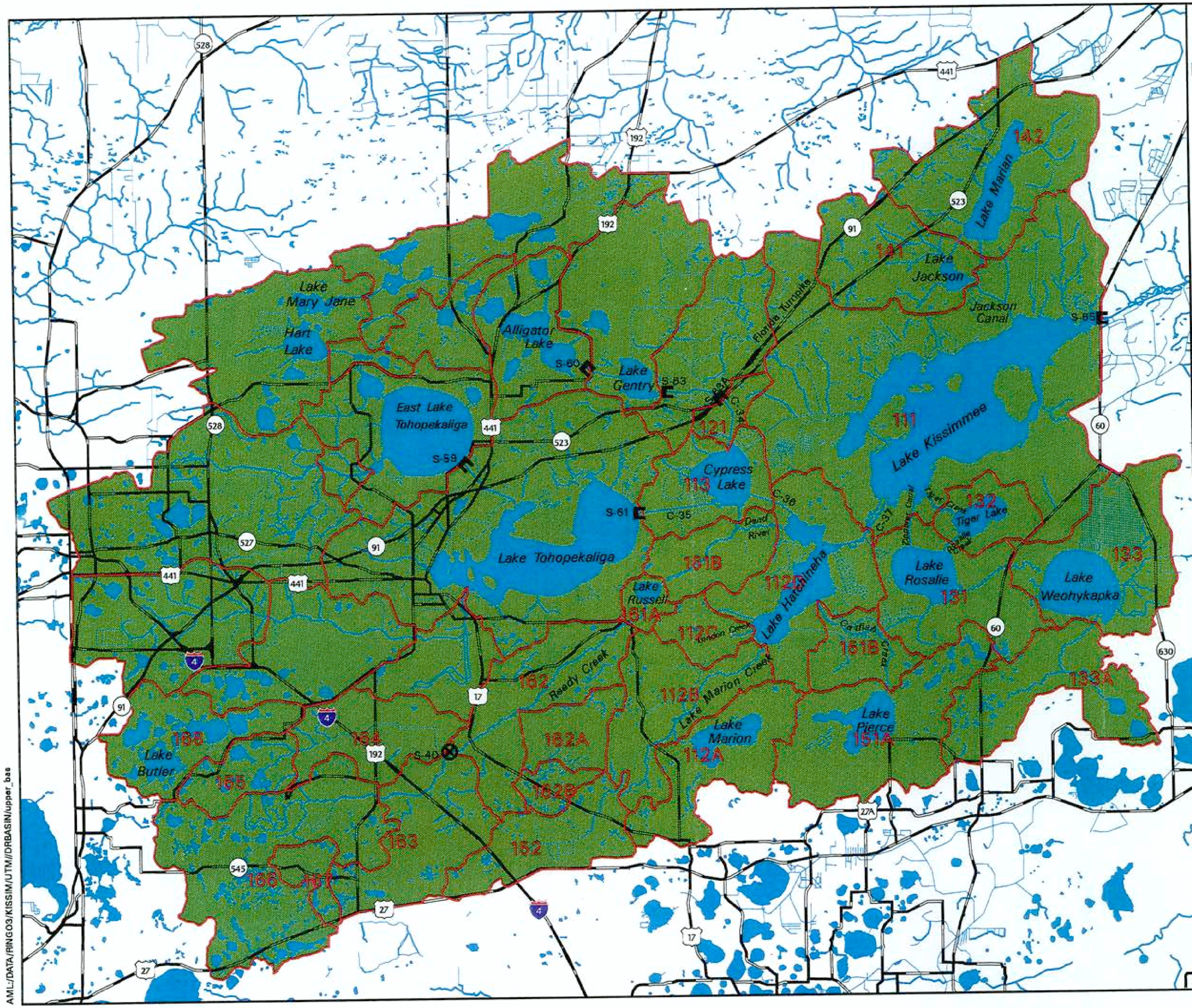


Figure 5.3.3 Approximate threshold velocities for bed movement of granular materials.

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT
Appendix A
Hydrology and Hydraulic Analyses

PLATES



REFER TO TABLE A-10 FOR PERTINENT DATA ON LABELED DRAINAGE AREAS

LEGEND

🟩 Upper/middle basin
Drainage divide
111 Drainage area number
Gated spillway
⊗ Non-Federal Contral Structure

North

Miles
3 0 3 6 9

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

UPPER / MIDDLE BASIN

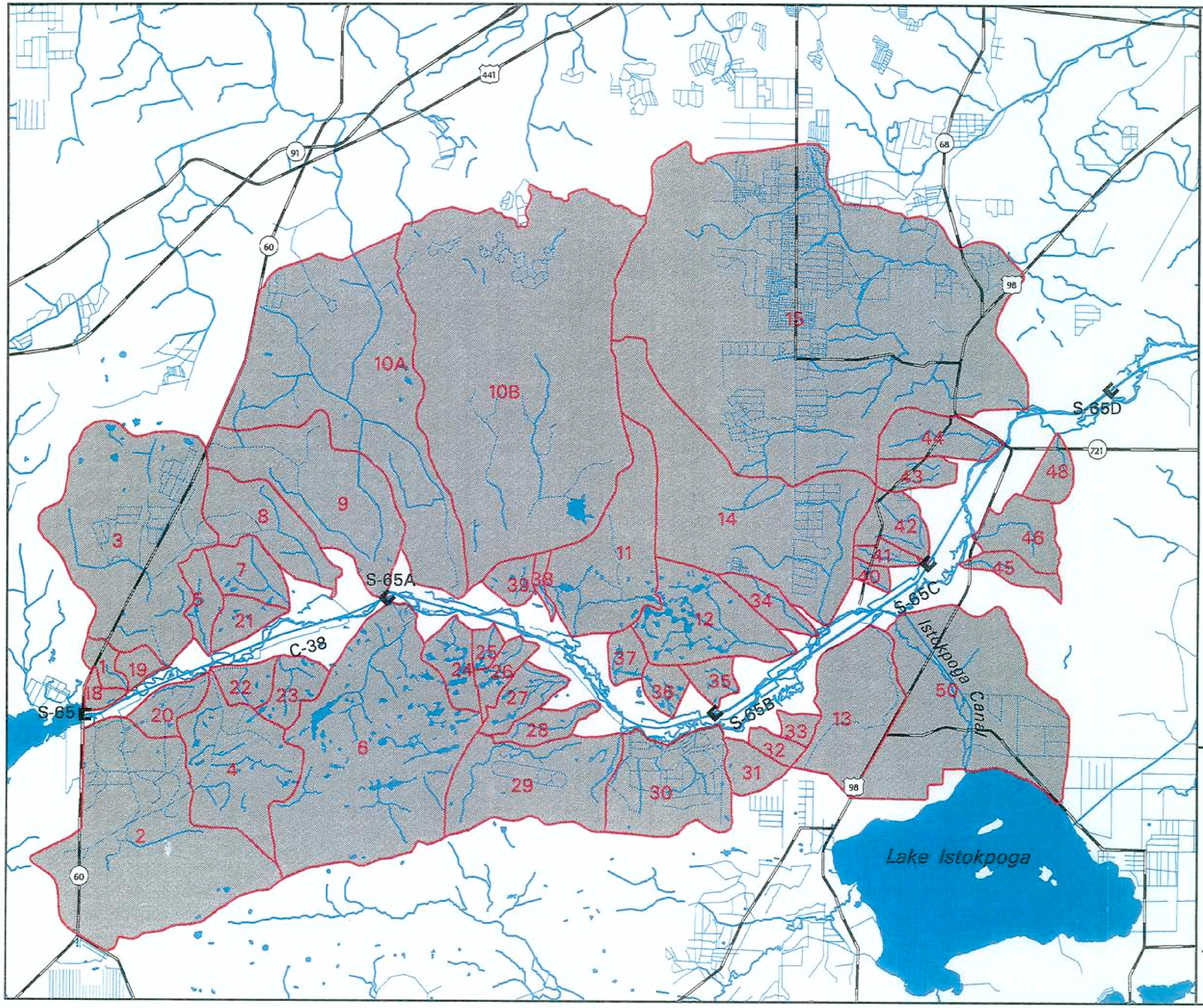
DRAINAGE AREAS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, JULY 1995

PLATE A-1

AML:/DATA/RINGO3/KISSIM/UTM//DRBASIN/upper_bas



REFER TO TABLE A-12 FOR PERTINENT DATA ON LABELED DRAINAGE AREAS

LEGEND

▨	Lower basin
—	Drainage divide
11	Drainage area number
⊓	Gated spillway

North

Miles
2 0 2 4 6

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

LOWER BASIN

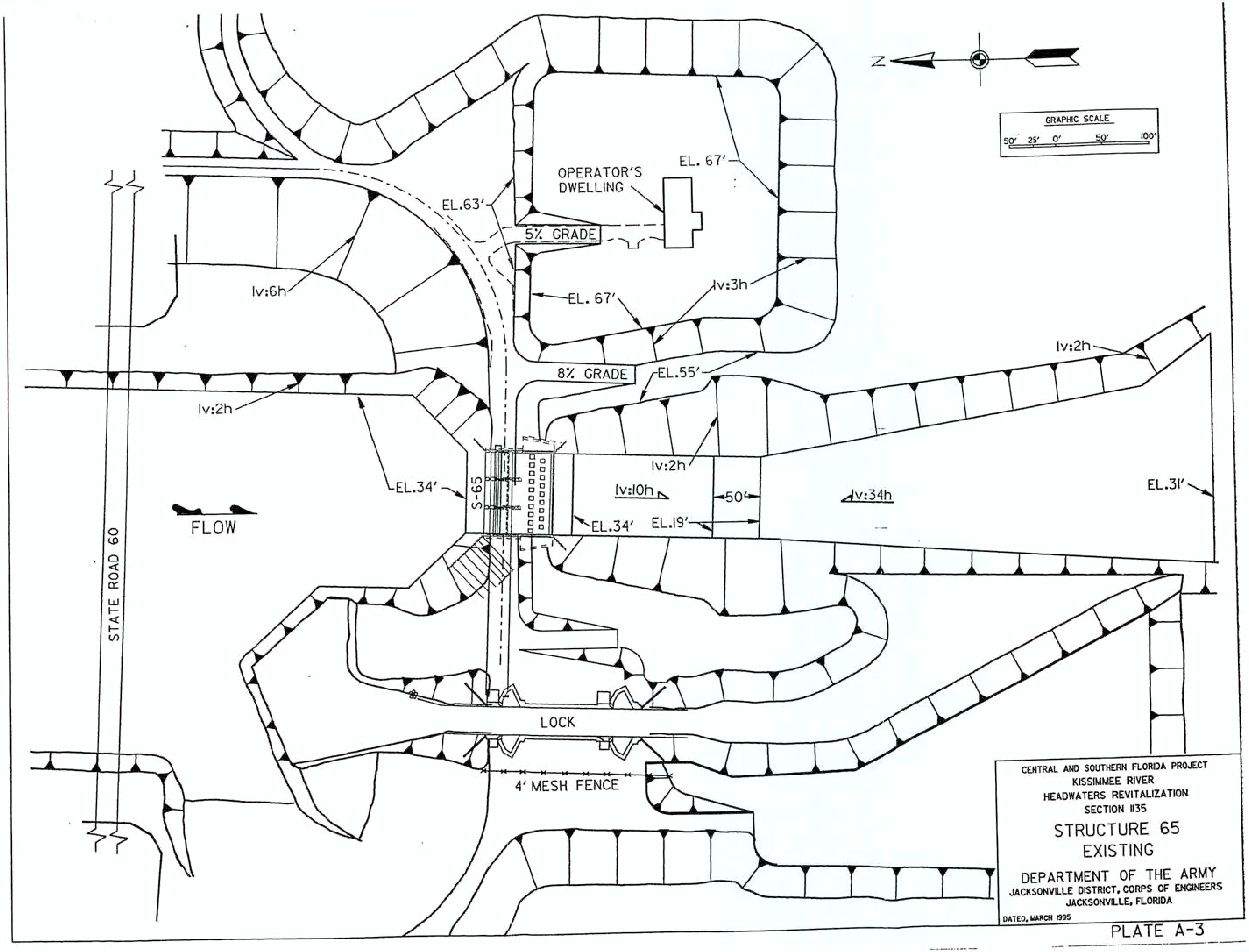
DRAINAGE AREAS

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, JULY 1995

AML:/DATA/RINGO3/KISSIM/UTM/DRBASIN/lower_bas



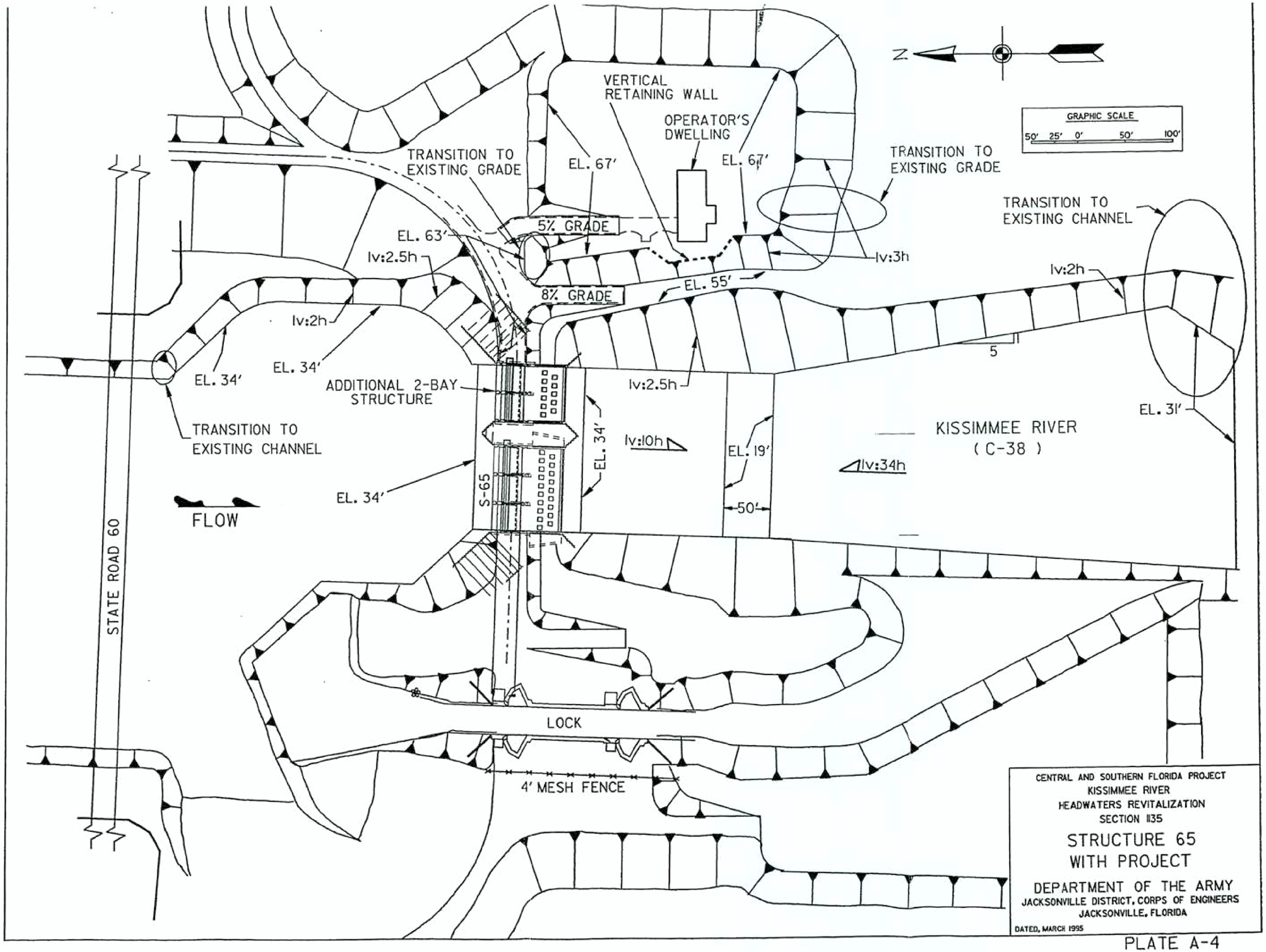
CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

STRUCTURE 65
EXISTING

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, MARCH 1995

PLATE A-3



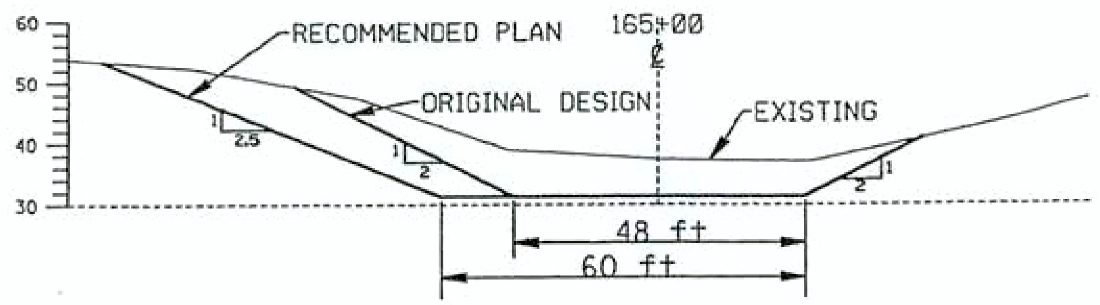
CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

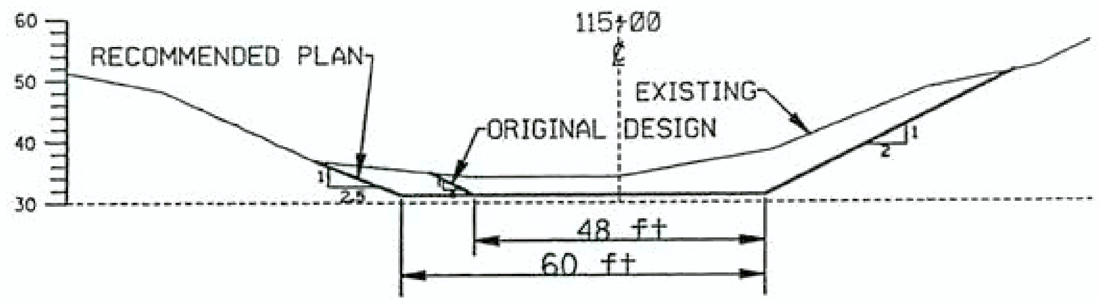
STRUCTURE 65
WITH PROJECT

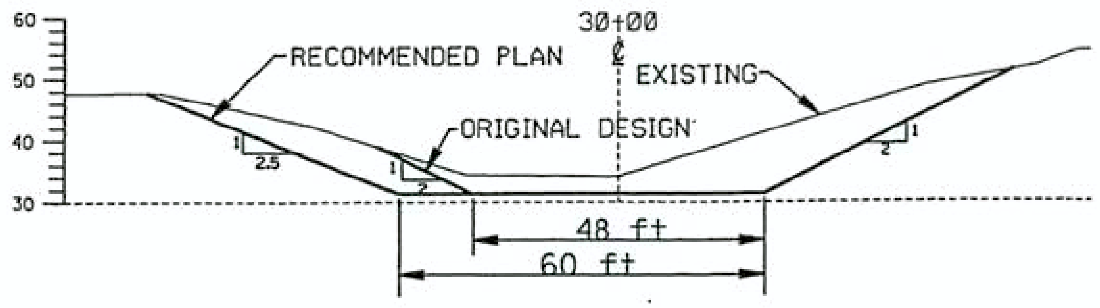
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, MARCH 1995

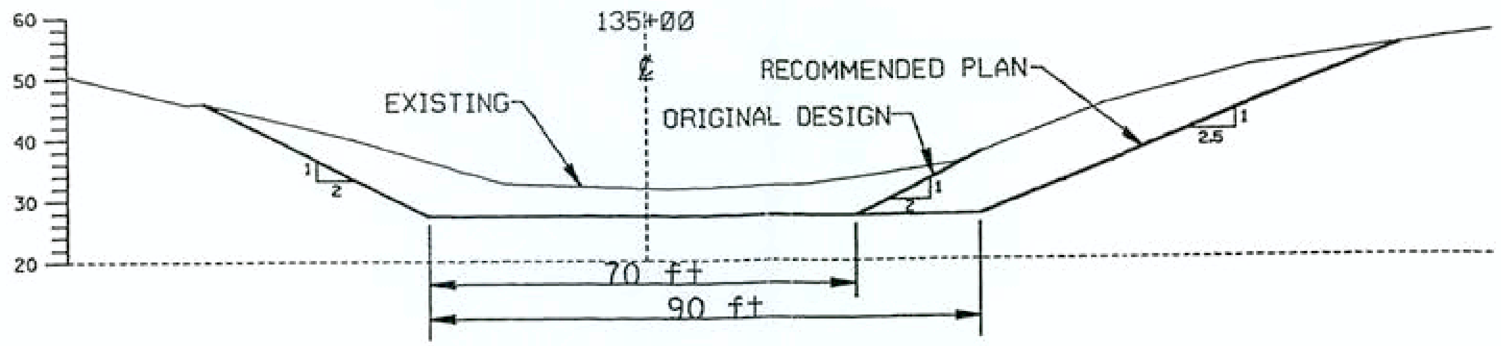
C-36

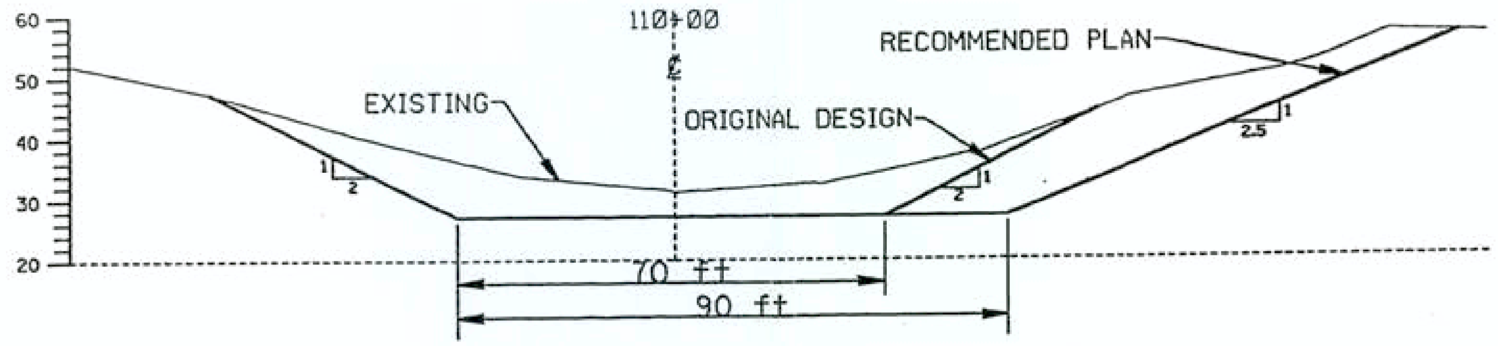


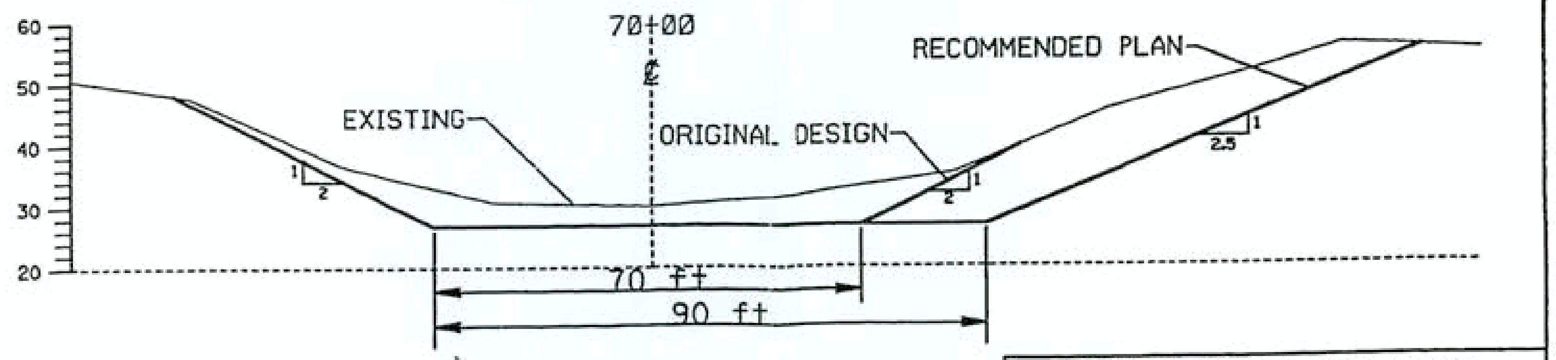




C-37







CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

CANAL 36 & 37 MODIFICATIONS
TYPICAL CROSS SECTIONS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, MARCH 1995

PLATE A-5

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX B

WATER CONTROL PLAN DISCUSSION

Appendix B
Water Control Plan Discussion

Table of Contents

Appendix B
Water Control Plan Discussion

TABLES

FIGURES

Appendix B
Water Control Plan Discussion

B-1. Kissimmee Basin. The Kissimmee Basin is an integrated system of lake storage capabilities and structure outlet capacities. The Upper Kissimmee Basin structures are operated according to the regulation schedules. The regulation schedule essentially represents the seasonal and monthly limits of storage which guides the regulation of the project for the planned purposes. The regulation schedules vary from high stages in the late fall and winter to low stages at the beginning of the wet season. The lakes are drawndown in the spring to provide flood control storage and fish and wildlife enhancement. The minimum levels are set to provide for sufficient flood control storage and navigation depths. The amount of seasonal fluctuation was derived by determining the effect of various water levels on the flood control, low water regulation, groundwater, fish and wildlife, and recreation. The maximum levels were governed by damage prevention for up to 30-percent of the Standard Project Flood (SPF) and reduced damages for larger floods and maximum level desirable for fish and wildlife. Runoff during the wet season is stored for use in the dry season. The regulation schedules take into account these varying, and often, conflicting purposes.

B-2. Kissimmee Basin - Pre-Regulation. Under natural conditions, the lakes in the Kissimmee River Basin fluctuated seasonally through a range in stage varying from about 2 to 10 feet. The existing outlet capacities were limited and the lakes functioned as natural detention reservoirs which stored large quantities of water during the wet season and was released during dry periods. Prior to regulation, the river received continuous inflows from the Upper Basin, with the lowest discharge occurring during the winter-spring dry season and steadily increasing to an end of the wet season (November) peak. Overflows of the lakes during the wet season inundated the large adjacent marsh areas from three to five months on average, and as long as ten months during wet years. Historical seasonal flows out of Lake Kissimmee provided opportunities for fluctuating water levels within the meandering river channel, oxbows, and natural river floodplains within the Lower Kissimmee Basin. Under historic hydrologic conditions, wet prairies were typically dry from spring through early summer, allowing annual plants such as wild millet to germinate and produce seed. Fall and early winter flooding made these wet prairies attractive feeding sites for resident and wintering waterfowl.

B-3. Current Regulation Schedule for Lakes Kissimmee, Hatchineha, and Cypress. These lakes are regulated by a single structure, S-65 located at the outlet of Lake Kissimmee at the head of C-38. Lake Kissimmee is normally regulated between elevations 49.0 and 52.5 ft., NGVD according to a seasonally varying schedule. One year in three the lake is regulated between 48.5 ft. and 52.5 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-1. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-1), releases of 3,000 cfs minimum can be made at anytime. During design flood conditions, discharge from S-65 will vary between 3,000 and 11,000 cfs according to downstream conditions. When local inflow to C-38 is equal to or greater than design flood runoff, S-65 will limit discharge to 3,000 cfs. After local inflow subsides, discharge from S-65 could increase to 11,000 cfs depending on downstream capacity. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

B-4. Effect of Lake Regulation. With the increased outlet capacities provided by the project, the lakes are regulated to prevent much of the fluctuation that occurred under natural conditions. When regulation was implemented, the fluctuation of Lakes Cypress, Hatchineha, and Kissimmee was set within a four foot range. The current regulation schedule requires that water levels be drawn down in advance of the wet season and that water levels be allowed to rise to maximum safe storage prior to the dry season. Consequently, discharges to the lower basin are generally limited during the wet season and extended periods of no flow are common as water is being stored in the lakes. Discharges increase in the dry season as water levels are once again being drawn down in advance of the next wet season. In addition, the range of water level fluctuations and maximum annual lake stages have been reduced and the outer fringe of littoral wetlands surrounding the lakes have been drained diminishing associated fish and wildlife values. These operation rules have resulted in discharge regimes that have been greatly altered compared to historical conditions. Since regulation, the natural seasonality of high and low periods have been reversed and there are extended periods during each year when there is no discharge from the upper lakes to the lower basin.

B-5. Goals and Objectives of the Proposed Regulation Schedule. Changes to the water management of the upper Kissimmee chain of lakes will provide the necessary storage and modifications to approximate historical flow characteristics required to achieve or exceed the benefits ascribed to Kissimmee River Restoration. In addition, the modification of the regulation schedule will increase the quantity and quality of the wetland habitat in the lake littoral zones in the upper chain of lakes to benefit fish and wildlife.

The primary criterion for achieving environmental improvements in the upper basin is to increase the maximum extent and frequency of high lake stages. The basic strategy is to modify the regulation schedule and operation rules to allow lake stages to fluctuate more naturally with rainfall and associated inflows from the watershed, and to reestablish outflow regimes that reflect historic (pre-regulation) stage-discharge relationship for the lakes. Hydrologic restoration for the lower basin requires reestablishment of continuous inflows from the lakes, particularly during July through October.

The following constraints were placed on the development of the proposed regulation schedule for Lakes Cypress, Hatchineha, and Kissimmee:

a. maintain the existing level of flood protection in the upper basin;

b. avoid adverse impacts to existing flood protection upstream of Lakes Gentry and Lake Tohopekaliga;

c. insure continuous flow in the Kissimmee River downstream of S-65 with duration and variability comparable to pre-project records; and

d. reestablish water schedules that result in flood plain inundation frequencies and recession rates comparable to pre-channelization hydroperiods.

B-6. Proposed Regulation Schedule for Lakes Kissimmee, Hatchineha, and Cypress. To achieve restoration, the proposed regulation schedule for Lakes Kissimmee, Cypress and Hatchineha has three new features: (1) eliminate the pulsating effect (on/off) effect of the current regulation schedule; (2) provide a seasonal shift in water releases from the lakes; and (3) increase the range of high to low water fluctuations in the lakes. In order to provide a more natural flow condition, the seasonal water storage had to be increased at the upper end of lake levels. The upper limit of water levels or increased storage capability was also controlled by flood protection constraints. The proposed regulation schedule is a seasonally varying schedule with a high stage of 54.0 ft. and a low of 52.5 ft., NGVD. This change will increase the quantity of littoral zone around the lakes. In addition, S-65 discharge capacity will be increased to 18,000 cfs eliminate impacts due to raising the top of the regulation schedule 1.5 ft. Widening Canals 35 and 36 (C-35 and C-36) will also be done to eliminate impacts to flood protection upstream of these lakes. The proposed regulation schedule is designed to provide the necessary discharges for downstream hydrology essential for restoration while permitting the inundation of approximately additional 7,236 acres in the upper basin.

a. Flood Control. The proposed regulation schedule for Lakes Kissimmee, Hatchineha, and Cypress has a flood control pool (Zone A) which varies seasonally between elevation 52.5 ft. and 54.0 ft., NGVD. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-2), releases of 2,500 cfs minimum can be made at anytime. During design flood conditions, discharge from S-65 can vary between 2,500 and 18,000 cfs according to conditions upstream of S-65.

Hydrologic modeling done for this study assumed that during floods, S-65 will discharge upto its maximum capacity in Zone A. However, operators discretion in making large flood control releases when in Zone A is required to prevent large surges occuring downstream.

b. Normal Operation. The proposed regulation schedule is devised to replicate historic flows in the lower basin to achieve restoration of the remnant flood plain marshes. The regulation schedule has several zones which dictate discharges downstream through S-65 based on the stage at the S-65 headwater. There are several gages located in Lake Kissimmee. Operating experience has shown that during high flow conditions, there is a drawdown of water levels at S-65. During these conditions, it is appropriate to monitor these other gages to obtain a more suitable indication of the lake stage for operating purposes. The zones are as follows with elevations referring to the S-65 headwater stage:

Period of record routings done for this study assumed S-65 discharges are incrementally increased as the stage in Lake Kissimmee increased. Accordingly, releases in Zone B2 should be increased or decreased as stages in Lake Kissimmee change. However, operator discretion is required in making these discharges to optimize environmental benefits both in the lakes and downstream river.

(1) Zone B1 - Stage between elevations 50.0 ft. and 52.0 ft., NGVD during January 1 through June 30. During the period from January 1 through April 30 when the stage is between 50.0 ft. and 52.0 ft. the discharge from S-65 will be 400 cfs. From May 1 through May 31 the 400 cfs zone varies between 51.0 ft. and 52.0 ft., NGVD. From June 1 through June 30, the 400 cfs discharge zone varies between 50.0 ft. and 51.0 ft, NGVD.

(2) Zone B2 - Stage between elevations 50.0 ft. and 54.0 ft., NGVD. When the S-65 stage is in this zone, the discharge will vary between 400 cfs at elevation 50.0 ft., 800 cfs at elevation 51.0 ft., 1,000 cfs at 52.0 ft., 1,600 cfs at elevation 53.0 ft., and 2,500 cfs at elevation 54.0 ft., NGVD.

(3) Zone C - Stage between elevations 49.0 ft. and 50.0 ft., NGVD. When the stage is in this range the discharge through S-65 will range between 150 and 400 cfs.

(4) Zone D - Stage between elevations 48.5 ft. and 49.0 ft., NGVD. When the stage is between these elevations, a constant flow of 150 cfs will be discharged through S-65.

(5) Zone E - Stage below elevation 48.5 ft., NGVD. Below 48.5 ft., NGVD no discharges would be made through S-65.

B-7. Water Control Plan Flexibility to Achieve Restoration. The goal of the proposed regulation schedule for Lakes Kissimmee, Hatchineha, and Cypress is to permit the lakes to fluctuate in a more natural manner and to support restoration of the Kissimmee River. However, because of the variability in hydro-meteorological conditions, it may be necessary to deviate from the discharges prescribed by the regulation schedule. These deviations will be done to maximize restoration opportunities in both the upper and lower basins and will be done in a manner consistent with maintaining the existing level of flood protection.

In addition a number of additional management activities will be periodically required to maintain and/or enhance the natural resources of the lakes. One such activity is the on-going aquatic plant management program. This program is designed to maintain exotic species at a maintenance control level, contingent upon available interagency funding sources, to protect flood control and navigation capabilities.

Another management practice used in the Kissimmee Basin are extreme drawdowns of the lakes. Extreme drawdowns and lake restoration projects are effective management tools for fisheries and aquatic plant management. Extreme drawdowns on Lake Kissimmee, Lake Tohopekaliga, and East Lake Tohopekaliga have been performed successfully, with fisheries responding in subsequent years.

The major problem exotic plant (as of this writing) in Lake Kissimmee, Hatchineha, and Cypress is the submersed plant hydrilla. Efforts to control this species in these lakes have been ongoing since the mid-1980's. Management activities for hydrilla in these lakes utilizes an integrated approach and includes biological, chemical, mechanical, and environmental manipulation practices.

While it is anticipated that the proposed water control plan will provide enhanced treatment opportunities, it is also recognized that under some conditions, additional water control activities and temporary regulation schedule modifications will be required. These modifications (i.e. extreme drawdowns and lake restoration projects) will be reviewed on a case-by-case basis and used as appropriate.

B-8. Effect of the Proposed Water Control Plan. The proposed project (proposed regulation schedule, land acquisition, and structural modifications) will result in hydrologic alterations that will provide environmental benefits in both the upper and lower basins. The proposed regulation schedule will enable a wider range of water levels, with higher peak discharges and lower minimum stages. As a result, there will be an increase in the size and quality of the peripheral marshes for the benefit of the fish and wildlife. Environmental benefits will result in the lower basin as a result of establishment of more natural timing of discharges from the upper basin.

B-9. Current Water Control Plan for Kissimmee River Basin.

a. General Objectives. A general plan for flood damage prevention in the Kissimmee Basin was incorporated in the comprehensive plan that was presented to Congress in 1948. The purpose of the general plan was to relieve flooding and minimize flood damages, largely in the upper Kissimmee basin. This was to be accomplished partially by flood storage in the lakes of the upper basin and partially by providing the capability to more rapidly remove the flood water from the basin when necessary. The report to Congress clearly stated that complete flood protection could not be provided, but that reasonable flood protection would result from such a plan.

The Kissimmee River Basin and Related Areas General Design Memorandum, Part II - Supplement 5 stated the following objectives for the Kissimmee River Comprehensive Plan:

a. Protection of lands adjacent to the lakes and along Kissimmee River from frequent and prolonged flooding.

b. Provision of water supply for agricultural uses in the area around the lakes and along the Kissimmee River.

c. Maintenance of lake stages at a desirable level for fish and wildlife and for recreational purposes.

d. Consideration of the relation and any adverse effects that improvements planned for Kissimmee River Basin might have on Lake Okeechobee, and finding means of preventing or reducing such adverse effects.

The project (C-38) also provides the Congressionally-authorized 3-foot navigation project (PL 56-154) and now permits year-round navigation from Lake Kissimmee to Lake Okeechobee. The regulation schedules have been developed for flood control, navigation, agricultural water supply, and environmental enhancement.

b. Water Control Plan for Remaining Lakes. With the exception of the single regulation schedule used for Lakes Kissimmee, Hatchineha, and Cypress, regulation schedules for the remainder of the upper chain of lakes in the Kissimmee Basin will not change with implementation of this project. However, several project canals will be widened to eliminate impacts due to the change in water management in Lakes Kissimmee, Hatchineha, and Cypress.

(1) Lake Gentry. Lake Gentry is regulated by S-63 located in C-34 at the south end of the lake. Water levels in C-34, downstream of S-63, are further stepped down by S-63A before it discharges into Lake Cypress. The lake is regulated between elevations 59.0 and 61.5 ft., NGVD according to a seasonally varying schedule. The current regulation schedule is found on Figure B-3. S-63 has a design capacity of 715 cfs. S-63 is designed to pass 30 percent of the SPF (approximately a 1-in-10 year flood) and will considerably reduce damages for storms greater than the 30 percent Standard Project Flood. S-63A also located in C-34 has a design discharge of 870 cfs and will restrict discharges during larger-than-design floods to 2,000 cfs. S-63A is designed to pass 30 percent of the SPF (approximately a 1-in-10 year flood) and will considerably reduce damages for storms greater than 30 percent of the Standard Project Flood.

(a) Flood Control. When the stage in Lake Gentry is in Zone A on the regulation schedule (Figure B-3), releases shall be made at the design capacity of 715 cfs except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases made to bring the lake back down to schedule within 15 days.

(b) Normal Operation. The lake is normally regulated between elevations 59.5 and 61.5 ft., NGVD according to a seasonally varying schedule. One year in three the lake is regulated between 59.0 and 61.5 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is found on Figure B-3. When the lake stage is in Zone B, releases may be made to maintain minimum flows downstream for water supply, navigation, and environmental purposes.

(2) Lakes Alligator, Center, Coon, Trout, Lizzie, and Brick. These lakes are controlled by two structures, S-58 located in C-32 which connects Lakes Trout and Joel, and S-60 located in C-33 between Lakes Alligator and Gentry. The lakes are regulated between elevations 61.5 and 64.0 ft., NGVD on a seasonally varying schedule. The current regulation schedule is shown on Figure B-4. S-58 has a design discharge capacity of 160 cfs. S-58 maintains stages in Lake Alligator upstream from the structure; passes up to 30 percent of the SPF (approximately a 1-in-10 year flood); and passes sufficient discharge during low-flow periods to meet irrigation demands downstream. S-60 is operated to maintain the optimum stage on Lake Alligator. The structure has a design capacity of 450 cfs. The structure is designed to pass up to 30 percent of the SPF (approximately a 1-in-10 year flood) without exceeding desirable stages; restricts discharge during floods to that which will not cause damaging velocities or stages downstream; and passes sufficient discharge during low-flow periods to maintain stages and satisfy irrigation demands downstream.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-4) releases shall be made at design capacity (610 cfs) except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases started to bring the lake back to schedule within 15 days.

(b) Normal Operation. The lakes are normally regulated between elevations 62.0 and 64.0 ft., NGVD on a seasonally varying schedule. One year in three the lakes are regulated between 61.5 ft. and 64.0 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-4. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(3) Lakes Joel, Myrtle, and Preston. These lakes are regulated by a single structure, S-57 located in C-30 connecting Lakes Myrtle and Mary Jane. The lakes are regulated between elevations 59.5 and 62.0 ft., NGVD on a seasonally varying schedule. The current regulation schedule is shown on Figure B-5. S-57 is operated to maintain the optimum stage in Lake Myrtle. The design capacity of S-57 is 170 cfs. S-57 is designed to pass up to 30 percent of the SPF (approximately a 1-in-10 year flood) and passes sufficient discharge during low-flow periods to satisfy irrigation demands downstream.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-5) releases shall be made at design capacity (170 cfs) except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases started to bring the lake back to schedule within 15 days.

(b) Normal Operation. The lakes normally are regulated between elevations 60.0 and 62.0 ft., NGVD according to a seasonally varying regulation schedule. When the 1 November stage is below 62.0 ft., the an alternate regulation schedule varying between 59.5 and 61.5 ft., NGVD is used. Regulation is to be such that drawdown to 59.5 ft. occurs at least twice but not more than three times in any six-year period for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-5. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(4) Lakes Hart and Mary Jane. Lakes Hart and Mary Jane are regulated by a single structure, S-62 located in C-29 which discharges into Lake Ajay. The lakes are regulated between elevations 59.5 and 61.0 ft., NGVD according to a seasonally varying schedule. The current regulation schedule is shown on Figure B-6. S-62 has a design capacity of 640 cfs. S-62 is designed to pass 30 percent of the SPF (approximately a 1-in-10 year flood) and will considerably reduce damages for storms greater than the 30 percent of the Standard Project Flood.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-6) releases shall be made at design capacity (640 cfs) except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases started to bring the lake back to schedule within 15 days.

(b) Normal Operation. The lakes are regulated between elevations 59.5 and 61.0 ft., NGVD on a seasonally varying schedule. The current regulation schedule is shown on Figure B-6. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(5) East Lake Tohopekaliga. East Lake Tohopekaliga and a small tributary lake named Ajay are regulated by S-59, located in the St. Cloud Canal (C-31) between East Lake Tohopekaliga and Lake Tohopekaliga. The lakes are regulated between elevations 54.5 and 58.0 ft., NGVD on a seasonally varying schedule. The current regulation schedule is found on Figure B-7. S-59 is used to maintain the optimum stage in East Lake Tohopekaliga. The design capacity of S-59 is 820 cfs. The structure is designed to pass up to 30 percent of the SPF (approximately a 1-in-10 year flood) without exceeding desirable stages; restricts discharges during floods to that which will not cause damaging velocities or stages downstream; and passes sufficient discharge during low-flow periods to maintain stages and satisfy irrigation demands downstream. A weir structure was built downstream of S-59 by the local sponsor to influence the tailwater of S-59. The crest of the weir is at

elevation 51.0 ft., NGVD. The weir is submerged; therefore, the tailwater influences the headwater of S-59.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-7) releases shall be made at design capacity (820 cfs) except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases started to bring the lake back to schedule within 15 days.

(b) Normal Operation. The lake is normally regulated between elevations 55.0 and 58.0 ft., NGVD according to a seasonally varying schedule. One year in three the lake is regulated between 54.5 ft and 58.0 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-7. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(6) Lake Tohopekaliga. Lake Tohopekaliga is regulated by S-61, located in the Southport Canal (C-35) at the south shore of the lake. The lakes are regulated between elevations 51.5 and 55.0 ft., NGVD on a seasonally varying schedule. The current regulation schedule is shown on Figure B-8. S-61 is used to maintain the optimum stage in Lake Tohopekaliga. S-61 has a design capacity of 2,300 cfs. The structure passes up to 30 percent of the SPF (approximately a 1-in-10 year flood) without exceeding desirable stages; restricts discharges during floods to that which will not cause damaging velocities or stages downstream; and passes sufficient discharge during low-flow periods to maintain stages and satisfy irrigation demands downstream.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-8) releases shall be made at design capacity (2,300 cfs) except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases started to bring the lake back to schedule within 15 days.

(b) Normal Operation. The lake is normally regulated between elevations 52.0 and 55.0 ft., NGVD according to a seasonally varying schedule. One year in three the lake is regulated between 51.5 ft. and 55.0 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-8. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(7) Lakes Kissimmee, Hatchineha, and Cypress. These lakes are regulated by a single structure, S-65 located at the outlet of Lake Kissimmee at the head of C-38. The lakes are regulated between elevations 48.5 and 52.5 ft., NGVD on a seasonally varying schedule. The current regulation schedule is shown on Figure B-1 and will remain in effect until the required structural modifications and land acquisition for implementation of the proposed regulation schedule is complete. S-65 consists of a spillway for regulating stages and a navigation lock. Discharge from S-65 will vary between 3,000 and 11,000 cfs

according to downstream conditions. When local inflow into C-38 is equal to or greater than design runoff, S-65 will be limited to a firm discharge capacity of 3,000 cfs and a secondary capacity of 8,000 cfs. (Firm capacity is that capacity available at any time). After local inflow subsides, discharge from S-65 could increase to 11,000 cfs depending on downstream capacity. In addition to the spillway and lock structures, there is a culvert structure located through the tieback levee at the natural channel of the Kissimmee River and serves as a water supply for the existing river.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-1), releases of 3,000 cfs minimum can be made at anytime. During design flood conditions, discharge from S-65 will vary between 3,000 and 11,000 cfs according to downstream conditions. When local inflow to C-38 is equal to or greater than design flood runoff, S-65 will limit discharge to 3,000 cfs. After local inflow subsides, discharge from S-65 could increase to 11,000 cfs depending on downstream capacity. When the lake stage is higher than 0.5 ft. above the scheduled stage, forecasts will be made and releases started to return the lake to schedule within 15 days.

(b) Normal Operation. Lake Kissimmee is normally regulated between elevations 49.0 and 52.5 ft., NGVD according to a seasonally varying schedule. One year in three the lake is regulated between 48.5 ft. and 52.5 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-1. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(8) Canal 38 (Kissimmee River). Except when pool levels drop below canal regulation levels, the pools shall be regulated automatically or manually, as designed, insofar as possible, in accordance with optimum levels shown in Table 1. An interim regulation schedule (Figure B-9) for the pools in C-38 was adopted in July 1982, however it has only been used in Pool B thus far. This regulation schedule may be implemented when the local sponsor (SFWMD) has acquired sufficient lands along the canal to implement the fluctuating schedule.

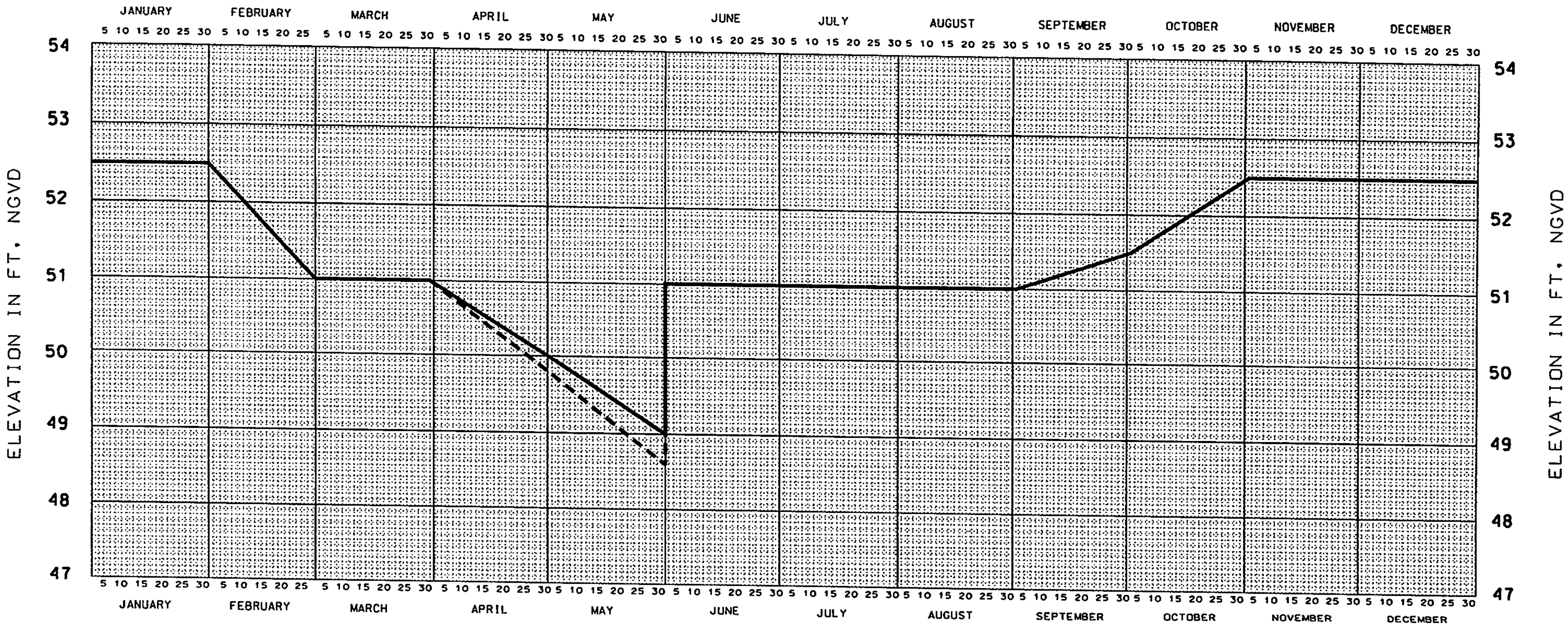
The water control plan for Canal 38 will be revised as appropriate to facilitate construction of the Kissimmee River Restoration Project.

Table B-1

Water Control Stages For C-38 Structures (ft.,NGVD)

Pool	Control Structure	Discharge	Optimum Stage	Design Stage
A	S-65A	11,000	46.3	46.3
B*	S-65B	14,000	40.0	40.0
C	S-65C	18,000	34.0	34.0
D	S-65D	21,300	26.8	28.0
E	S-65E	24,000	21.0	22.0

* During high flow periods, the S-65B headwater stage is raised to 41.0 to 41.5 ft., NGVD to reduce erosive velocities across the test fill for the river restoration project.



ZONE	RELEASES S-65
A	3,000 CFS. UP TO DESIGN CAPICITY (11,000 CFS) W/O EXCEEDING DESIGN CONDITIONS DOWNSTREAM. WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE, FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS.

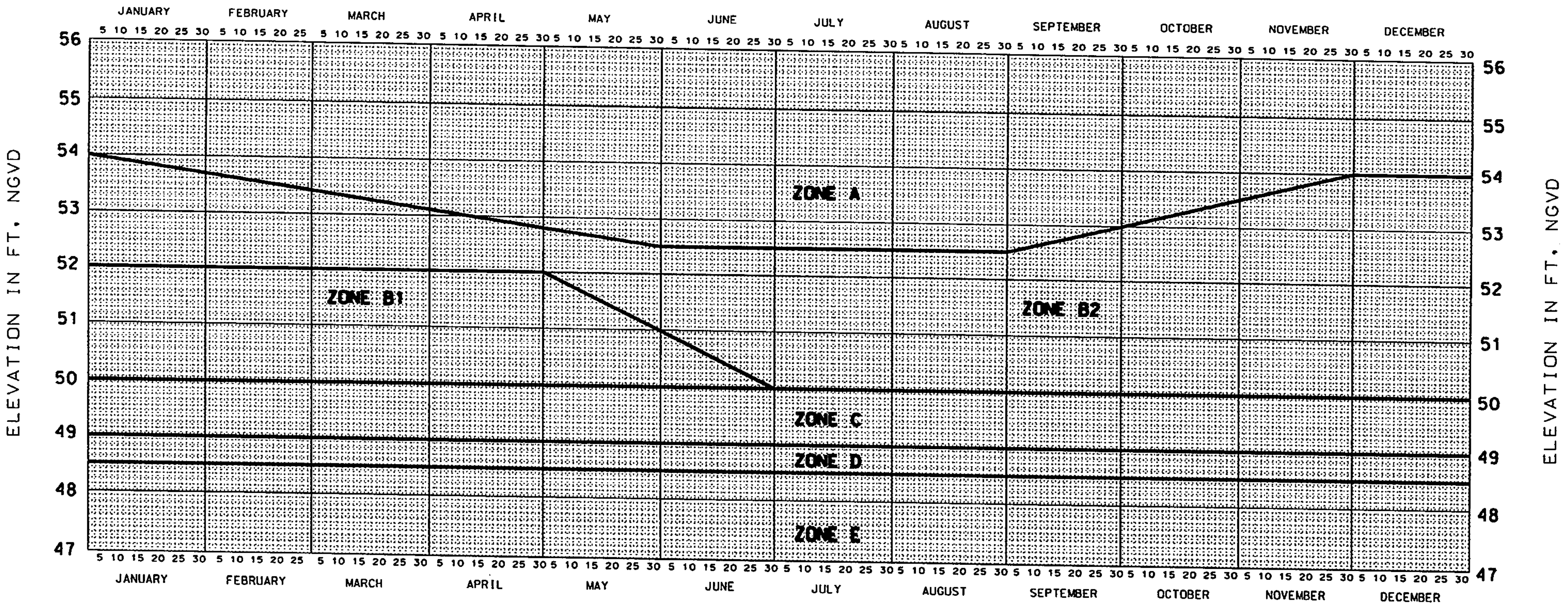
NOTE: (--------) USE THIS SCHEDULE ONE YEAR IN THREE.

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKES KISSIMMEE, HATCHINEHA
AND CYPRESS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
DATED: 01 DECEMBER 1981

FIGURE B-1



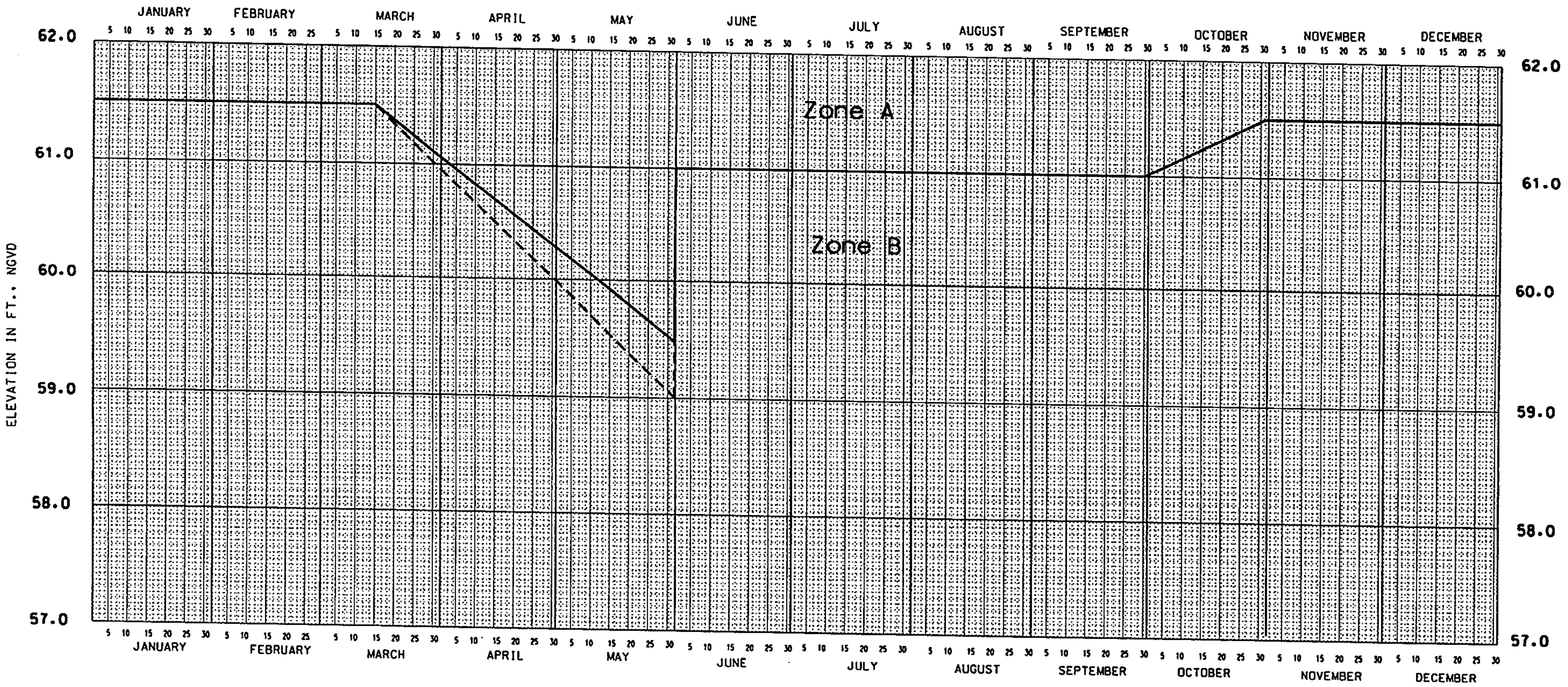
ZONE	RELEASES S-65
A	UP TO MAXIMUM RELEASES AT S-65.
B1	CONSTANT DISCHARGE OF 400 CFS.
B2	DISCHARGE WILL VARY BETWEEN 400 CFS AND 2500 CFS.
C	DISCHARGE WILL VARY BETWEEN 150 CFS AND 400 CFS.
D	CONSTANT DISCHARGE OF 150 CFS.
E	NO RELEASES.

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKES KISSIMMEE, HATCHINEHA
AND CYPRESS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
PROPOSED: AUGUST 1995

FIGURE B-2



ZONE	RELEASES
A	AT DESIGN CAPACITY (715 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS

NOTE: (----------) USE THIS SCHEDULE ONE YEAR IN THREE

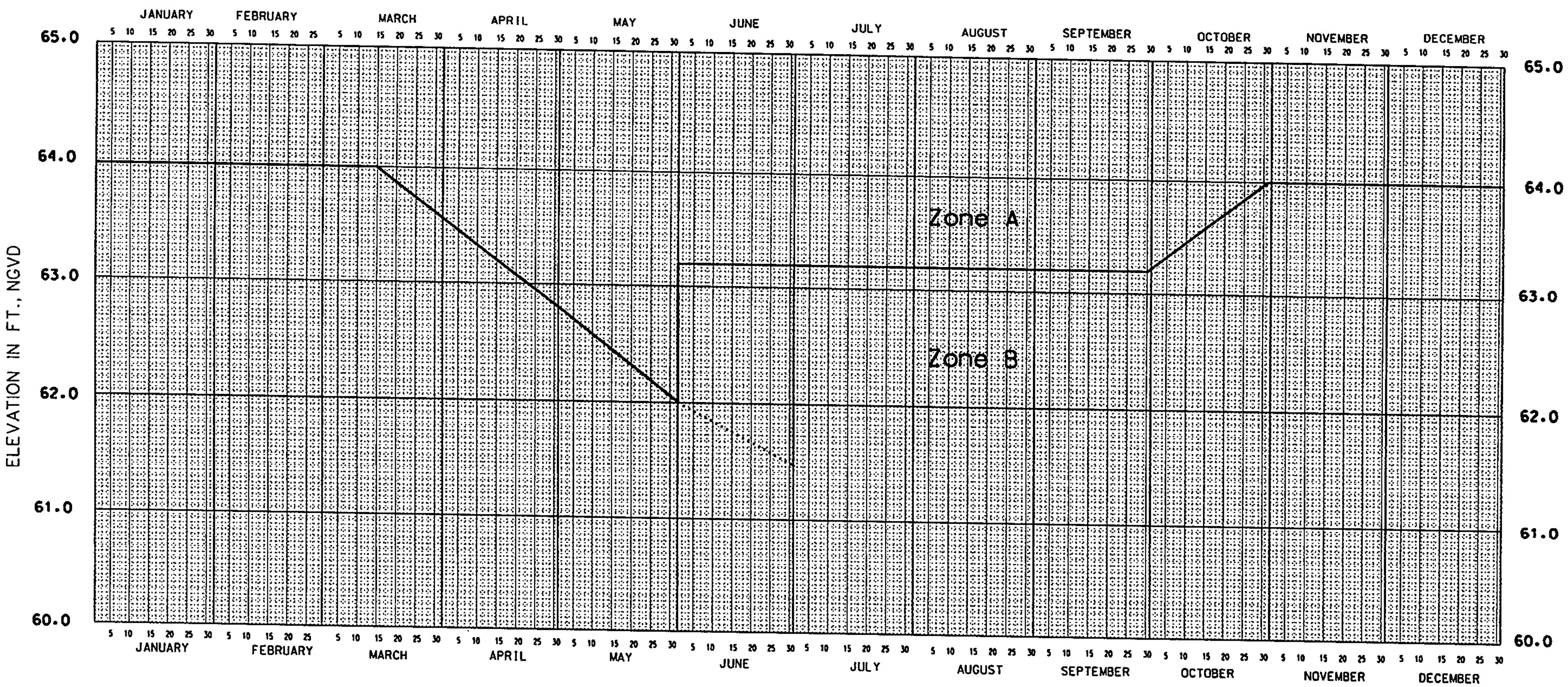
CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKE GENTRY

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981

Figure B-3



ZONE	RELEASES
A	AT DESIGN CAPACITY (610 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS

NOTE: (– – – – – – – – –) USE THIS SCHEDULE ONE YEAR IN THREE

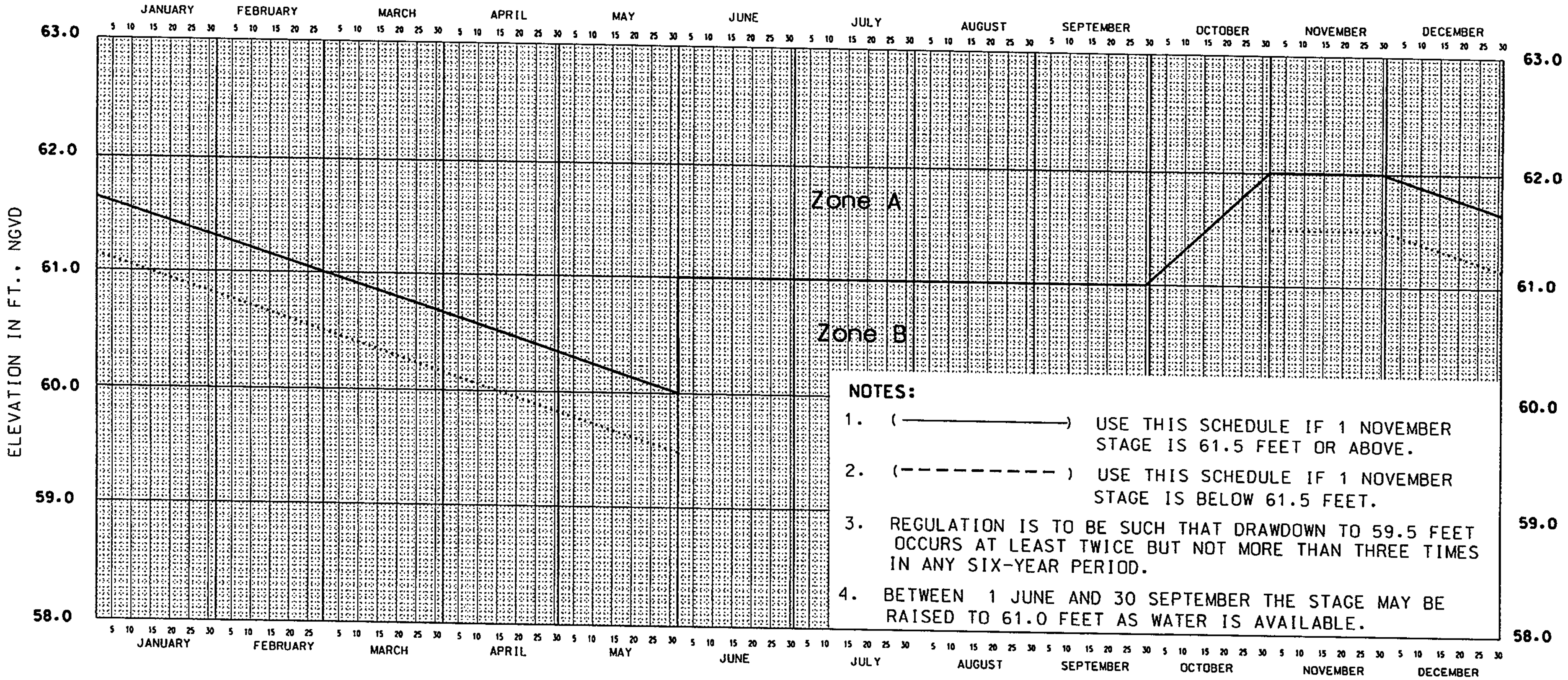
CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKES ALLIGATOR, BRICK,
LIZZIE, COON, CENTER,
& TROUT

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981

Figure B-4



NOTES:

1. (————) USE THIS SCHEDULE IF 1 NOVEMBER STAGE IS 61.5 FEET OR ABOVE.
2. (- - - - - - - - -) USE THIS SCHEDULE IF 1 NOVEMBER STAGE IS BELOW 61.5 FEET.
3. REGULATION IS TO BE SUCH THAT DRAWDOWN TO 59.5 FEET OCCURS AT LEAST TWICE BUT NOT MORE THAN THREE TIMES IN ANY SIX-YEAR PERIOD.
4. BETWEEN 1 JUNE AND 30 SEPTEMBER THE STAGE MAY BE RAISED TO 61.0 FEET AS WATER IS AVAILABLE.

ZONE	RELEASES S-57
A	AT DESIGN CAPACITY (170 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS

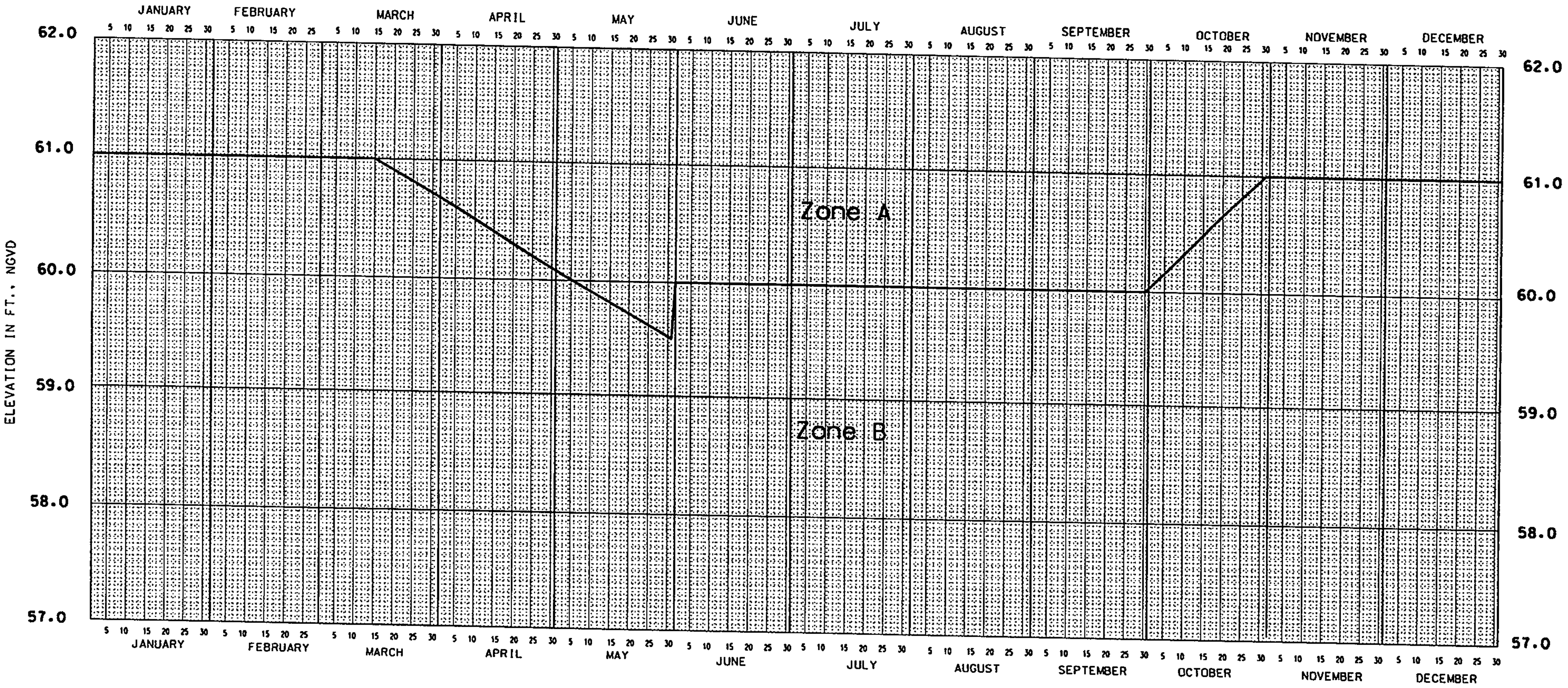
CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKES JOEL, MYRTLE
& PRESTON

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981

Figure B-5



ZONE	RELEASES
A	AT DESIGN CAPACITY (640 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTATIN MINIMUM FLOWS

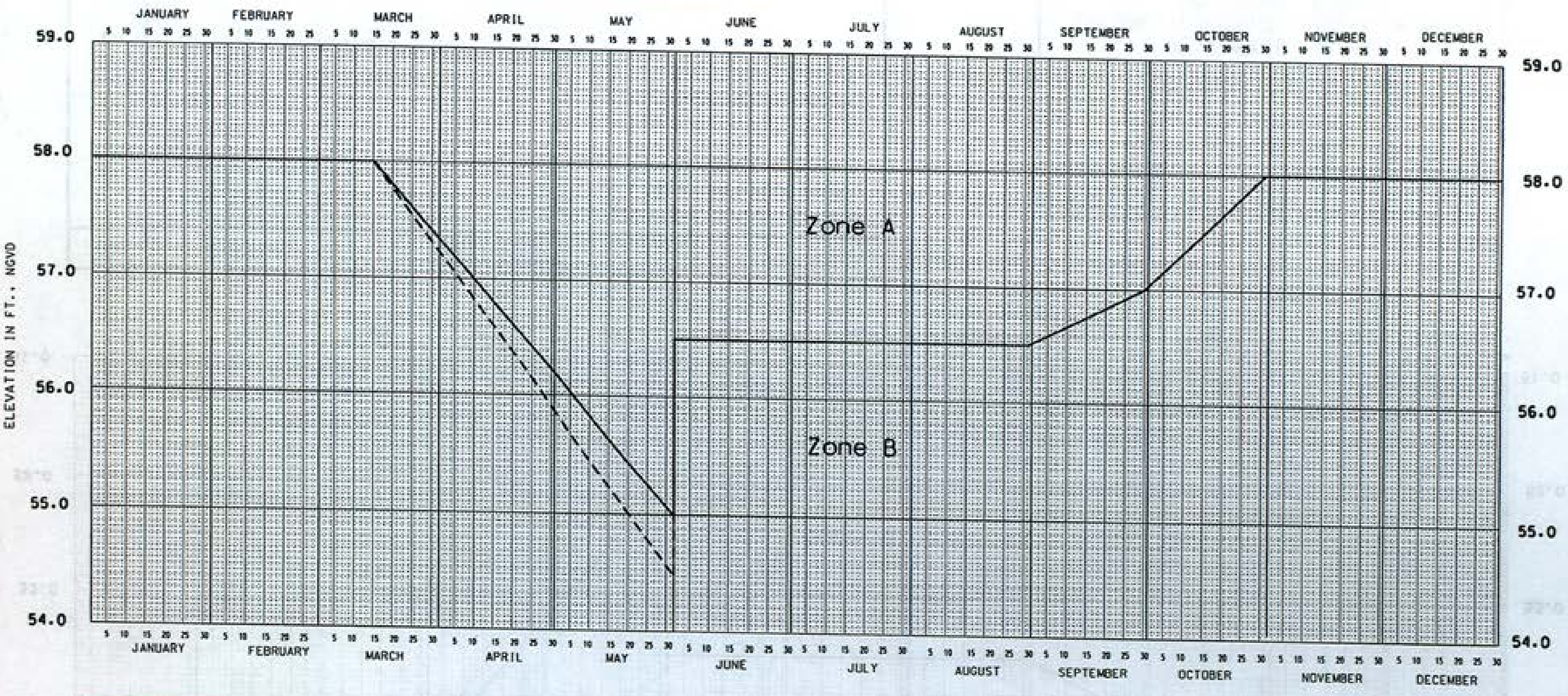
CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKES HART &
MARY JANE

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 12 APRIL 1982

Figure B-6



ZONE	RELEASES
A	AT DESIGN CAPACITY (820 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS

NOTE: (----------) USE THIS SCHEDULE ONE YEAR IN THREE

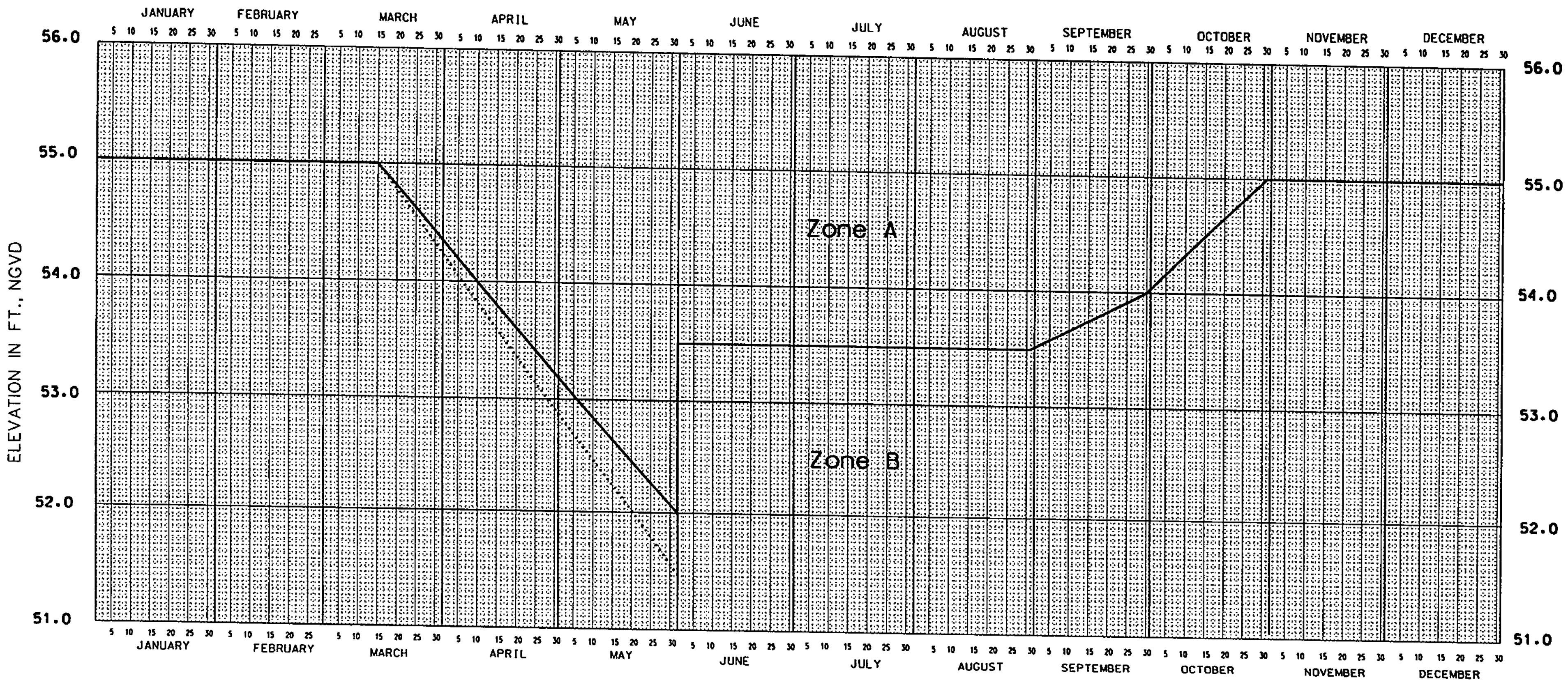
CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

EAST LAKE TOHOPEKALIGA

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981

Figure B-7



ZONE	RELEASES
A	AT DESIGN CAPACITY (2300 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS

NOTE: (-----------) USE THIS SCHEDULE ONE YEAR IN THREE

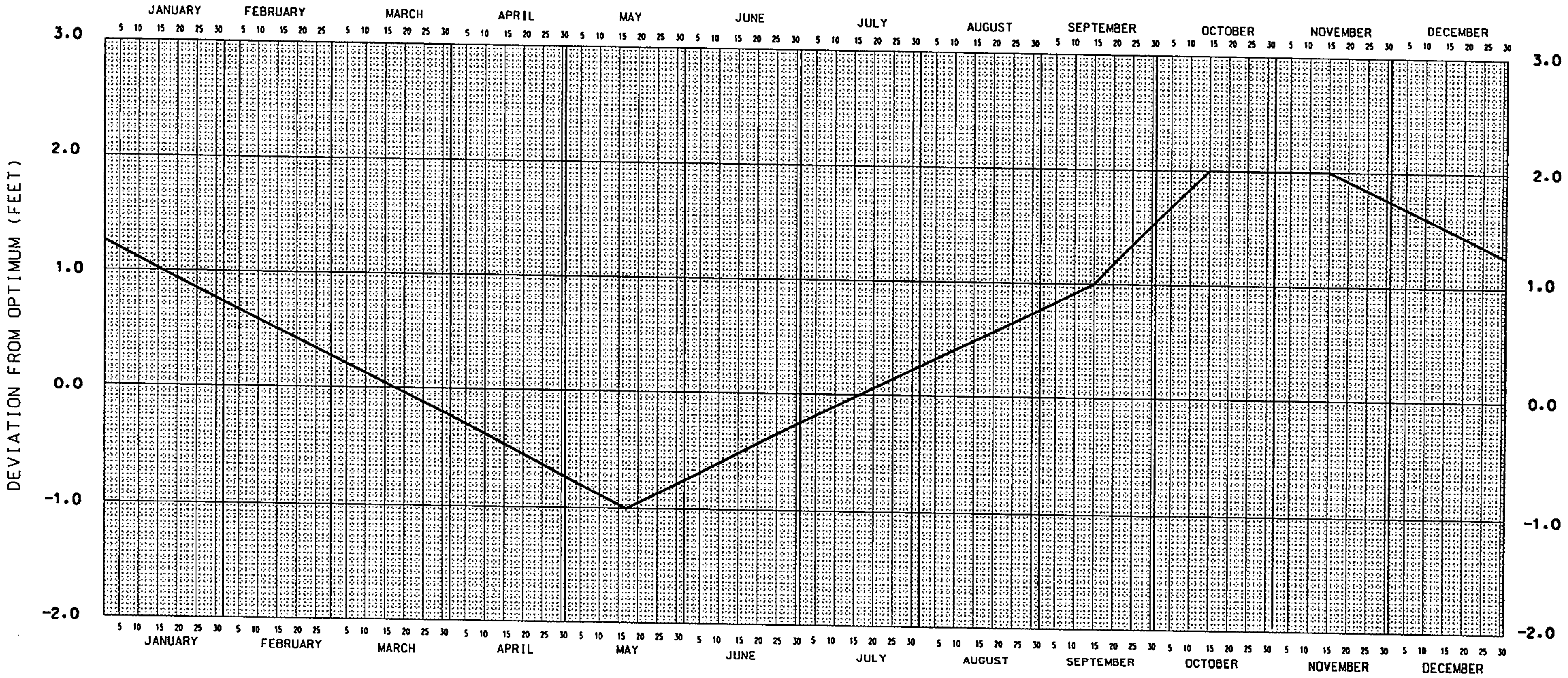
CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKE TOHOPEKALIGA

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981

Figure B-8



NOTES:

1. THE OPTIMUM & DESIGN WATER SURFACE ELEV. FOR THE POOLS ARE (FT. NGVD):

		OPTIMUM	DESIGN
a.	S-65A	46.3	46.3
b.	S-65B	40.0	40.0
c.	S-65C	34.0	34.0
d.	S-65D	26.8	28.0
e.	S-65E	21.0	22.0

2. LIMIT RISE IN POOL A TO 1.9 FEET.
3. RESTORE C-38 POOLS TO DESIGN OR OPTIMUM WATER SURFACE ELEVATION AS APPROPRIATE IN ADVANCE OF HURRICANES OR TROPICAL STORMS.
4. THE POOLS SHOULD BE BALANCED THE SAME AMOUNT ABOVE OR BELOW SCHEDULE WHEN SCHEDULE CAN NOT BE ATTAINED BECAUSE OF HIGH OR LOW WATER.

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN
KISSIMMEE RIVER POOLS
(S-65 A, B, C, D, & E)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: JULY 1982

Figure B-9

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX C

GEOTECHNICAL ENGINEERING DATA

TABLE OF CONTENTS

LIST OF PLATES

APPENDICES

GEOTECHNICAL ENGINEERING DATA

1. SCOPE AND PURPOSE. This appendix presents the results of geotechnical subsurface investigations performed at the proposed structure location and along the proposed improved channel alignments. The purpose of the investigations is to define the geologic features and engineering characteristics of the foundation materials and to define canal excavation requirements.

2. STRUCTURE S-65 EXPANSION.

2.1. Investigations Performed. Two core borings (CB-S65K-9 and CB-S65K-10) were drilled in July 1994 at the proposed structure location in order to determine the engineering characteristics of the materials encountered. The materials were sampled continuously utilizing the Standard Penetration Test according to ASTM D-1586.

All samples were field classified in accordance with the Unified Soil Classification System (USCS). Grain size analysis, moisture content, and Atterberg limits were performed on select samples. The locations of the core borings are shown on Plate C-1.

2.2. Materials Encountered. The materials encountered at the proposed structure S-65 expansion location are characteristic of the general geology of the area. The materials are documented in the core boring logs (Appendix C-1) and laboratory test results (Appendix C-2). Where differences in classifications occur, laboratory classifications take precedence over field visual classifications shown on the core boring logs.

The materials are both fill and natural soils. The fill was placed during the construction of the tieback levee for the original structure S-65. The fill material is primarily a medium to very dense fine quartz sand (SP) with pockets of clay and silt. The natural soils, which underlie the fill, are highly variable and primarily composed of sands (SP, SM, SC,), silts (MH) and clays (CL, CH). Plate C-3 shows the geologic cross section for the proposed structure location.

2.3. Foundation Conditions. The proposed structure will have a bottom elevation of 29.5 feet, NGVD. A tremie concrete seal, for dewatering purposes, extends 10.0 feet below the structure to elevation 19.5 feet, NGVD. In conjunction with the tremie concrete seal, helical soil anchors will be used to resist uplift forces during dewatering.

The placement of the tremie concrete seal involves overexcavation by 10 feet, which also serves to remove unsuitable foundation materials (CH and MH) encountered at foundation grade. In addition, the tremie concrete seal will provide lateral support for the cofferdam by acting as a bottom strut resulting in a more economical cofferdam section.

An analysis was made to evaluate the bearing capacity of the foundation material which consists of a layer of SM material. The critical loading case is the SPF loading condition. The factor of safety against a bearing failure is adequate. The thickness of the tremie seal and the capacity of the helical anchors are such that hydrostatic uplift will not be a problem. Settlement was calculated and is considered negligible for the structure.

2.4. Excavation. Excavation for the structure S-65 expansion will be required to elevation 19.5 feet, NGVD to accommodate the tremie concrete seal. Excavation will take place inside the cofferdam and will be accomplished in the wet using conventional excavation methods.

2.5. Disposal of Excavated Material. Excavated materials which are unsuitable for construction and in excess of what is needed for backfill during construction will be disposed of in the designated borrow area.

2.6. Structural Backfill. Backfill material will be obtained from required structure and channel widening excavations. Select backfill, consisting of material with no more than 10 percent passing a No. 200 sieve, will be placed adjacent to the structure. The maximum particle size will be three inches. Materials classified as GW, GP, SW, SP, GW-GM, GW-GC, GP-GM, GP-GC, SW-SM, SW-SC, SP-SM, and SP-SC will be suitable for structural backfill. If the contractor can not satisfy the above gradation requirements with on-site material, he will be required to obtain the backfill from a commercial source. Structural backfill will be compacted to 95 percent of the standard proctor density.

2.7. Dewatering. Dewatering will be accomplished using a sheetpile cofferdam, a tremie concrete seal, and sump pumps. The tremie thickness and helical anchors were designed using the maximum headwater at elevation 58 feet, NGVD, which corresponds to the SPF event. If the headwater should exceed the design water surface elevation, the excavation will be flooded until the headwater recedes. Flooding the structure will alleviate excess pressures that could cause a foundation failure. Also, the excess water can be pumped off more economically than increasing the tremie thickness.

2.8. Stone Protection. The existing S-65 is protected on either side by a section of grouted riprap. Replacement of grouted riprap is not desirable due to the potential for undetectable voids to form beneath the grouted riprap. Loose riprap will be placed adjacent to the new structure. It will have the same requirements as the channel protection riprap, which is discussed below.

3. S-65 EXPANSION APPROACH AND GETAWAY CHANNELS.

3.1. Investigations Performed. Three core borings (CB-S65K-11 to CB-S65K-13) were obtained along the alignment of the getaway channel in July 1994. The borings were drilled in the same manner as those previously discussed. Refer to Plate C-1 for the core boring locations.

3.2. Materials Encountered. The materials encountered during the field investigation are characteristic of the materials found in other areas of the project. The materials are documented in the core boring logs (Appendix C-1) and laboratory test results (Appendix C-2). Where differences in classifications occur, laboratory classifications take precedence over field visual classifications shown on the core boring logs.

The materials are both fill and natural soils. The fill was placed during the construction of the original structure S-65. The fill material is primarily a medium density to very dense fine quartz sand (SP). The natural soils, which underlay the fill, are highly variable and primarily composed of sands (SP, SM, SC,), silts (ML) and clays (CL, CH). Plate C-4 shows the geologic cross section for the proposed getaway channel location.

3.3. Excavation. Excavation for the S-65 expansion approach channel will be required to elevation 34.0 feet, NGVD. The getaway channel will require excavation ranging from elevation 34.0 to 19.0 feet, NGVD. Prior to the excavation for channel widening, the existing riprap will be removed and stockpiled for potential reuse. The materials can be removed using conventional land based excavation methods.

3.4. Slope Stability. Slopes were analyzed for stability using the UTEXAS3 computer program. The End of Construction (EOC) and Steady State Seepage (SSS) conditions were considered in accordance with EM 1110-2-1913. Strength properties were assumed based on field classification, SPT blow count correlations, and visual inspection by the project engineer and geologist.

Slope stability analysis was not performed for the widening of the approach channel since the excavation is minimal and the existing slopes of 1V on 2H are stable.

Slope stability analyses were performed for the widening of the getaway channel due to the extreme depth of excavation and the adjacent spoil mound on which the operators dwelling is located. The top part of the embankment consists of fill material (SP) underlain by what once was natural ground consisting of layers of sand (SP), silty sand (SM), clayey sand (SC), silt (ML), and clay (CL, CH). The natural water table in the upper slope was determined to be near elevation 57 feet, NGVD during subsurface investigations and water levels in the getaway channel vary with the regulation schedule. Various canal water levels were used in the analysis.

Based on the results of the slope stability analysis, the channel side slope will be 1V to 2.5H. An intermediate berm with a minimum width of 20 feet is incorporated to allow for future maintenance of the riprap protected channel slopes. The upper slope will be 1V on 3H to allow for safe maintenance of the grassed slope. The upper portion of the slope will encroach upon the existing lock operators dwelling and an adjacent antenna tower. A retaining wall will be constructed in this area to eliminate impacts to these structures.

The factors of safety of the critical failure surfaces for the EOC and SSS cases are 1.75 and 1.32, respectively. The EOC factor of safety is in accordance with EM 1110-2-1913, but the SSS case does not meet the minimum factor of safety of 1.4. However, LMVD DIVR 1110-1-400 addresses channel side slopes specifically and it indicates that a minimum factor of safety of 1.25 is required for the long term loading case using S shear strengths. In addition, the existing channel slope has remained stable at 1V on 2H since the original construction of S-65. Flattening of the slope beyond 1V on 2.5H would have adverse impacts as the slope would encroach upon the existing operators dwelling and an adjacent antenna tower. The cross section used in the analysis is shown on Plate C-7, as well as the location of the critical failure surfaces and the strength parameters.

3.5. Slope/Erosion Protection. The maximum exit velocity anticipated at the structure is approximately 7.4 feet per second, which is less than that of existing conditions (11 feet per second). This velocity will decrease further upon reaching the discharge channel. The maximum entrance velocity reaches 8.0 feet per second but this flow is considered laminar and does not control the riprap design. The existing protection consists of 18 inches of riprap underline by 9 inches of bedding material.

Riprap was chosen as the form of protection for the approach and discharge channels. Key factors considered in selecting riprap include constructability for underwater placement, long term stability, and existing project conditions. The riprap design is based on the application of EM 1110-2-1601 and the computer program RIPRAP 15. The riprap stone should have a minimum unit weight of 165 pcf (saturated surface dry).

The design for the upstream riprap requires a minimum section consisting of 9 inches of riprap with a 6 inch bedding layer. In order to provide for uncertainties associated with under water placement and to account for the subject to attack by large floating debris or by waves from wind, the upstream riprap thickness will be increased to 18 inches with a 9 inch bedding layer. This is consistent with the existing riprap. The riprap will tie into existing riprap on the bottom and will extend up to elevation 60 feet, NGVD adjacent to the structure and elevation 54.5 feet, NGVD along the channel slope. The protection will extend 80 feet upstream of the structure.

The design for the downstream riprap required the use of the Isbach equation to account for turbulent flow. The calculated required thickness has been increased by 50% in order to account for underwater placement in a turbulent zone. The downstream thickness will be 22 inches with a 9 inch bedding layer. The riprap will tie into existing riprap on the bottom and will extend up to elevation 60 feet, NGVD adjacent to the structure and elevation 52 feet, NGVD along the channel slope. The protection will extend 180 feet downstream of the apron.

The reuse of existing riprap removed for channel excavation will be permitted providing it meets the specification and gradation requirements. For cost estimating purposes it is assumed that 50% of removed riprap will be salvageable. It is doubtful that the bedding material will be salvageable.

The riprap should be well graded within the following limits:

Limits of Stone Weight (pounds)		**Percent Lighter (by Weight)**
Max	Min	
292	116	100
86	58	50
43	18	15

The bedding stone should be well graded within the following limits:

Stone Size (inches) or Sieve Number	**Percent Finer (by Weight)**
3	85-100
1½	70-85
¾	58-72
No. 4	30-45
No. 20	10-25
No. 50	0-12

3.6. Retaining Wall. As mentioned above, a retaining wall will be required to minimize impacts to existing structures resulting from the widening of S-65 getaway channel. A steel sheet pile wall was the most economical. The material in this area is spoil material placed during construction of C-38. The fill material is primarily a medium to very dense fine quartz sand (SP) with pockets and layers of clayey and silty materials. Based on an analysis using the CWALSHT computer program, the sheet pile wall will be cantilever and will have a maximum tip elevation of 48 feet, NGVD.

4. CANAL MAINTENANCE SHOAL REMOVAL.

4.1. Investigations Performed. Twelve core borings (CB-C35-S1 thru CB-C35-S5, CB-C36-S1 thru CB-C36-S3, and CB-C37-S1 thru CB-C37-S4) were drilled in February 1994 along the centerline of canals C-35, C-36, and C-37 in order to evaluate the shoal material present in the canals. The materials were sampled continuously utilizing 5 foot split spoon driven with a 140-pound hammer falling 30-inches. Blow counts were recorded for each foot of penetration.

All samples were field classified in accordance with the Unified Soil Classification System (USCS). The locations of the core borings are shown on Plate C-2.

4.2. Materials Encountered. The shoal materials encountered in all three canals consist of fine quartz sand (SP). The materials are documented in the core boring logs (Appendix C-1)

4.3. Excavation. Shoal removal from canals C-35, C-36, and C-37 will be considered maintenance which will restore them to their original as-built cross sections. Excavation will be performed by side cast dredging utilizing conventional land based excavation methods.

4.4. Disposal of Excavated Material. Excavated material from maintenance operations will be placed in the adjacent upland disposal areas.

5. C-36 and C-37 CANAL IMPROVEMENTS.

5.1. Investigations Performed. Seventeen core borings (CB-C36-K1 thru CB-C36-K9 and CB-C37-K1 thru CB-C37-K8) were drilled in August and September 1992 along the alignments for proposed canal improvements in order to determine the engineering characteristics of the materials encountered. The materials were sampled continuously using methods described in ASTM D-1586.

All samples were field classified in accordance with the Unified Soil Classification System (USCS). The locations of the core borings are shown on Plate C-2.

5.2. Materials Encountered. The materials encountered at the proposed C-36 and C-37 canal improvements are characteristic of the general geology of the area. The materials are documented in the core boring logs (Appendix C-1).

The upper 5 to 10 feet of material consists of sand (SP) and clayey sand (SC) deposited during original canal excavation. They are underlain by natural ground made up of a layer of peat (PT) ranging in thickness from 0 to 6 feet. The natural soils, which underlie the peat, are highly variable and are primarily composed of sands (SP, SC), and clays (CL, CH). Plates C-5 and C-6 show the geologic cross sections for the proposed C-36 and C-37 canal improvements respectively.

5.3. Excavation. Canals C-36 and C-37 will be widened by side cast dredging utilizing conventional land based excavation methods. Canal C-36 will be widened from 48 feet to 60 feet along the west side and C-37 will be widened from 70 feet to 90 feet along the east side.

5.4. Disposal of Excavated Material. Excavated material from the widening operations will be placed in the same disposal areas as the excavated materials from the maintenance operations.

5.5. Slope Stability. Slopes were analyzed for stability using the UTEXAS3 computer program. The End of Construction (EOC) and Steady State Seepage (SSS) conditions were considered in accordance with EM 1110-2-1913. Strength properties were assumed based on field classification, SPT blow count correlations, and visual inspection by the project engineer and geologist. All factors of safety are in accordance with EM 1110-2-1913.

Because the area geology is relatively uniform, the cross section generated for the analysis is assumed to be the worst case and will apply to both C-36 and C-37 canal improvements.

The canals were originally designed with side slopes of 1V on 2H for the canals and the adjacent disposal mound. Recent surveys indicate that existing canal side slopes vary from 1V to 2H to 1V to 3H. Slope stability analysis indicates that a section consisting of canal and disposal mound side slopes of 1V to 2.5H will be stable. A berm with a minimum width of 25 feet will be required between the top of the canal slope and the toe of the disposal mound. The height of the disposal mound will be limited to approximately 10 feet. The factors of safety of the critical failure surfaces for the EOC and SSS cases are 1.3 and 2.6, respectively. The cross section used in the analysis is shown on Plate C-8, as well as the critical failure surfaces and the strength parameters.

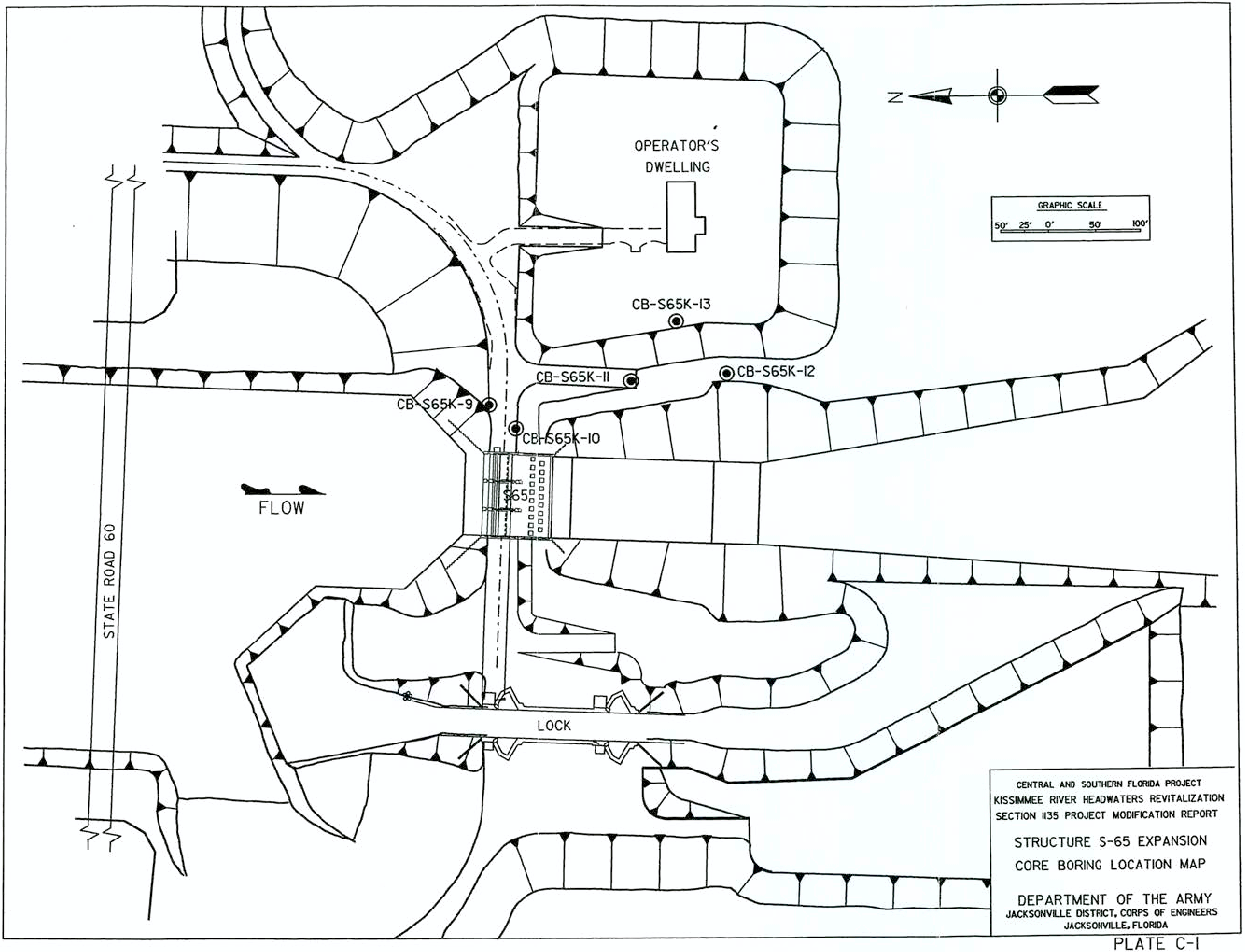
5.6. Slope/Erosion Protection. The improved canal side slopes will be require grassing to prevent surface erosion.

6. **LOCAL LEVEE MODIFICATIONS**. In order to meet project requirements, 5 local levees will be degraded to allow for storage and environmental restoration. The levees will be breached by creating approximately 100 foot wide openings at various spacings. Material from the levees will be pushed back into the original adjacent borrow canal using conventional earth moving equipment.

A sixth levee, known as the "Exposition" levee, will remain intact. A minimal subsurface investigation consisting of hand auger borings, along with a thorough inspection of the levee, was performed in April 1995. A typical cross section consists of a 7 to 10 foot high levee with a 12 to 15 foot top width and approximately 1 on 3 side slopes. A small berm separates the toe of the levee from both land and lake side borrow canals. The levee section is fairly uniform throughout the entire length of the levee and little to no surface erosion was evident. The materials encountered in the levee fill section consist primarily of medium density quartz sands with pockets of clay. The foundation materials are primarily composed of sands and clays. The levee was evaluated for a loading condition equivalent to the 10 year event with project features. Based on the results of the field investigation and experience, the levee will be adequate to protect against a 10 year storm which will result in a relatively low head of approximately 2 feet for a limited duration.

APPENDIX C-1

CORE BORING LOGS

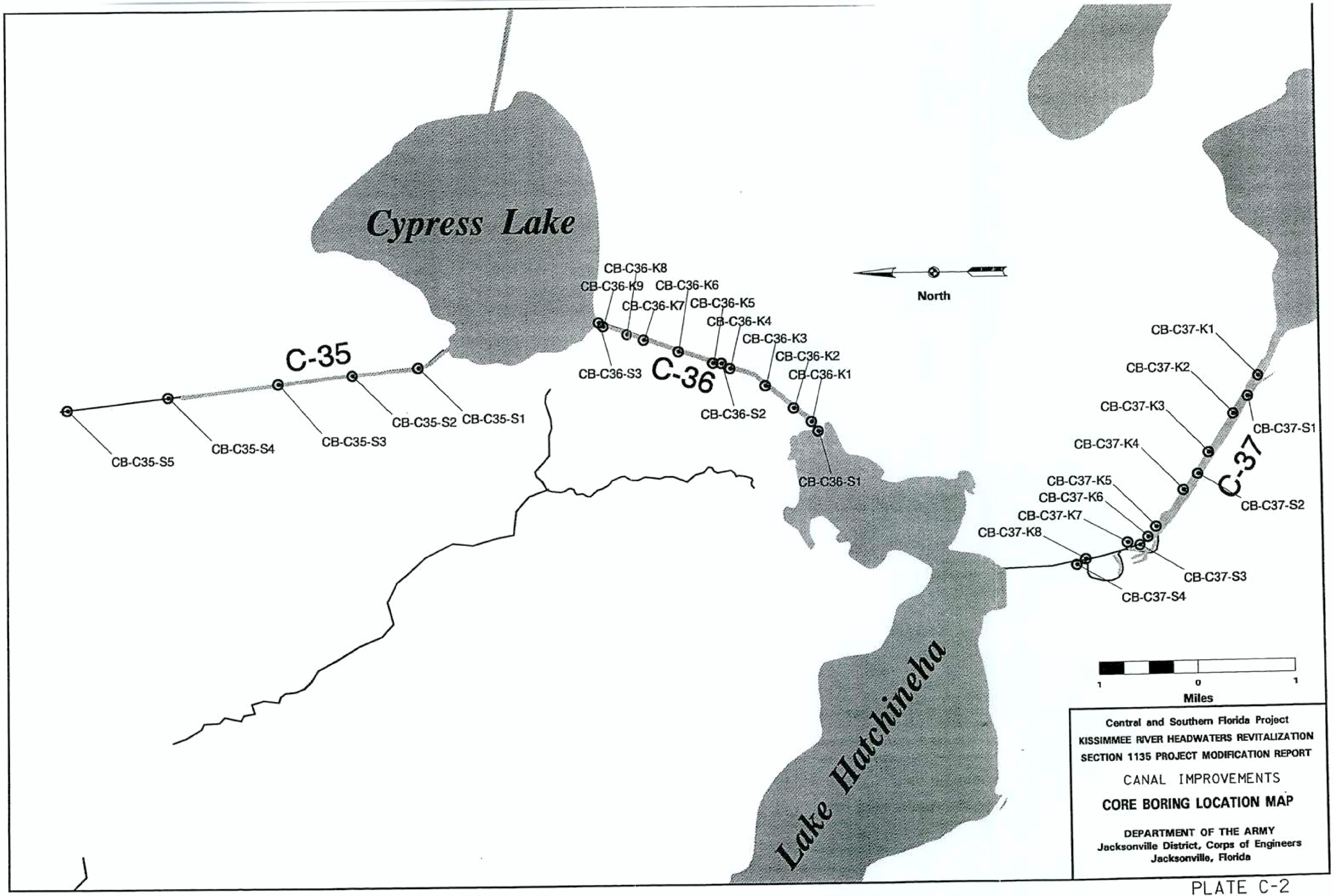


CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

STRUCTURE S-65 EXPANSION
CORE BORING LOCATION MAP

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PLATE C-1



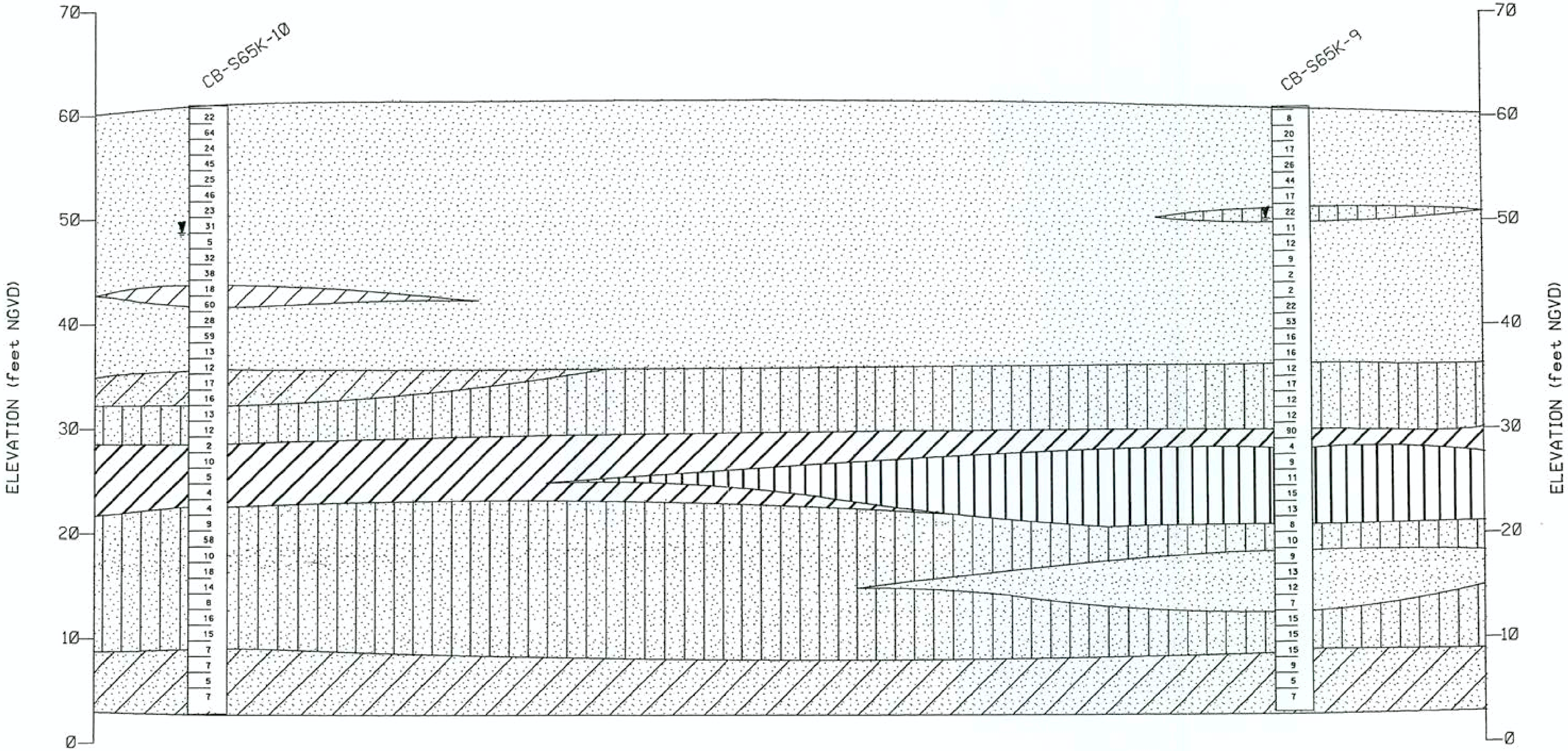
Central and Southern Florida Project
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

CANAL IMPROVEMENTS

CORE BORING LOCATION MAP

DEPARTMENT OF THE ARMY
Jacksonville District, Corps of Engineers
Jacksonville, Florida

PLATE C-2



NOTE: NUMBERS ON BORINGS ARE STANDARD PENETRATION TEST RESULTS IN BLOWS/FT

SOIL LEGEND:

- ░ (SP) POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.
- ▨ (SC) CLAYEY SANDS, SAND-CLAY
- ▨ (CL) INORGANIC CLAYES OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.
- ▥ (SM) SILTY SANDS, SAND-SILT
- ▥ (MH) INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS, ELASTIC SILTS.
- ▨ (CH) INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.

CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

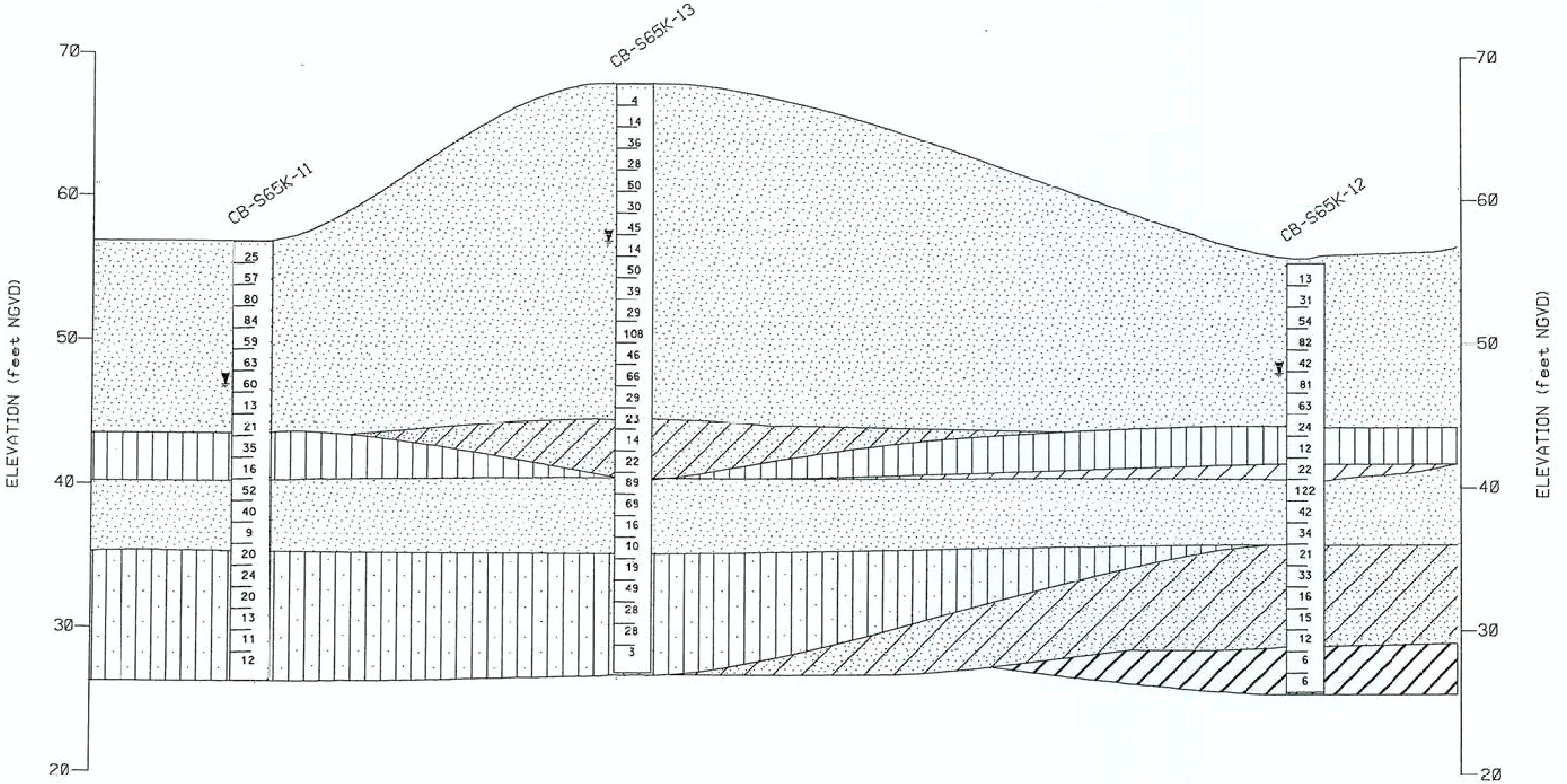
STRUCTURE S-65 EXPANSION

GEOLOGIC SECTION

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PLATE C-3



NOTE: NUMBERS ON BORINGS ARE STANDARD PENETRATION TEST RESULTS IN BLOWS/FT

SOIL LEGEND:

░ (SP) POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.

▨ (SC) CLAYEY SANDS, SAND-CLAY

▨ (CL) INORGANIC CLAYES OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.

▥ (SM) SILTY SANDS, SAND-SILT

▥ (ML) INORGANIC SILTS AND VERY FINE SANDS. ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY

▨ (CH) INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.

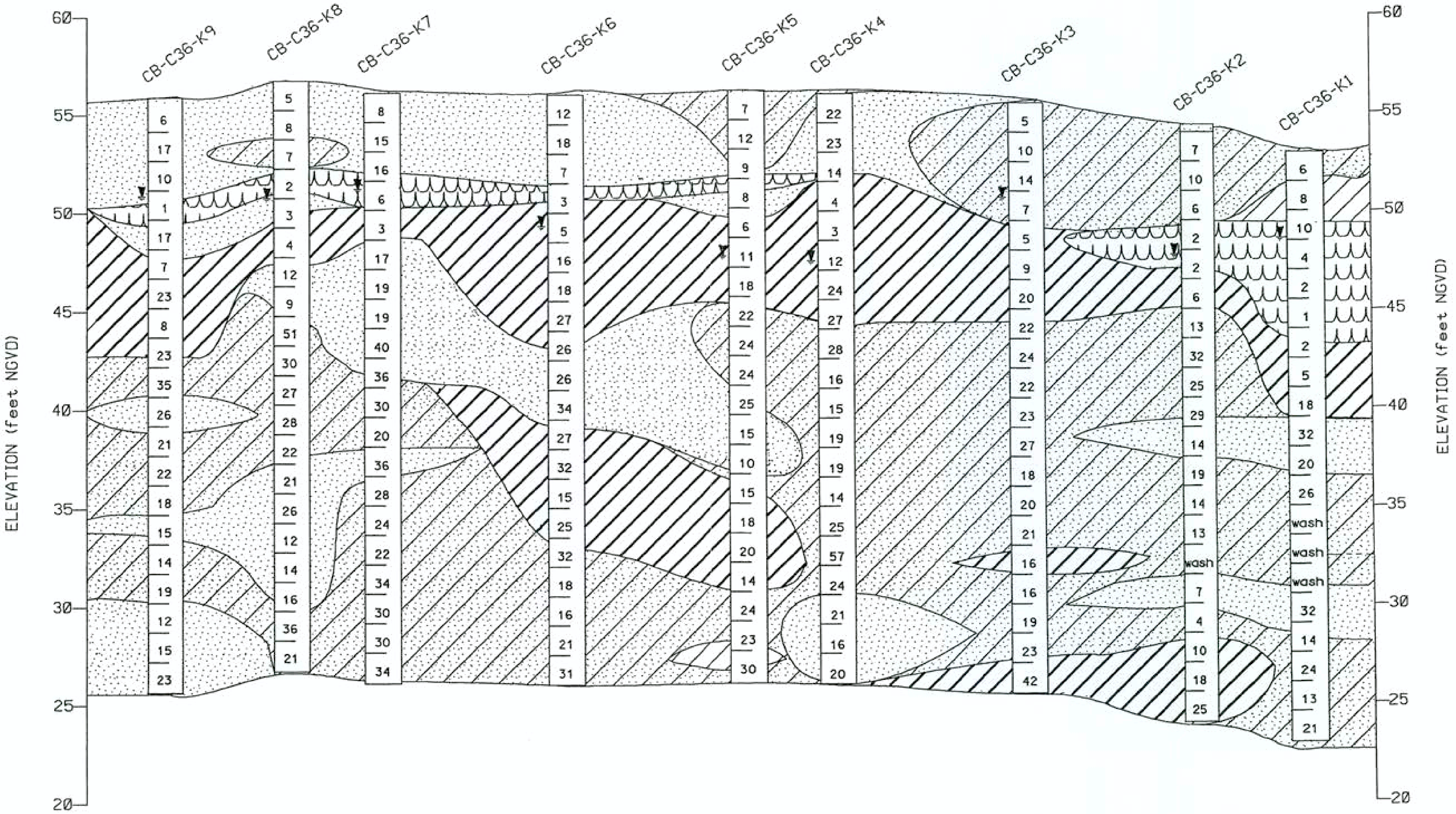
CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

S-65 GETAWAY CHANNEL

GEOLOGIC SECTION

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA



NOTE: NUMBERS ON BORINGS ARE STANDARD PENETRATION TEST RESULTS IN BLOWS/FT

SOIL LEGEND:

░ (SP) POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.

▨ (SC) CLAYEY SANDS, SAND-CLAY

▨ (CL) INORGANIC CLAYES OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.

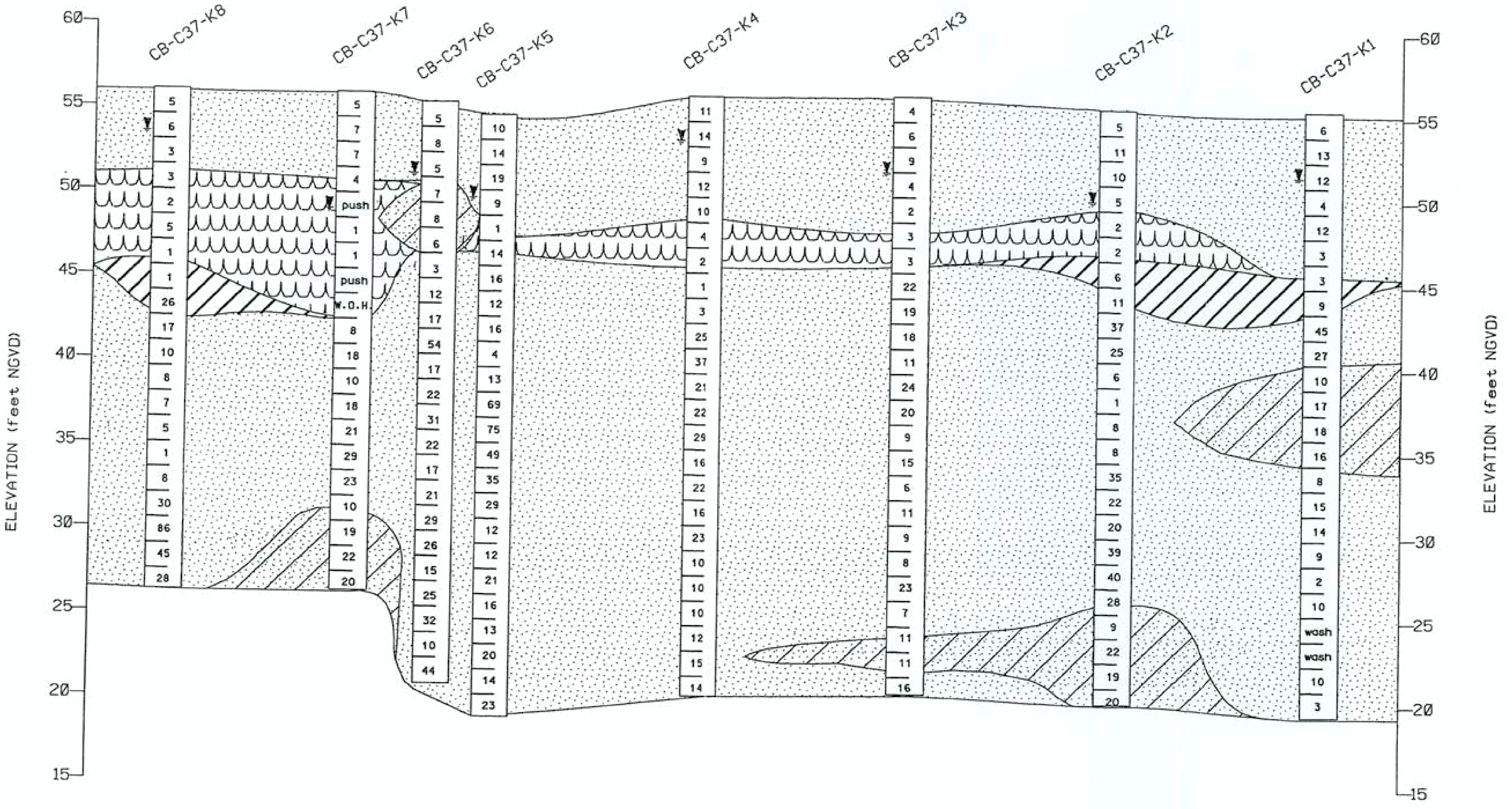
▨ (CH) INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.

▨ (PT) PEAT AND OTHER HIGHLY ORGANIC SOILS.

CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

C-36 CANAL IMPROVEMENTS
GEOLOGIC SECTION

(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA



NOTE: NUMBERS ON BORINGS ARE STANDARD PENETRATION TEST RESULTS IN BLOWS/FT

SOIL LEGEND:

░ (SP) POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.

▨ (CH) INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.

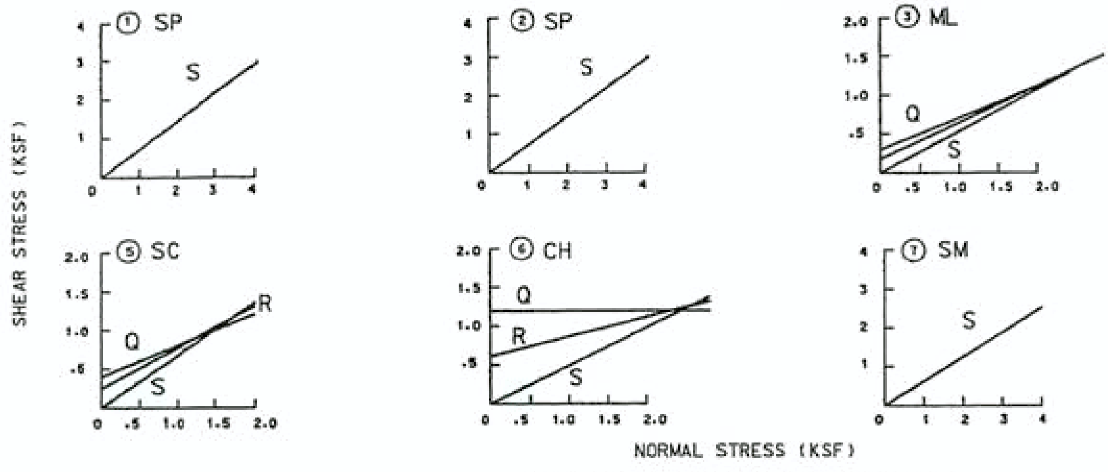
▨ (SC) CLAYEY SANDS, SAND-CLAY

⏝ (PT) PEAT AND OTHER HIGHLY ORGANIC SOILS.

CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

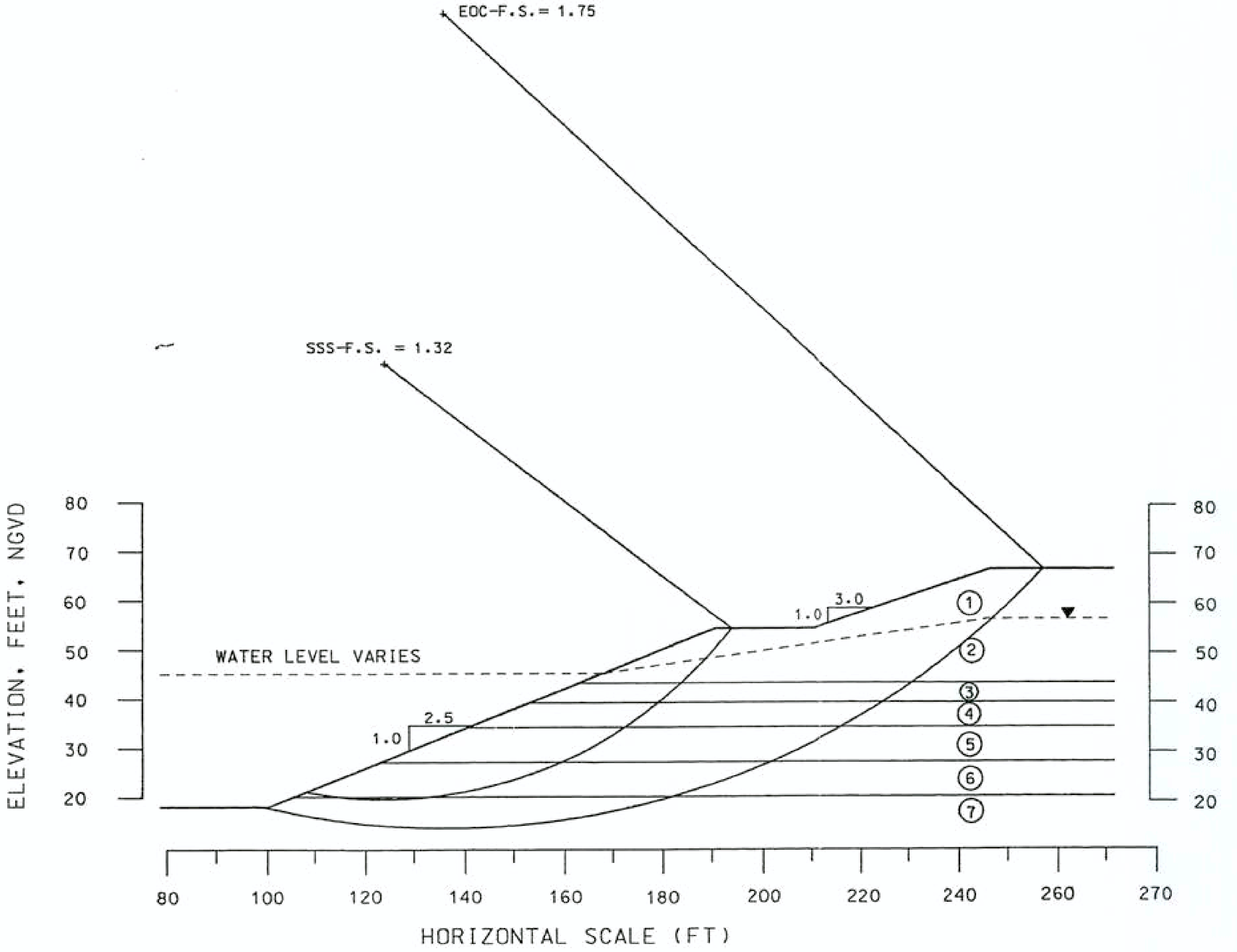
C-37 CANAL IMPROVEMENTS
GEOLOGIC SECTION

(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA



COMPOSITE STRENGTH ENVELOPES

ASSUMED DESIGN DATA				Q		R		S	
MATERIAL LAYER	MATERIAL TYPE	UNIT WT. (PCF)		Q STRENGTH		R STRENGTH		S STRENGTH	
		γ_m	γ_s	Φ	C	Φ	C	Φ	C
1	SP	120	130	—	—	—	—	36	0
2	SP	120	130	—	—	—	—	36	0
3	ML	110	120	22	0.3	25	0.2	28	0
4	SP	120	130	—	—	—	—	38	0
5	SC	120	125	22	0.4	28	0.25	34	0
6	CH	100	110	0	1.2	14	0.65	26	0
7	SM	120	125	—	—	—	—	32	0



NOTES:

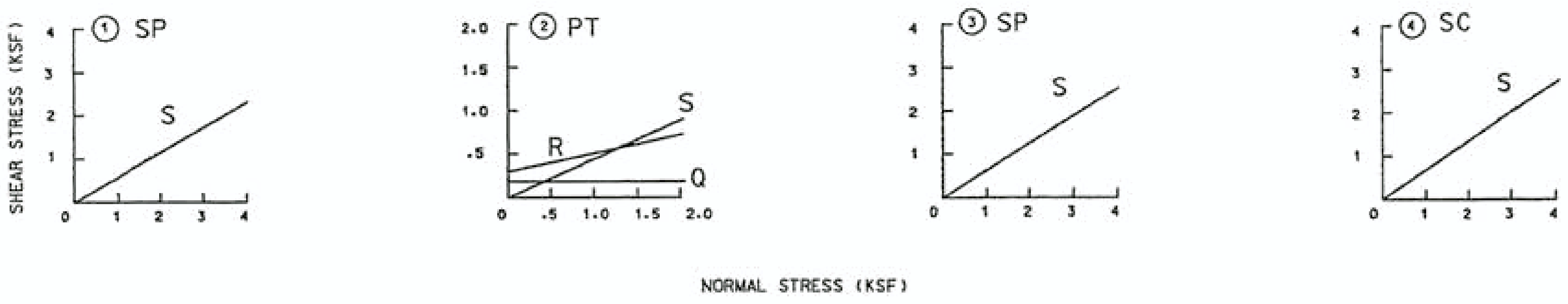
1. CIRCULAR ANALYSIS WAS PERFORMED USING THE UTEXAS-3 COMPUTER PROGRAM
2. COREBORINGS CB-S65-13 WAS USED TO DEVELOP THE SECTION FOR ANALYSIS

CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

STRUCTURE S-65 GETAWAY CHANNEL

SLOPE STABILITY ANALYSIS

(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

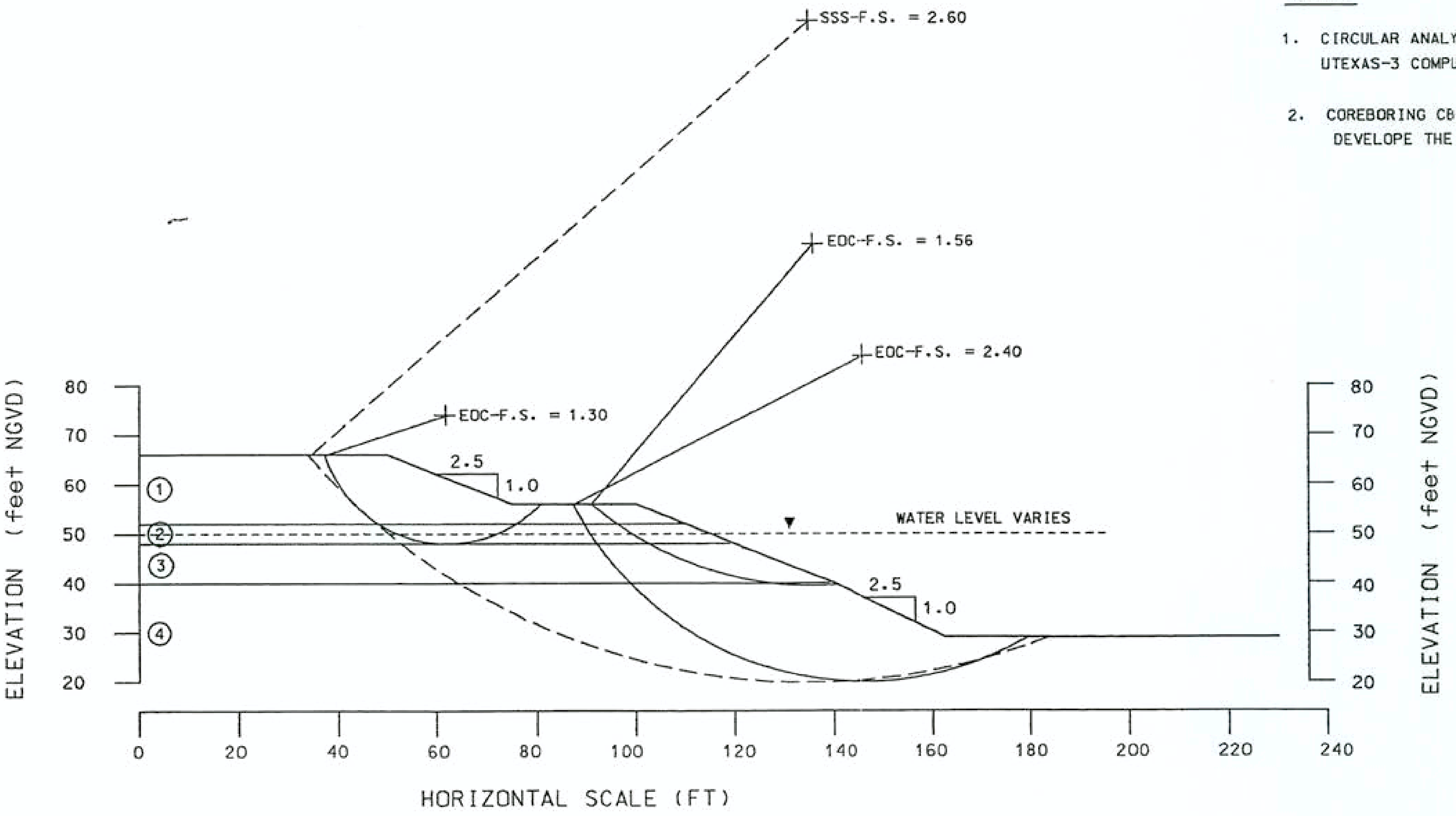


COMPOSITE STRENGTH ENVELOPES

ASSUMED DESIGN DATA				Q		R		S	
MATERIAL LAYER	MATERIAL TYPE	UNIT WT. (PCF)		Q STRENGTH		R STRENGTH		S STRENGTH	
		γ_m	γ_s	Φ (DEG)	C (KSF)	Φ (DEG)	C (KSF)	Φ(DEG)	C (KSF)
1	SP	110	120	---	---	---	---	30	0
2	PT	70	75	0	0.2	12	0.3	24	0
3	SP	115	125	---	---	---	---	32	0
4	SC	115	125	---	---	---	---	34	0

NOTES:

1. CIRCULAR ANALYSIS WAS PERFORMED USING THE UTEXAS-3 COMPUTER PROGRAM
2. COREBORING CB-C36-K7 WAS USED TO DEVELOPE THE SECTION FOR ANALYSIS



CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

C-36 AND C-37 CANAL IMPROVEMENTS

SLOPE STABILITY ANALYSIS

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

Hole No.CB-S65K-9

DRILLING LOG

DIVISION SOUTH ATLANTIC

INSTALLATION JACKSONVILLE DISTRICT

SHEET 1 OF 3

1. PROJECT STRUCTURE 65/KISSIMMEE RIVER
2. LOCATION *(Coordinates or Station)* X=592,352 Y=1261,336
3. DRILLING AGENCY CORPS OF ENGINEERS
4. HOLE NO. *(As shown on drawing title and file number)* CB-S65K-9
5. NAME OF DRILLER L.C. GREGORY
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN Ft.
8. DEPTH DRILLED INTO ROCK Ft.
9. TOTAL DEPTH OF HOLE 60 Ft.
10. SIZE AND TYPE OF BIT SEE REMARKS
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 2
15. ELEVATION GROUND WATER 50.2
16. DATE HOLE STARTED 7/20/94 COMPLETED 7/21/94
17. ELEVATION TOP OF HOLE 63.0 Ft.
18. TOTAL CORE RECOVERY FOR BORING 78.4 %
19. SIGNATURE OF M. MARTY GOFF

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
63.0	.0					63.0		0
						Rock Bit		
						61.5		
60.0	3.0					60.0		2.5
			SAND, fine to medium, quartz, brown, damp, trace shell fragments (SP)	60	1	SPLIT SPOON	5 3 5	
						58.5		
				87	2	SPLIT SPOON	7 8 12	5
						57.0		
			(CH layer at depth 6.3')	73	3	SPLIT SPOON	6 7 10	
						55.5		7.5
			8.5' to 8.9' – black silty layer with thin red to brown sandy layers. Color change at 10.1' to light brown. From depth 9.6' to 10.1' brown sand with black silty sand laminae throughout.	100	4	SPLIT SPOON	6 9 17	
						54.0		
				93	5	SPLIT SPOON	23 20 24	10
						52.5		
				73	6	SPLIT SPOON	7 9 8	
						51.0		
50.7	12.3				7			
50.3	12.7		SAND, fine to medium, quartz, green (SM)	100	8	SPLIT SPOON	6 10 12	12.5
			SAND, brown, fine to medium, quartz, damp (SP)			49.5		
			wet. (SP)	93	9	SPLIT SPOON	6 5 6	
						48.0		15
			depth 15.7' to 15.8' black (CH) layer	100	10	SPLIT SPOON	6 5 7	
			trace wood fragments (SP)			46.5		
				47	11	SPLIT SPOON	11 5 4	17.5
						45.0		
				53	12	SPLIT SPOON	0 1 1	
						43.5		
				33	13	SPLIT SPOON	0 1 1	20
						42.0		
			21.3' black silty sand layer	47	14	SPLIT SPOON	1 1 21	
						40.5		22.5
						(continued)		

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PROJECT STRUCTURE 65/KISSIMMEE RIVER

HOLE NUMBER CB-S65K-9

Hole No.CB-S65K-9

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 63.0 Ft.	SHEET 2 OF 3
PROJECT STRUCTURE 65/KISSIMMEE RIVER	INSTALLATION JACKSONVILLE DISTRICT	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
40.5	22.5					40.5		22.5
				87	15	SPLIT SPOON 39.0	11 24 29	
				87	16	CSG TO 25.5' 37.5	3 7 9	25
36.0	27.0			73	17	NO CSG ADVANCE 36.0	3 9 7	
			Silty SAND, fine medium, quartz, wet, soft, green (SM)	73	18	NO CSG ADVANCE 34.5	5 6 6	27.5
				80	19	CSG TO 30.0' 33.0	6 6 11	30
31.2	31.8			67	20	NO CSG ADVANCE 31.5	7 5 7	
30.0	33.0		SAND, slight silt, green, fine to medium, quartz, (SP-SM)	73	21	NO CSG ADVANCE 30.0	4 5 7	32.5
28.5	34.5		Silty SAND, green, fine to medium, quartz, soft (SM)	80	22	CSG TO 34.5' 28.5	6 82 8	
28.0	35.0		Clay, green, Fat, Firm, trace silt (CH) SILT, light green, slightly clayey, trace shell, soft (MH) calcareous. Below 36.6' very shelly (shell fragments sand to gravel size)	100	23 24	NO CSG ADVANCE 27.0	2 2 2	35
				60	25	SPLIT SPOON 25.5	1 3 6	37.5
				60	26	SPLIT SPOON 24.0	6 5 6	
			Some sand (shell and quartz) trace gravel size shell fragments, soft. Trace sandy limestone fragments (gravel size)	67	27	SPLIT SPOON 22.5	8 8 7	40
21.0	42.0			73	28	SPLIT SPOON 21.0	6 7 6	
19.3	43.7		Silty SAND, trace shell fragments (some with weathering), green fine to medium, quartz (SM) (Shell fragments are sand to gravel size)	100	29	SPLIT SPOON 19.5	5 3 5	42.5
18.9 18.0	44.1 45.0		SC layer from 43.7' to 44.1'	80	30	SPLIT SPOON 18.0	5 5 5	45
			SAND, fine to medium, quartz, green, wet, trace shell fragments, loose (SP)	80	31	SPLIT SPOON 16.5	4 4 5	
15.0	48.0			47	32	SPLIT SPOON 15.0	4 6 7	47.5
			Silty SAND, light green, fine to medium, quartz, trace shell fragments (SM)	60	33	SPLIT SPOON 13.5	9 7 5	
				87	34	SPLIT SPOON	5	50
						(continued)		

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MAR 71

PROJECT	HOLE NUMBER
STRUCTURE 65/KISSIMMEE RIVER	CB-S65K-9

Hole No.CB-S65K-9

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 63.0 Ft.		SHEET 3 OF 3
PROJECT STRUCTURE 65/KISSIMMEE RIVER	INSTALLATION JACKSONVILLE DISTRICT	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
13.0	50.0						
		░	Trace to little shell fragments (Sand to gravel size)	87	34	SPLIT SPOON 12.0	4 3
		░	little shell with sandy limestone fragments	100	35	SPLIT SPOON 10.5	52 7 8
		░	Little shell fragments, little silt (SM)	100	36	SPLIT SPOON 9.0	11 4 11
9.0	54.0						
		▨	Clayey, SAND, olive green, trace shell fragments (weathered), fine to medium, quartz (SC).	100	37	CSG TO 55.5' 7.5	8 4 11
		▨		100	38	SPLIT SPOON 6.0	5 4 5
		▨		100	39	SPLIT SPOON 4.5	3 3 2
		▨		87	40	SPLIT SPOON 3.0	2 3 4
3.0	60.0						

NOTES:

Soils are field visually classified in accordance with the Unified Soils Classification System.

After the visual classification was performed, Atterberg limits and water contents were obtained from some of the samples: the results and final Unified Soil Classification take precedence over the visual classification.

The following laboratory tests were performed as indicated below:

```
Sample #18:  Sieve Analysis
              (SC)  Visual

Sample #26:  Sieve Analysis
             W=25.9%
             LL=32
             PL=15
             PJ=17  (SC)

Sample #34: Sieve Analysis
             (SC) Visual

Sample #37:  Sieve Analysis
             W=33.5
             LL=28
             PL=17
             PI=11  (SC)
```

140# Hammer with 30" Drop used on 2.0' Split Spoon. (1 3/8" I.D. X 2" O.D.)

PROJECT	HOLE NUMBER
STRUCTURE 65/KISSIMMEE RIVER	CB-S65K-9

Hole No.CB-S65K-10

DRILLING LOG

DIVISION SOUTH ATLANTIC

INSTALLATION JACKSONVILLE DISTRICT

SHEET 1 OF 3

1. PROJECT STRUCTURE 65/KISSIMMEE RIVER
2. LOCATION (Coordinates or Station) X=592,326 Y=1261,322
3. DRILLING AGENCY CORPS OF ENGINEERS
4. HOLE NO. (As shown on drawing title and file number) CB-S65K-10
5. NAME OF DRILLER R.A. GORDON/L.C. GREGORY
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN Ft.
8. DEPTH DRILLED INTO ROCK Ft.
9. TOTAL DEPTH OF HOLE 60 Ft.
10. SIZE AND TYPE OF BIT SEE REMARKS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 2
15. ELEVATION GROUND WATER 48.8
16. DATE HOLE STARTED 7/19/94 COMPLETED 7/20/94
17. ELEVATION TOP OF HOLE 63.03 Ft.
18. TOTAL CORE RECOVERY FOR BORING 73.3 %
19. SIGNATURE OF M. MARTY GOFF

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER		REMARKS Bit or Barrel	BLOWS/ .5'	
63.0	.0					63.0			0
62.2	.8	■	Pavement				Rock Bit		
						61.5			
60.0	3.0					60.0			2.5
		░	SAND, fine to medium, quartz, brown, trace shell fragments, trace fines (SP)	80	1	58.5	SPLIT SPOON	4 8 14	
				100	2 20	57.0	SPLIT SPOON	16 26 38	5
				67	3	55.5	SPLIT SPOON	4 10 14	
				100	4	54.0	SPLIT SPOON	17 21 24	7.5
				100	5	52.5	SPLIT SPOON	11 12 13	10
				100	6	51.0	SPLIT SPOON	19 21 25	
				67	7	49.5	SPLIT SPOON	11 13 10	12.5
				100	8	48.0	SPLIT SPOON	12 15 16	15
				33	9	46.5	SPLIT SPOON	2 2 3	
				53	10	45.0	SPLIT SPOON	8 12 20	17.5
43.5	19.5			87	11 12	43.5	SPLIT SPOON	4 14 24	
42.0	21.0	▨	CLAY, dark brown to black, firm to stiff, trace sand, medium plasticity (CL). Little clay silt in thin layers throughout	100		42.0	SPLIT SPOON	4 7 11	20
		░	SAND, fine to medium, quartz, tan, wet, trace fines (thin layer of silty sand at 21.7') (SP)	73	13	40.5 (continued)	SPLIT SPOON	18 29 31	22.5

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MAR 71

PROJECT STRUCTURE 65/KISSIMMEE RIVER

HOLE NUMBER CB-S65K-10

Hole No.CB-S65K-10

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 63.03 Ft.	SHEET 2 OF 3
PROJECT STRUCTURE 65/KISSIMMEE RIVER	INSTALLATION JACKSONVILLE DISTRICT	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
40.5	22.5					40.5	
				73	14	SPLIT SPOON 39.0	6 8 20
				60	15	NO CSG ADVANCE 37.5	25 33 26
35.7	27.3			60	16	NO CSG ADVANCE 36.0	3 5 8
			Clayey SAND, fine to medium, quartz, brown to greenish, soft, low to medium plasticity (SC) Silt content increasing with depth	87	17 18	NO CSG ADVANCE 34.5	6 6 6
33.0	30.0			73	19	CSG TO 30.0' 33.0	3 6 11
			Silty SAND, fine to medium, quartz, green, soft, moist (SM)	73	20	NO CSG ADVANCE 31.5	4 6 10
			Trace very weathered shell fragments	73	21	NO CSG ADVANCE 30.0	4 5 8
28.5	34.5			87	22	NO CSG ADVANCE 28.5	3 6 6
			CLAY, green, soft, Fat, plastic, trace sand, trace shell fragments (CH) Silt content increasing with depth	100	23	CSG TO 36.0' 27.0	1 1 1
				60	24	SPLIT SPOON 25.5	0 4 6
				67	25	SPLIT SPOON 24.0	7 2 3
22.5	40.5			0		SPLIT SPOON 22.5	0 3 1
22.2 21.0 20.7	40.8 42.0 42.3		SAND, little shell fragments (sand size to gravel), wet, soft, calcareous, (SM) with SC layer from 40.5' to 40.8'. Trace rock fragments to gravel size from 42.0' to 42.3'. From 43.8' to 44.2' SC layer.	67	26	SPLIT SPOON 21.0	0 2 2
19.2	43.8			53	27	SPLIT SPOON 19.5	6 5 4
18.8	44.2			100	28	SPLIT SPOON 18.0	4 8 52 6
16.5	46.5			100	29	SPLIT SPOON 16.5	5 5 5
15.0	48.0		SAND, fine medium, quartz, trace shell fragments, trace silt, wet, green (SP)	67	30	SPLIT SPOON 15.0	4 7 11
			Silty SAND, trace to little shell fragments, wet, slightly calcareous, green (SM)	31	31	SPLIT SPOON 13.5	8 7 7
				73	32	SPLIT SPOON	4
						(continued)	

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MAR 71

PROJECT	HOLE NUMBER
STRUCTURE 65/KISSIMMEE RIVER	CB-S65K-10

Hole No.CB-S65K-10

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 63.03 Ft.	SHEET 3 OF 3		
PROJECT STRUCTURE 65/KISSIMMEE RIVER	INSTALLATION JACKSONVILLE DISTRICT		

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
13.0	50.0						
				73	32	SPLIT SPOON 12.0	4 4
				87	33	SPLIT SPOON 10.5	6 9 7
9.0	54.0			100	34	SPLIT SPOON 9.0	7 8 7
			Clayey SAND, trace silt green, trace shell fragments (weathered), soft, fine to medium, quartz, (SC).	100	35	CSG TO 55.5' 7.5	7 3 4
				87	36	SPLIT SPOON 6.0	6 3 4
				73	37	SPLIT SPOON 4.5	3 2 3
3.0	60.0			87	38	SPLIT SPOON 3.0	3 3 4
			NOTES:			140# Hammer with 30" Drop Used on 2.0" Split Spoon. (1 3/8" I.D. X 2" O.D.)	

NOTES:

Soils are field visually classified in accordance with the Unified Soils Classification System.

After the visual classification was performed, Atterberg limits and water contents were obtained from some of the samples: the results and final Unified Soil Classification take precedence over the visual classification.

The following laboratory tests were performed as indicated below:

Sample #18:	Sieve Analysis (SC) Visual
Sample #23:	Sieve Analysis W=67.5 LL=101 PL=22 PI=79 (CH)
Sample #28:	Sieve Analysis (SC) Visual
Sample #34:	Sieve Analysis W=25.1 LL=31 PL=17 PI=14 (SC)

50 52.5 55 57.5 60 62.5 65 67.5 70 72.5 75 77.5

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MAR 71

PROJECT
STRUCTURE 65/KISSIMMEE RIVER

HOLE NUMBER
CB-S65K-10

Hole No.CB-S65K-11

DRILLING LOG

DIVISION SOUTH ATLANTIC

INSTALLATION JACKSONVILLE DISTRICT

SHEET 1 OF 2

1. PROJECT STRUCTURE 65/KISSIMMEE RIVER
2. LOCATION (Coordinates or Station) X=592,380 Y=1261,192
3. DRILLING AGENCY CORPS OF ENGINEERS
4. HOLE NO. (As shown on drawing title and file number) CB-S65K-11
5. NAME OF DRILLER R.A. GORDON
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN Ft.
8. DEPTH DRILLED INTO ROCK Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT SEE REMARKS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 2
15. ELEVATION GROUND WATER 46.9
16. DATE HOLE STARTED 7/14/94 COMPLETED 7/14/94
17. ELEVATION TOP OF HOLE 56.47 Ft.
18. TOTAL CORE RECOVERY FOR BORING 87.7 %
19. SIGNATURE OF M. MARTY GOFF

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'	
56.5	.0					56.5		0
55.0	1.5		SAND, fine to medium, quartz, trace silt, trace shell fragments, slightly calcareous, trace organics, brown, with white, calcareous layer from 0.2' to 0.6' (SP)	53	1	SPLIT SPOON 55.0	7 12 13	
			SAND, fine to medium, clean (SP)	60	2	SPLIT SPOON 53.5	19 27 30	2.5
			Trace Fines below depth 4.0	93	3	SPLIT SPOON 52.0	33 37 43	
				45	4	SPLIT SPOON 50.5	33 36 48	5
				100	5	SPLIT SPOON 49.0	24 27 32	7.5
				100	6	SPLIT SPOON 47.5	14 27 36	
			Trace silt (in thin layers) (SP)	100	7	SPLIT SPOON 46.0	26 36 24	10
				100	8	SPLIT SPOON 44.5	18 9 4	
43.8 43.5	12.7 13.0		SILT, dark gray to black, organic stain, trace sand, stiff, low plasticity, damp, clayey layer from 12.7' to 13.0' (ML)	100	9 10	CSG TO 13.5' 43.0	2 4 17	12.5
				93	11	CSG TO 15.0' 41.5	12 19 16	15
41.1 40.9 40.5	15.4 15.6 16.0		From depth 15.4' to 15.6' clayey layer. SAND, with little silt, fine to medium, quartz, dark brown, wet (SP-SM)	100	12 13	NO CSG ADVANCE 40.0	7 7 9	
38.5	18.0		Silt decreasing with depth.	73	14	NO CSG ADVANCE 38.5	7 24 28	17.5
			SAND, fine to medium, quartz, tan, clean, wet (SP)	67	15	CSG TO 19.5' W/300LBS HAMMER 37.0	5 18 22	
35.5	21.0		SC layer depth 19.9' to depth 20.0 SC layer depth 20.5 to 20.6 Trace Fines, tan to brown	80	16	NO CSG ADVANCE 35.5	2 3 6	20
			Silty SAND, fine to medium, quartz, soft, moist, green (SM)	87	17	NO CSG ADVANCE 34.0	5 7 13	22.5

(continued)

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PROJECT STRUCTURE 65/KISSIMMEE RIVER

HOLE NUMBER CB-S65K-11

Hole No.CB-S65K-11

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.47 Ft.

SHEET 2 OF 2

PROJECT STRUCTURE 65/KISSIMMEE RIVER

INSTALLATION JACKSONVILLE DISTRICT

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
34.0	22.5					34.0	
				67	18	CSG TO 24.0' W/300LBS HAMMER 32.5	8 11 13
				93	19	SPLIT SPOON 31.0	7 9 11
				100	20	SPLIT SPOON 29.5	7 5 8
			Occasional gravel size (sandy) rock fragments.	100	21	SPLIT SPOON 28.0	3 6 5
			Trace weathered limestone fragments. Trace clay.	100	22	SPLIT SPOON 26.5	5 6 6
26.5	30.0						

NOTES:

Soils are field visually classified in accordance with the Unified Soils Classification System.

After the visual classification was performed. Atterberg limits and water contents were obtained from some of the samples: the results and final Unified Soil Classification take precedence over the visual classification.

The following laboratory tests were performed as indicated below:

Sample #3: Sieve Analysis
(SP-SM) Visual

Sample #17: Sieve Analysis
W=32.4
LL=34
PL=20
PI=14 (SC)

140# Hammer with 30" Drop Used on 2.0' Split Spoon. (1 3/8" I.D. X 2" O.D)

Hole No.CB-S65K-12

DRILLING LOG	DIVISION SOUTH ATLANTIC	INSTALLATION JACKSONVILLE DISTRICT SHEET 1 OF 2

1. PROJECT STRUCTURE 65/KISSIMMEE RIVER
2. LOCATION *(Coordinates or Station)* X=592,387 Y=1261,095
3. DRILLING AGENCY CORPS OF ENGINEERS
4. HOLE NO. *(As shown on drawing title and file number)* CB-S65K-12
5. NAME OF DRILLER R.A. GORDON
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN Ft.
8. DEPTH DRILLED INTO ROCK Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT SEE REMARKS
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 2
15. ELEVATION GROUND WATER 48.1
16. DATE HOLE STARTED 7/13/94 COMPLETED 7/14/94
17. ELEVATION TOP OF HOLE 55.73 Ft.
18. TOTAL CORE RECOVERY FOR BORING 93 %
19. SIGNATURE OF M. MARTY GOFF

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
55.7	.0					55.7		0
			SAND, fine to medium, quartz, brown, clayey, trace organics (SP-SC)	87	1	HOLE CLEANED W/6.0" AUGER 54.2	4 6 7	
				93	2	SPLIT SPOON 52.7	7 12 19	2.5
			Silt content increasing with depth. Occasional sand layer.	100	3	SPLIT SPOON 51.2	20 26 26	
				100	4	GROUNDWATER MEASURED AT 6.0" 49.7	25 35 47	5
49.7	6.0							
			SAND, fine to medium, quartz, tan, clean, wet (SP)	100	5	CON'T CLEANING HOLE W/AUGER 48.2	16 20 22	7.5
				100	6	" 46.7	33 37 44	
			Color change to gray to brown, with dark gray layering throughout.	100	7	" 45.2	20 30 33	10
44.6	11.1							
			SAND, silty, dark gray to brown (SP-SM)	100	8 9	" 43.7	11 11 13	
43.9	11.8							
			SILT, dark gray, little to some sand, soft, low plasticity (ML)	100	11	CSG TO 13.5' 42.2	7 5 7	12.5
41.8	13.9							
			Clay, Firm, little sand, low to medium plasticity, greenish, gray (CL)	93	12 13	SPLIT SPOON 40.7	3 10 12	
40.7	15.0							15
			SAND, fine to medium, quartz, trace Fines, tan to gray, wet (SP)	87	14	NO CSG ADVANCE 39.2	21 43 79	
				60	15	NO CSG ADVANCE 37.7	6 20 22	17.5
				73	16	CSG TO 19.5' NO CSG ADVANCE 36.2	19 15 19	
36.2	19.5							
			SAND, fine to medium, quartz, clayey, light green, low plasticity (SC)	87	17	34.7	3 8 13	20
				87	18	CSG TO 22.5' 33.2	15 16 27	22.5
						(continued)		

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PROJECT	HOLE NUMBER
STRUCTURE 65/KISSIMMEE RIVER	CB-S65K-12

Hole No.CB-S65K-12

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 55.73 Ft.	SHEET 2 OF 2
PROJECT STRUCTURE 65/KISSIMMEE RIVER	INSTALLATION JACKSONVILLE DISTRICT	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
33.2	22.5					33.2	
		▨		100	19	NO CSG ADVANCE 31.7	3 7 9
		▨		93	20	NO CSG ADVANCE 30.2	3 6 9
29.5	26.2	▨	Clay, Fat, trace, sand, silt, green (CH)	100	21 22	CSG TO 27.0' 28.7	7 6 6
		▨		100	23 24	NO CSG ADVANCE 27.2	2 2 4
25.7	30.0	▨		93	25	SPLIT SPOON 25.7	2 2 4

NOTES:

Soils are field visually classified in accordance with the Unified Soils Classification System.

After the visual classification was performed. Atterberg limits and water contents were obtained from some of the samples: the results and final Unified Soil Classification take precedence over the visual classification.

The following laboratory tests were performed as indicated below:

Sample #2: Sieve Analysis
(SC) Visual

Sample #11: Sieve Analysis
(CH) Visual

Sample #23: Sieve Analysis
W=48.3
LL=70
PL=19
PI=51 (CH)
SG=2.63

140# Hammer with 30" Drop Used on 2.0' Split Spoon. (1 3/8" I.D. X 2" O.D)

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT STRUCTURE 65/KISSIMMEE RIVER	HOLE NUMBER CB-S65K-12

Hole No.CB-S65K-13

DRILLING LOG

DIVISION SOUTH ATLANTIC	INSTALLATION JACKSONVILLE DISTRICT — SHEET 1 OF 2
1. PROJECT STRUCTURE 65/KISSIMMEE RIVER	10. SIZE AND TYPE OF BIT SEE REMARKS
2. LOCATION *(Coordinates or Station)* X=592,428 Y=1261,159	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
3. DRILLING AGENCY CORPS OF ENGINEERS	12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
4. HOLE NO. *(As shown on drawing title and file number)* CB-S65K-13	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
5. NAME OF DRILLER R.A. GORDON	14. TOTAL NUMBER OF CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER 56.97
	16. DATE HOLE STARTED 7/14/94 COMPLETED 7/18/94
7. THICKNESS OF BURDEN Ft.	17. ELEVATION TOP OF HOLE 67.57 Ft.
8. DEPTH DRILLED INTO ROCK Ft.	18. TOTAL CORE RECOVERY FOR BORING 77.5 %
9. TOTAL DEPTH OF HOLE 40.5 Ft.	19. SIGNATURE OF M. MARTY GOFF

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)
67.6	.0		SAND, fine to medium, quartz, trace Fines, trace organic brown (SP)
61.6	6.0		SAND, fine to medium, quartz, silty (occurs in layer), gray-brown, trace shell fragments and trace red-brown staining (SP-SM)
57.6	10.0		SAND, fine to medium, quartz, white to tan, clean (SP)
56.6	11.0		SAND, fine to medium, quartz, little clay, gray and brown with red brown mottling, throughout (SP-SC) SAND, slightly clayey, green to gray (mottled) (SP-SC) (SP) and (SC) layers
51.1	16.5		SAND, fine to medium, quartz, moist, trace Fines (SP) From 21.5' to 21.8' - SC layer 22.3' to 22.5 - SC layer wet.

CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
		67.6	
87	1	HOLE CLEANED W/6.0" AUGER 66.1	1 2 2
87	2	SPLIT SPOON 64.6	5 6 8
67	3	SPLIT SPOON 63.1	11 16 20
87	4	SPIT SPOON 61.6	8 14 14
93	5	SPLIT SPOON 60.1	18 24 26
100	6	SPLIT SPOON 58.6	16 16 14
100	7	SPLIT SPOON 57.1	12 19 26
100	8	SPLIT SPOON 55.6	6 7 7
100	9	CSG TO 13.5' 54.1	18 26 24
80	10	CST TO 15.0' 52.6	11 15 24
60	11	CSG TO 16.5' 51.1	12 13 16
80	12	NO CSG ADVANCE 49.6	39 47 61
67	13	CSG TO 19.5' 48.1	10 23 23
60	14	NO CSG ADVANCE 46.6	16 31 35
67	15	NO CSG ADVANCE 45.1	8 16 13
		(continued)	

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MAR 71

PROJECT STRUCTURE 65/KISSIMMEE RIVER

HOLE NUMBER CB-S65K-13

Hole No.CB-S65K-13

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 67.57 Ft.	SHEET 2 OF 2
PROJECT STRUCTURE 65/KISSIMMEE RIVER	INSTALLATION JACKSONVILLE DISTRICT	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
45.1	22.5					45.1		
44.5	23.1			87	16 17	NO CSG ADVANCE 43.6	8 9 14	22.5
44.1	23.5		Clayey SAND, slightly plasticity, dark brown (SC)					
43.6	24.0		Clay, dark brown, trace to little sand, soft, medium plasticity (CL) Clayey SAND, medium plasticity, soft, wet, dark brown (SC) Occasional (CH) layer throughout.	87	18 19	NO CSG ADVANCE 42.1	3 5 9	25
				100	20	NO CSG ADVANCE 40.6	6 8 14	
40.6	27.0		SAND, fine to medium, quartz, brown, wet, trace Fines (SP)	80	21	NO CSG ADVANCE 39.1	16 34 55	27.5
				73	22	NO CSG ADVANCE 37.6	19 34 35	30
				40	23	CSG TO 30.5' 36.1	7 8 8	
35.6	32.0		Silty SAND, fine to medium, quartz, green, soft (SM)	87	24 25	NO CSG ADVANCE 34.6	1 2 8	32.5
				67	26	SPLIT SPOON 33.1	7 8 11	
				73	27	SPLIT SPOON 31.6	11 21 28	35
31.6	36.0		Trace very weathered shell fragments. (SM)	87	28	CSG TO 37.5' 30.1	8 10 18	37.5
			Below 38.5', loose, little silt, very wet.	73	29	NO CSG ADVANCE 28.6	11 12 16	
27.1	40.5			7	30	NO CSG ADVANCE 27.1	7 2 1	40
			NOTES: Soils are field visually classified in accordance with the Unified Soils Classification System. After the visual classification was performed, Atterberg limits and water contents were obtained from some of the samples; the results and final Unified Soil Classification take precedence over the visual classification. The following laboratory tests were performed as indicated below: Sample #6: Sieve Analysis (SC) Visual Sample #13: Sieve Analysis (SP-SM) Visual Sample #28: Sieve Analysis W=30.2 LL=34 PL=27 PI=7 (ML)			140# Hammer with 30" Drop Used on 2.0' Split Spoon. (1 3/8" I.D. X 2" O.D)		42.5 45 47.5 50

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PROJECT STRUCTURE 65/KISSIMMEE RIVER	HOLE NUMBER CB-S65K-13

Hole No.CB-C35-S1

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District

SHEET 1 OF 1

1. PROJECT Kissimmee River Restoration-Section 1135
2. LOCATION (Coordinates or Station) X=388,714 Y=1364,274
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C35-S1
5. NAME OF DRILLER R Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 5 Ft.
10. SIZE AND TYPE OF BIT See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 02/09/94 COMPLETED 02/09/94
17. ELEVATION TOP OF HOLE 41.05 Ft.
18. TOTAL CORE RECOVERY FOR BORING 60.0 %
19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
41.0	.0					41.0	
		░	SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	60	1	Used 5 Foot Split Spoon.	SETTLE SETTLE 2 3 6
36.0	5.0					36.0	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 9.2'	

0
2.5
5
7.5
10
12.5
15
17.5
20
22.5

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MAR 71

PROJECT	HOLE NUMBER
Kissimmee River Restoration-Section 1135	CB-C35-S1

Hole No.CB-C35-S2

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 1

1. PROJECT Kissimmee River Restoration-Section 1135
2. LOCATION *(Coordinates or Station)* X=388,316 Y=1367,752
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C35-S2
5. NAME OF DRILLER R Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 5 Ft.
10. SIZE AND TYPE OF BIT See Remarks
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 02/09/94 COMPLETED 02/09/94
17. ELEVATION TOP OF HOLE 41.25 Ft.
18. TOTAL CORE RECOVERY FOR BORING 80.0 %
19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
41.2	.0					*41.2*	
		▨	SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	80	1	Used 5 Foot Split Spoon.	SETTLE SETTLE 2 3 5
36.2	5.0					*36.2*	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 9.0'	

0
2.5
5
7.5
10
12.5
15
17.5
20
22.5

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MAR 71

PROJECT	HOLE NUMBER
Kissimmee River Restoration-Section 1135	CB-C35-S2

Hole No.CB-C35-S3

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District SHEET 1 OF 1

1. PROJECT
Kissimmee River Restoration-Section 1135

2. LOCATION *(Coordinates or Station)*
X=387,895 Y=1371,729

3. DRILLING AGENCY
Corps of Engineers

4. HOLE NO. *(As shown on drawing title and file number)* CB-C35-S3

5. NAME OF DRILLER
R Gordon

6. DIRECTION OF HOLE
☒ VERTICAL ☐ INCLINED

7. THICKNESS OF BURDEN 0 Ft.

8. DEPTH DRILLED INTO ROCK 0 Ft.

9. TOTAL DEPTH OF HOLE 5 Ft.

10. SIZE AND TYPE OF BIT See Remarks

11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*
NGVD

12. MANUFACTURER'S DESIGNATION OF DRILL
CD-33

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN
disturbed: 1 undisturbed: 0

14. TOTAL NUMBER OF CORE BOXES 1

15. ELEVATION GROUND WATER

16. DATE HOLE STARTED COMPLETED
02/09/94 02/09/94

17. ELEVATION TOP OF HOLE 38.05 Ft.

18. TOTAL CORE RECOVERY FOR BORING 85.0 %

19. SIGNATURE OF GEOLOGIST
M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
38.0	.0					*38.0*	
		░	SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	85	1	Used 5 Foot Split Spoon.	SETTLE 2 3 5 9
33.0	5.0					*33.0*	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 12.2'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

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MAR 71

PROJECT	HOLE NUMBER
Kissimmee River Restoration-Section 1135	CB-C35-S3

Hole No.CB-C35-S4

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 1

1. PROJECT Kissimmee River Restoration-Section 1135
2. LOCATION (Coordinates or Station) X=387,212 Y=1377,690
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C35-S4
5. NAME OF DRILLER R Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 5 Ft.
10. SIZE AND TYPE OF BIT See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 02/09/94 COMPLETED 02/09/94
17. ELEVATION TOP OF HOLE 39.25 Ft.
18. TOTAL CORE RECOVERY FOR BORING 50.0 %
19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
39.2	.0					39.2	
		▨	SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	50	1	Used 5 Foot Split Spoon.	SETTLE SETTLE 2 3 5
34.2	5.0					34.2	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 11.0'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

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PROJECT Kissimmee River Restoration-Section 1135

HOLE NUMBER CB-C35-S4

Hole No.CB-C35-S5

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 1

1. PROJECT Kissimmee River Restoration-Section 1135
2. LOCATION *(Coordinates or Station)* X=386,557 Y=1383,150
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C35-S5
5. NAME OF DRILLER R Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 5 Ft.
10. SIZE AND TYPE OF BIT See Remarks
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 02/09/94 COMPLETED 02/09/94
17. ELEVATION TOP OF HOLE 40.25 Ft.
18. TOTAL CORE RECOVERY FOR BORING 20.0 %
19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
40.2	.0					40.2	
		▨	SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	20	1	Used 5 Foot Split Spoon.	2 5 7 8 10
35.2	5.0					35.2	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 10.0'	

0
2.5
5
7.5
10
12.5
15
17.5
20
22.5

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MAR 71

PROJECT Kissimmee River Restoration-Section 1135

HOLE NUMBER CB-C35-S5

Hole No.CB-C36-S1

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 1

1. PROJECT Kissimmee River Restoration-Section 1135
2. LOCATION *(Coordinates or Station)* X=385,116 Y=1342,801
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C36-S1
5. NAME OF DRILLER R Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 5 Ft.
10. SIZE AND TYPE OF BIT See Remarks
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
17. ELEVATION TOP OF HOLE 35.75 Ft.
18. TOTAL CORE RECOVERY FOR BORING 40.0 %
19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'	
35.7	.0					35.7		0
		▨	SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments. SP	40	1	Used 5 Foot Split Spoon.	SETTLE 3 6 9 11	2.5
30.7	5.0					30.7		5
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 14.5'		7.5 10 12.5 15 17.5 20 22.5

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PROJECT Kissimmee River Restoration-Section 1135

HOLE NUMBER CB-C36-S1

Hole No.CB-C36-S2

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District

SHEET 1 OF 1

1. PROJECT Kissimmee River Restoration-Section 1135
2. LOCATION *(Coordinates or Station)* X=388,811 Y=1347,911
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C36-S2
5. NAME OF DRILLER R Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 5 Ft.
10. SIZE AND TYPE OF BIT See Remarks
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
17. ELEVATION TOP OF HOLE 35.55 Ft.
18. TOTAL CORE RECOVERY FOR BORING 80.0 %
19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
35.5	.0					35.5	
		░	SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments. SP	80	1	Used 5 Foot Split Spoon.	3 5 7 11 12
30.5	5.0	░				30.5	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 14.7'	

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PROJECT Kissimmee River Restoration-Section 1135	HOLE NUMBER CB-C36-S2

Hole No.CB-C36-S3

DRILLING LOG | DIVISION South Atlantic | INSTALLATION Jacksonville District | SHEET 1 OF 1

1. PROJECT Kissimmee River Restoration-Section 1135
2. LOCATION *(Coordinates or Station)* X=391,056 Y=1354,541
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C36-S3
5. NAME OF DRILLER R Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 5 Ft.
10. SIZE AND TYPE OF BIT See Remarks
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
17. ELEVATION TOP OF HOLE 37.75 Ft.
18. TOTAL CORE RECOVERY FOR BORING 50.0 %
19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
37.7	.0					37.7	
		▨	SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments. SP	50	1	Used 5 Foot Split Spoon.	SETTLE SETTLE 3 5 9
32.7	5.0					32.7	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 12.5'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

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MAR 71

PROJECT Kissimmee River Restoration-Section 1135 | HOLE NUMBER CB-C36-S3

Hole No.CB-C37-S1

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 1

1. PROJECT Kissimmee River Restoration-Section 1135
2. LOCATION *(Coordinates or Station)* X=386,658 Y=1319,647
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C37-S1
5. NAME OF DRILLER R Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 5 Ft.
10. SIZE AND TYPE OF BIT See Remarks
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
17. ELEVATION TOP OF HOLE 31.25 Ft.
18. TOTAL CORE RECOVERY FOR BORING 60.0 %
19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
31.2	.0					*31.2*	
		▨	SAND, Fine to medium grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	60	1	Used 5 Foot Split Spoon.	SETTLE 3 7 12 16
26.2	5.0					*26.2*	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 19.0'	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

Hole No.CB-C37-S2

DRILLING LOG
DIVISION South Atlantic
INSTALLATION Jacksonville District
SHEET 1 OF 1

1. PROJECT Kissimmee River Restoration-Section 1135
2. LOCATION *(Coordinates or Station)* X=382,520 Y=1322,452
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C37-S2
5. NAME OF DRILLER R Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 5 Ft.
10. SIZE AND TYPE OF BIT See Remarks
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
17. ELEVATION TOP OF HOLE 30.25 Ft.
18. TOTAL CORE RECOVERY FOR BORING 85.0 %
19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
30.2	.0					30.2	
		▒	SAND, Fine to medium grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	85	1	Used 5 Foot Split Spoon.	SETTLE SETTLE 2 2 4
25.2	5.0					25.2	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 20.0'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

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PROJECT Kissimmee River Restoration-Section 1135
HOLE NUMBER CB-C37-S2

Hole No.CB-C37-S3

DRILLING LOG DIVISION South Atlantic	INSTALLATION Jacksonville District SHEET 1 OF 1
1. PROJECT Kissimmee River Restoration-Section 1135	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION *(Coordinates or Station)* X=378,735 Y=1325,657	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
4. HOLE NO. *(As shown on drawing title and file number)* CB-C37-S3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER R Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 30.85 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 60.0 %
9. TOTAL DEPTH OF HOLE 5 Ft.	19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
30.8	.0					30.8	
			SAND, Fine to medium grains, quartz, light reddish tan brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	60	1	Used 5 Foot Split Spoon.	SETTLE SETTLE 4 5 9
25.8	5.0					25.8	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 19.4'	

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PROJECT Kissimmee River Restoration-Section 1135

HOLE NUMBER CB-C37-S3

Hole No.CB-C37-S4

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 1

1. PROJECT Kissimmee River Restoration-Section 1135
2. LOCATION *(Coordinates or Station)* X=377,727 Y=1328,994
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C37-S4
5. NAME OF DRILLER R Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 5 Ft.
10. SIZE AND TYPE OF BIT See Remarks
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
17. ELEVATION TOP OF HOLE 32.95 Ft.
18. TOTAL CORE RECOVERY FOR BORING 80.0 %
19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
33.0	.0					33.0	
		▨	SAND, Fine to medium grains, quartz, light reddish tan brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	80	1	Used 5 Foot Split Spoon.	SETTLE SETTLE 3 5 7
28.0	5.0					28.0	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 17.3'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

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MAR 71

PROJECT Kissimmee River Restoration-Section 1135

HOLE NUMBER CB-C37-S4

Hole No.CB-C36-K1

DRILLING LOG
DIVISION South Atlantic
INSTALLATION Jacksonville District
SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station) X=385,629 Y=1343,156
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C36-K1
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER 48.6
16. DATE HOLE STARTED 8/04/92 COMPLETED 8/04/92
17. ELEVATION TOP OF HOLE 52.96 Ft.
18. TOTAL CORE RECOVERY FOR BORING 74 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
53.0	.0					53.0		0
51.3	1.7		SAND, fine-medium grain, quartz, tan, with black organic stain, little clay, trace roolets. (SC)	73	1	SPLIT SPOON 51.5	2 3 3	
49.3	3.7		CLAY, black, slightly damp, medium plasticity, little sand to occasionally in lens. (CL)	100	2	SPLIT SPOON 50.0	3 4 4	2.5
			PEAT, black, slightly damp, trace roots, trace sand, low plasticity (PT). (Natural Ground)	100	3	SPLIT SPOON 48.5	4 5 5	
				100	4	SPLIT SPOON 47.0	1 2 2	5
			Sand lens (SP) with piece of bone.	67	5	SPLIT SPOON 45.5	1 1 1	7.5
			Area of some roots damp to moist below 8.0'.	100	6	SPLIT SPOON 44.0	W.O.H. W.O.H. 1	
43.3	9.7			100	7	SPLIT SPOON 42.5	W.O.H. W.O.H. 2	10
41.0	12.0		CLAY, dark gray, damp, soft, trace sand (quartz). (CH)	100	8	SPLIT SPOON 41.0	1 3 2	
39.5	13.5		below depth 12.0, gray, trace-little sand, trace decomposing shell fragments, soft. (CH)	100	9	SPLIT SPOON 39.5	3 5 13	12.5
			SAND, fine-medium grain, quartz, wet, gray. Trace clay. (SP)	60	10	SPLIT SPOON 38.0	WASH 7 25	15
36.5	16.5			33	11	SPLIT SPOON 36.5	4 7 13	
35.0	18.0		SAND, fine-medium grain, quartz, gray, little to some clay, wet. (SC)	80	12	SPLIT SPOON 35.0	13 12 14	17.5
				0	13	33.5	WASHED WASHED WASHED	
				0	14	32.0	WASHED WASHED WASHED	20
30.5	22.5			0	15	30.5	WASHED WASHED WASHED	22.5

(continued)

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MAR 71

PROJECT KISSIMMEE UPPER BASIN
HOLE NUMBER CB-C36-K1

Hole No.CB-C36-K1

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 52.96 Ft.

SHEET 2 OF 2

PROJECT KISSIMMEE UPPER BASIN

INSTALLATION Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
30.5	22.5					30.5	
		░	SAND, fine-medium grain, quartz, gray trace clay in lens/nodules. (SP)	100	16	SPLIT SPOON	12 15 17
29.0	24.0					29.0	
		░	SAND, fine-medium grain, quartz. (SP)	100	17	SPLIT SPOON	2 5 9
28.1	24.9						
		▨	SAND, fine-medium grain, quartz, gray, little-some clay. (SC)			27.5	
				80	18	SPLIT SPOON	7 11 13
						26.0	
				100	19	SPLIT SPOON	5 4 9
						24.5	
				80	20	SPLIT SPOON	4 6 15
23.0	30.0					23.0	

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

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PROJECT KISSIMMEE UPPER BASIN

HOLE NUMBER CB-C36-K1

Hole No.CB-C36-K2

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District — SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN	10. SIZE AND TYPE OF BIT Vibracore
2. LOCATION *(Coordinates or Station)* X=386,367 Y=1344,099	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. *(As shown on drawing title and file number)* CB-C36-K2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
5. NAME OF DRILLER R. Gordon	14. TOTAL NUMBER OF CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER 47.79
	16. DATE HOLE STARTED 8/05/92 COMPLETED 8/05/92
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 53.99 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 73 %
9. TOTAL DEPTH OF HOLE 30 Ft.	19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
54.0	.0					54.0		
			SAND, fine-medium grain, quartz, tan-light brown, trace rootlets, slightly damp, little clay. (SC)	73	1	SPLIT SPOON 52.5	2 3 4	0
				100	2	SPLIT SPOON 51.0	3 4 6	2.5
49.6	4.4		Color change to light green.	100	3	SPLIT SPOON 49.5	3 3 3	
			PEAT, black, trace roots, trace sand, damp to moist, very soft. (PT). (Natural Ground)	100	4	SPLIT SPOON 48.0	1 1 1	5
46.6	7.4			67	5	SPLIT SPOON 46.5	W.O.H. 1 1	7.5
45.0	9.0		CLAY, gray, soft, damp, little sand, Fat, trace rootlets. (CH)	100	6	SPLIT SPOON 45.0	W.O.H. 3 3	
			SAND, fine-medium grain, quartz, gray, wet, little clay (clay occasionally in lens). (SC)	100	7	SPLIT SPOON 43.5	8 6 7	10
				100	8	SPLIT SPOON 42.0	8 15 17	
			Below depth 12.0, gray with yellow brown mottling	100	9	SPLIT SPOON 40.5	13 12 13	12.5
39.0	15.0			60	10	SPLIT SPOON 39.0	11 11 18	15
37.5	16.5		SAND, fine-medium grain, quartz, wet, gray, trace clay. (SP)	33	11	SPLIT SPOON 37.5	4 7 7	
			SAND, fine-medium grain, quartz, wet, gray, little to some clay. (SC)	80	12	SPLIT SPOON 36.0	8 9 10	17.5
				67	13	34.5	5 5 9	
33.0	21.0			60	14	33.0	8 9 4	20
31.5	22.5			0	15	31.5	WASH	22.5

(continued)

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MAR 71

PROJECT KISSIMMEE UPPER BASIN	HOLE NUMBER CB-C36-K2

Hole No.CB-C36-K2

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 53.99 Ft.	SHEET 2 OF 2
PROJECT KISSIMMEE UPPER BASIN	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
31.5	22.5					31.5	
		░	SAND, fine-medium grain, quartz, gray, wet. (SP)	100	16	SPLIT SPOON 30.0	1 2 5
29.4	24.6	░		100	17	SPLIT SPOON 28.5	4 1 3
28.5	25.5	░▨	SAND, fine-medium grain, quartz, gray, wet little clay. (SC)				
		▨	CLAY, brown, firm to stiff, wet, little sand. (CH)	80	18	SPLIT SPOON 27.0	3 4 6
		▨	Sand lenses (SP)	100	19	SPLIT SPOON 25.5	4 8 10
24.0	30.0	▨		80	20	SPLIT SPOON 24.0	6 10 15

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

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PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C36-K2

Hole No.CB-C36-K3

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station) X=387,579 Y=1345,597
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C36-K3
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER 50.7
16. DATE HOLE STARTED 8/05/92 COMPLETED 8/06/92
17. ELEVATION TOP OF HOLE 55.50 Ft.
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
55.5	.0					55.5		
			SAND, fine-medium grain, quartz, slightly damp, tan to light brown, little clay, little roots. (SC)	93	1	SPLIT SPOON 54.0	2 3 2	0
			occasional yellow-brown mottling	80	2	SPLIT SPOON 52.5	2 4 6	2.5
				100	3	SPLIT SPOON 51.0	3 6 8	
				80	4	SPLIT SPOON 49.5	6 5 2	5
49.1	6.4		CLAY, gray, firm, little sand, fat. (CH)	87	5	SPLIT SPOON 48.0	1 2 3	7.5
				100	6	SPLIT SPOON 46.5	2 4 5	
				100	7	SPLIT SPOON 45.0	7 7 13	10
44.2	11.3		SAND, fine-medium grain, grey, quartz, wet, little to some clay (SC)	100	8	SPLIT SPOON 43.5	12 11 11	
				100	9	SPLIT SPOON 42.0	7 10 14	12.5
				87	10	SPLIT SPOON 40.5	11 11 11	15
				80	11	SPLIT SPOON 39.0	12 11 12	
				60	12	SPLIT SPOON 37.5	13 13 14	17.5
				100	13	SPLIT SPOON 36.0	6 8 10	
				100	14	SPLIT SPOON 34.5	11 10 10	20
33.0	22.5			87	15	SPLIT SPOON 33.0 (continued)	6 13 18	22.5

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PROJECT KISSIMMEE UPPER BASIN

HOLE NUMBER CB-C36-K3

Hole No.CB-C36-K3

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 55.50 Ft.		SHEET 2 OF 2
PROJECT KISSIMMEE UPPER BASIN	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
33.0	22.5					33.0	
31.5	24.0		CLAY, dark gray, soft to firm, little sand. (CH)	47	16	SPLIT SPOON 31.5	5 6 10
			SAND, fine-medium grain, quartz, wet, little clay. (SC)	80	17	SPLIT SPOON 30.0	6 8 8
				100	18	SPLIT SPOON 28.5	6 9 10
27.4	28.1			100	19	SPLIT SPOON 27.0	4 8 15
25.5	30.0		CLAY, dark gray, fat, soft to firm, little sand. (CH)	100	20	SPLIT SPOON 25.5	8 15 27

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

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PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C36-K3

Hole No.CB-C36-K4

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION *(Coordinates or Station)* X=388,525 Y=1347,456
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C36-K4
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER 47.53
16. DATE HOLE STARTED 8/06/92 COMPLETED 8/07/92
17. ELEVATION TOP OF HOLE 56.03 Ft.
18. TOTAL CORE RECOVERY FOR BORING 79 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
56.0	.0					56.0		
			SAND, fine-medium grain, quartz, tan, trace clay. (SP)	67	1	SPLIT SPOON 54.5	5 10 12	0
				87	2	SPLIT SPOON 53.0	5 10 13	2.5
52.0 51.5	4.0 4.5		Peat, black, slightly damp, some sand. (PT)	60	3	SPLIT SPOON 51.5	4 6 8	
			CLAY, gray, damp, fat, soft, with little sand. (CH)	60	4	SPLIT SPOON 50.0	1 2 2	5
				67	5	SPLIT SPOON 48.5	1 1 2	7.5
				80	6	SPLIT SPOON 47.0	4 6 6	
				100	7	SPLIT SPOON 45.5	5 12 12	10
44.5	11.5			100	8	SPLIT SPOON 44.0	9 12 15	
			SAND, fine to medium grain, quartz, wet, gray to green, little clay (occasionally in lenses) (SC)	73	9	SPLIT SPOON 42.5	9 12 16	12.5
				80	10	SPLIT SPOON 41.0	8 8 8	15
				80	11	SPLIT SPOON 39.5	5 6 9	
				67	12	SPLIT SPOON 38.0	5 9 10	17.5
				67	13	SPLIT SPOON 36.5	7 8 11	
35.0	21.0			80	14	SPLIT SPOON 35.0	5 5 9	20
34.5 33.5	21.5 22.5		Clay layer (CH) from 21.0' - 21.5'.	93	15	SPLIT SPOON 33.5 (continued)	9 10 15	22.5

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MAR 71

PROJECT KISSIMMEE UPPER BASIN

HOLE NUMBER CB-C36-K4

Hole No.CB-C36-K4

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 56.03 Ft.	SHEET 2 OF 2
PROJECT KISSIMMEE UPPER BASIN	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
33.5	22.5					33.5	
33.1	22.9	▨	Sand layer (SP) from 22.5' - 22.9'. Below Depth 24.0, dark gray to grey	100	16	SPLIT SPOON 32.0	9 22 35
30.5	25.5	▨		87	17	SPLIT SPOON 30.5	6 13 11
			SAND, fine-medium grain, quartz, gray, trace clay. (SP)	73	18	SPLIT SPOON 29.0	5 10 11
				73	19	SPLIT SPOON 27.5	4 7 9
26.0	30.0		Fragments of sandy limestone up to 1/4 inch.	80	20	SPLIT SPOON 26.0	5 10 10
			Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

-22.5
-25
-27.5
-30
-32.5
-35
-37.5
-40
-42.5
-45
-47.5
-50

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PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C36-K4

Hole No.CB-C36-K5

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station) X=388,826 Y=1348,349
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C36-K5
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 2
15. ELEVATION GROUND WATER 47.81
16. DATE HOLE STARTED 8/10/92 COMPLETED 8/10/92
17. ELEVATION TOP OF HOLE 56.11 Ft.
18. TOTAL CORE RECOVERY FOR BORING 87.3 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
56.1	.0					56.1		0
			SAND, fine-medium grain, quartz, white-tan with dark gray clayey layers, slightly damp, with little clay. (SC)	87	1	SPLIT SPOON 54.6	2 3 4	
				87	2	SPLIT SPOON 53.1	4 5 7	2.5
				80	3	SPLIT SPOON 51.6	6 5 4	
51.4 50.8 49.8	4.7 5.3 6.3		PEAT, black, damp, little sand. (PT) Natural Ground SAND, fine-medium grain, quartz, gray damp-wet. (SP) CLAY, gray, wet, soft, little sand, fat. (CH)	93	4	SPLIT SPOON 50.1	3 4 4	5
				73	5	SPLIT SPOON 48.6	1 2 4	7.5
				93	6	SPLIT SPOON 47.1	6 5 6	
				93	7	SPLIT SPOON 45.6	5 7 11	10
45.6	10.5		SAND, fine-medium grain, quartz, gray, yellow brown mottling, trace shell fragments, little clay. (SC)	100	8	SPLIT SPOON 44.1	8 8 14	
				87	9	SPLIT SPOON 42.6	11 12 12	12.5
				87	10	SPLIT SPOON 41.1	10 10 14	15
				67	11	SPLIT SPOON 39.6	7 11 14	
39.6	16.5		SAND, fine-medium grain, quartz, gray with yellow-brown mottling, wet, trace clay. (SP)	67	12	SPLIT SPOON 38.1	5 7 8	17.5
				53	13	SPLIT SPOON 36.6	3 3 7	
36.6	19.5		SAND, fine-medium grain, quartz, gray, little clay. (SC)	93	14	SPLIT SPOON 35.1	8 7 8	20
35.1	21.0		CLAY, green, firm-stiff, dry, little sand, medium plasticity. (CH)	100	15	SPLIT SPOON 33.6	4 7 11	22.5

(continued)

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT KISSIMMEE UPPER BASIN

HOLE NUMBER CB-C36-K5

Hole No.CB-C36-K5

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 56.11 Ft.	SHEET 2 OF 2
PROJECT KISSIMMEE UPPER BASIN	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
33.6	22.5					33.6	
32.4	23.7	▨		100	16	SPLIT SPOON	6 10
32.1	24.0	▨	SILT, black. (OH)			32.1	10
31.5	24.6	▨	CLAY, gray, dry, medium plasticity, little sand. (CH)	100	17	SPLIT SPOON	4 6
31.2	24.9	▨	SILT, black, (OH) little sand.			30.6	8
31.0	25.1	▨	Clay (CH)				
29.1	27.0	▨	SILT, black, little sand, dry. (OH)	93	18	SPLIT SPOON 29.1	2 15 9
27.8	28.3	▒	SAND, fine-medium grain, quartz, trace silt, little clay, gray. (SC)	100	19	SPLIT SPOON 27.6	20 18 5
27.0	29.1	▨	CLAY, green, dry, stiff. (CH)				
26.1	30.0	▒	SAND, fine-medium grain, quartz, gray-green, little clay. (SC)	93	20	SPLIT SPOON 26.1	7 13 17

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5
25
27.5
30
32.5
35
37.5
40
42.5
45
47.5
50

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C36-K5

Hole No.CB-C36-K6

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station) X=389,458 Y=1350,219
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C36-K6
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER 49.31
16. DATE HOLE STARTED 8/11/92 COMPLETED 8/11/92
17. ELEVATION TOP OF HOLE 56.01 Ft.
18. TOTAL CORE RECOVERY FOR BORING 78 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
56.0	.0			..		56.0		
			SAND, fine-medium grain, quartz, tan, trace clay and roots upper foot (SP)	100	1	SPLIT SPOON 54.5	3 5 7	0
				93	2	SPLIT SPOON 53.0	5 7 11	2.5
51.5	4.5			100	3	SPLIT SPOON 51.5	4 4 3	
50.6	5.4		PEAT, black, dry, little sand, trace clay. (PT) Natural Ground CLAY, gray, soft to stiff, wet, little sand, (CH)	73	4	SPLIT SPOON 50.0	1 2 1	5
				67	5	SPLIT SPOON 48.5	1 2 3	7.5
				100	6	SPLIT SPOON 47.0	4 6 10	
				100	7	SPLIT SPOON 45.5	9 7 11	10
			Some sand below 12.0	100	8	SPLIT SPOON 44.0	10 10 17	
43.0	13.0		SAND, fine-medium grain, quartz, gray with yellow-brown mottling, trace clay. (SP)	0	9	SPLIT SPOON 42.5	10 13 13	12.5
				73	10	SPLIT SPOON 41.0	10 10 16	15
				80	11	SPLIT SPOON 39.5	8 13 21	
38.8	17.2		CLAY, green, firm to stiff, trace-little sand, fat, trace peat. (CH)	73	12	SPLIT SPOON 38.0	5 10 17	17.5
				87	13	SPLIT SPOON 36.5	10 14 18	
				73	14	SPLIT SPOON 35.0	8 4 11	20
				100	15	SPLIT SPOON 33.5	6 9 16	22.5

(continued)

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT KISSIMMEE UPPER BASIN

HOLE NUMBER CB-C36-K6

Hole No.CB-C36-K6

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.01 Ft.

SHEET 2 OF 2

PROJECT KISSIMMEE UPPER BASIN

INSTALLATION Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.5	22.5					33.5	
33.0	23.0						
		▨	SAND, fine-medium grain, quartz, green with little clay. (SC)	73	16	SPLIT SPOON 32.0	8 12 20
				100	17	SPLIT SPOON 30.5	6 9 9
				87	18	SPLIT SPOON 29.0	3 6 10
				87	19	SPLIT SPOON 27.5	5 9 12
26.0	30.0			97	20	SPLIT SPOON 26.0	7 15 16
			Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

-22.5 -25 -27.5 -30 -32.5 -35 -37.5 -40 -42.5 -45 -47.5 -50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT KISSIMMEE UPPER BASIN

HOLE NUMBER CB-C36-K6

Hole No.CB-C36-K7

DRILLING LOG | DIVISION South Atlantic | INSTALLATION Jacksonville District | SHEET 1 OF 2

1. PROJECT
KISSIMMEE UPPER BASIN

2. LOCATION *(Coordinates or Station)*
X=390,105 Y=1352,090

3. DRILLING AGENCY
Corps of Engineers

4. HOLE NO. *(As shown on drawing title and file number)* CB-C36-K7

5. NAME OF DRILLER
R. Gordon

6. DIRECTION OF HOLE
☒ VERTICAL ☐ INCLINED

7. THICKNESS OF BURDEN 0 Ft.

8. DEPTH DRILLED INTO ROCK 0 Ft.

9. TOTAL DEPTH OF HOLE 30 Ft.

10. SIZE AND TYPE OF BIT Vibracore

11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*
NGVD

12. MANUFACTURER'S DESIGNATION OF DRILL
Failing 1500

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN
disturbed: 0 undisturbed: 0

14. TOTAL NUMBER OF CORE BOXES 1

15. ELEVATION GROUND WATER 51.23

16. DATE HOLE STARTED 8/12/92 COMPLETED 8/12/92

17. ELEVATION TOP OF HOLE 56.13 Ft.

18. TOTAL CORE RECOVERY FOR BORING 82 %

19. SIGNATURE OF GEOLOGIST
M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
56.1	.0					56.1		0
			SAND, fine-medium grain, quartz, tan to white, trace clay rootlets upper foot. (SP)	93	1	SPLIT SPOON 54.6	1 3 5	
			Damp to moist.	100	2	SPLIT SPOON 53.1	5 7 8	2.5
51.6	4.5		Little peat last .8'.	80	3	SPLIT SPOON 51.6	6 7 9	
49.8	6.3		PEAT, black, little sand, wet. (PT) Natural Ground	100	4	SPLIT SPOON 50.1	1 1 5	5
			SAND, fine-medium grain, quartz, tan (occasionally layers of CH or SC material). (SP) (CH) clay layer 6.6 - 6.9 with little sand	80	5	SPLIT SPOON 48.6	1 1 2	7.5
			(CH) clay layer 8.2 - 8.8 with little sand	100	6	SPLIT SPOON 47.1	3 7 10	
			(CH) clay layer 9.6 - 9.9 with little sand	100	7	SPLIT SPOON 45.6	7 7 12	10
44.1	12.0			47	8	SPLIT SPOON 44.1	11 6 13	
			SAND, fine-medium grain, quartz, gray to brown, wet, little clay. (SC)	80	9	SPLIT SPOON 42.6	17 19 21	12.5
			(SP) sand layer 13.7 - 13.9 (SP) sand layer 14.2 - 14.4 (CH) clay layer 15.0 - 15.4 with little sand	67	10	SPLIT SPOON 41.1	17 19 17	
				93	11	SPLIT SPOON 39.6	12 13 17	15
37.7	18.4			73	12	SPLIT SPOON 38.1	7 9 11	17.5
36.6	19.5		SAND, fine-medium grain, quartz, brown, wet, trace clay. (SP)	80	13	SPLIT SPOON 36.6	17 17 19	
			SAND, fine-medium grain, quartz, gray-brown, little clay. (SC)	80	14	SPLIT SPOON 35.1	9 13 15	20
				80	15	SPLIT SPOON 33.6	7 11 13	22.5

(continued)

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT KISSIMMEE UPPER BASIN | HOLE NUMBER CB-C36-K7

Hole No.CB-C36-K7

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 56.13 Ft.	SHEET 2 OF 2
PROJECT KISSIMMEE UPPER BASIN	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
33.6	22.5					33.6	
		▨		73	16	SPLIT SPOON 32.1	8 11 11
		▨		80	17	SPLIT SPOON 30.6	12 16 18
		▨		80	18	SPLIT SPOON 29.1	11 14 16
		▨		73	19	SPLIT SPOON 27.6	6 12 18
26.1	30.0	▨		87	20	SPLIT SPOON 26.1	10 14 20
			Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C36-K7

Hole No.CB-C36-K8

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2

1. PROJECT
KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station)
X=390,406 Y=1353,019
3. DRILLING AGENCY
Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C36-K8
5. NAME OF DRILLER
R. Gordon
6. DIRECTION OF HOLE
☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL
Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN
disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 2
15. ELEVATION GROUND WATER 50.76
16. DATE HOLE STARTED 8/12/92 COMPLETED 8/13/92
17. ELEVATION TOP OF HOLE 56.76 Ft.
18. TOTAL CORE RECOVERY FOR BORING 79 %
19. SIGNATURE OF GEOLOGIST
M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
56.8	.0					56.8		
			SAND, fine-medium grain, quartz, tan to white, trace clay, trace roots. (SP)	80	1	SPLIT SPOON 55.3	2 2 3	0
54.9 54.7 54.4 54.3 53.8	1.9 2.1 2.4 2.5 3.0		(CH) Clay layer 1.9' - 2.1'. (CH) Clay layer 2.4' - 2.5'.	80	2	SPLIT SPOON 53.8	2 3 5	2.5
			SAND, fine-medium grain, quartz, tan with black-brown and orange mottling, little clay. (SC)	100	3	SPLIT SPOON 52.3	2 3 4	
51.9 50.5	4.9 6.3		PEAT, black, wet, trace roots. (PT) Natural Ground	100	4	SPLIT SPOON 50.8	2 1 1	5
50.0	6.8		Sand, fine-medium grain, quartz, wet. (SP) CLAY, gray, soft, trace to little sand. (CH)	100	5	SPLIT SPOON 49.3	2 2 1	7.5
				73	6	SPLIT SPOON 47.8	1 2 2	
47.3	9.5		SAND, fine-medium grain, quartz, wet, tan. (SP)	100	7	SPLIT SPOON 46.3	5 5 7	10
44.8	12.0			100	8	SPLIT SPOON 44.8	6 3 6	
			SAND, fine-medium grain, quartz, gray, wet, little clay. (SC)	67	9	SPLIT SPOON 43.3	2 21 30	12.5
				67	10	SPLIT SPOON 41.8	14 15 15	15
				100	11	SPLIT SPOON 40.3	14 14 13	
				73	12	SPLIT SPOON 38.8	8 14 14	17.5
37.5	19.3			87	13	SPLIT SPOON 37.3	10 9 13	
			SAND, fine-medium grain, quartz, wet, gray, trace clay. (SP)	73	14	SPLIT SPOON 35.8	2 6 15	20
				27	15	SPLIT SPOON 34.3 (continued)	7 13 13	22.5

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C36-K8

Hole No.CB-C36-K8

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.76 Ft.

SHEET 2 OF 2

PROJECT KISSIMMEE UPPER BASIN

INSTALLATION Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
34.3	22.5					34.3	
		░		27	16	SPLIT SPOON	3 4 8
32.8	24.0					32.8	
		░	SAND, fine-medium grain, quartz, gray, wet, trace clay. (SP) Color change from gray-brown to gray-green.	60	17	SPLIT SPOON	3 6 8
						31.3	
		░		73	18	SPLIT SPOON	5 6 10
30.2	26.6					29.8	
		▨	SAND, fine-medium grain, quartz, gray-brown, little-some clay. (SC) (Bottom is green.)	100	19	SPLIT SPOON	13 17 19
						28.3	
		▨		87	20	SPLIT SPOON	7 9 12
26.8	30.0					26.8	

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5
25
27.5
30
32.5
35
37.5
40
42.5
45
47.5
50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT KISSIMMEE UPPER BASIN

HOLE NUMBER CB-C36-K8

Hole No.CB-C36-K9

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION *(Coordinates or Station)* X=390,846 Y=1354,307
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C36-K9
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER 50.85
16. DATE HOLE STARTED 8/13/92 COMPLETED 8/13/92
17. ELEVATION TOP OF HOLE 55.65 Ft.
18. TOTAL CORE RECOVERY FOR BORING 73 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
55.7	.0					*55.7*	
			SAND, fine-medium grain, quartz, with trace clay, also trace rootlets. (SP)	100	1	SPLIT SPOON *54.2*	1 3 3
			(CH) Clay layer 1.9' – 2.1'.	80	2	SPLIT SPOON *52.7*	2 3 14
			(CH) Clay layer 3.1' – 3.2'. Peat layer 3.7' – 3.8'.	100	3	SPLIT SPOON *51.2*	6 5 5
50.3	5.3		PEAT, black, wet, trace rootlets, trace to little sand. (PT)	80	4	SPLIT SPOON *49.7*	3 1
49.5	6.2		SAND, fine-medium grain, quartz, gray with brown, wet, trace peat. (SP)	93	5	SPLIT SPOON *48.2*	W.O.H. 10 7
47.5	8.1		CLAY, gray, soft-firm, little-some sand. (CH)	87	6	SPLIT SPOON *46.7*	1 1 6
				93	7	SPLIT SPOON *45.2*	4 10 13
				0	8	SPLIT SPOON *43.7*	2 2 6
42.7	12.9		SAND, fine-medium grain, quartz, gray, with little clay. (SC)	73	9	SPLIT SPOON *42.2*	6 8 15
				100	10	SPLIT SPOON *40.7*	18 18 17
40.7	15.0		SAND, fine-medium grain, quartz, tan. (SP) with trace clay.	67	11	SPLIT SPOON *39.2*	7 9 17
38.8	16.8		SAND, fine-medium grain, quartz, brown with little clay firm. (SC)	60	12	SPLIT SPOON *37.7*	4 10 11
				47	13	SPLIT SPOON *36.2*	WASH 8 14
				60	14	SPLIT SPOON *34.7*	6 6 12
34.7	21.0		SAND, fine-medium grain, quartz, gray, trace clay, wet. (SP)	60	15	SPLIT SPOON *33.2*	3 8 7
33.2	22.5					*(continued)*	

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MAR 71

PROJECT KISSIMMEE UPPER BASIN

HOLE NUMBER CB-C36-K9

Hole No.CB-C36-K9

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 55.65 Ft.	SHEET 2 OF 2
PROJECT KISSIMMEE UPPER BASIN	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
33.2	22.5					33.2	
		▨	SAND, fine-medium, grain, quartz, gray-green, little clay (soft-firm). (SC)	87	16	SPLIT SPOON 31.6	7 6 8
30.1	25.5	▨		47	17	SPLIT SPOON 30.1	2 7 12
		░	SAND, fine-medium grain, quartz, wet, gray, trace clay. (SP)	80	18	SPLIT SPOON 28.6	3 5 7
		░		73	19	SPLIT SPOON 27.1	3 4 11
25.6	30.0	░		80	20	SPLIT SPOON 25.6	5 7 16
			Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C36-K9

Hole No.CB-C37-K1

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION *(Coordinates or Station)* X=387,750 Y=1319,059
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C37-K1
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 36 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER 51.53
16. DATE HOLE STARTED 9/01/92 COMPLETED 9/01/92
17. ELEVATION TOP OF HOLE 55.43 Ft.
18. TOTAL CORE RECOVERY FOR BORING 73 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
55.4	.0					55.4		0
		░	SAND, fine-medium grain, quartz, tan, damp, trace clay, trace roots. (SP)	73	1	SPLIT SPOON 53.9	1 2 4	
				87	2	SPLIT SPOON 52.4	4 5 8	2.5
52.4	3.0	░	Color change to brown. Wet.	73	3	SPLIT SPOON 50.9	4 4 8	
				67	4	SPLIT SPOON 49.4	4 3 1	5
			Sand with peat from 6.3' to 6.5'.	93	5	SPLIT SPOON 47.9	3 5 7	7.5
				53	6	SPLIT SPOON 46.4	2 1 2	
45.9	9.5	▨	CLAY, gray, damp, soft, fat, trace to little sand. (CH)	100	7	SPLIT SPOON 44.9	1 1 2	10
				87	8	SPLIT SPOON 43.4	2 3 6	
43.4	12.0	░	SAND, fine-medium grain, quartz, moist-slightly-wet, gray, trace clay. (SP)	80	9	SPLIT SPOON 41.9	10 17 28	12.5
				73	10	SPLIT SPOON 40.4	9 14 13	
40.4	15.0	▨	SAND, fine-medium grain, quartz, wet, little clay, gray. (SC)	87	11	SPLIT SPOON 38.9	5 4 6	15
				73	12	SPLIT SPOON 37.4	4 7 10	17.5
				73	13	SPLIT SPOON 35.9	3 7 11	
				73	14	SPLIT SPOON 34.4	3 8 8	20
34.2	21.2	░	SAND, fine-medium grain, quartz, wet, tan, slightly-calcareous. (SP)	73	15	SPLIT SPOON 32.9	1 1 7	22.5
						(continued)		

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PROJECT KISSIMMEE UPPER BASIN

HOLE NUMBER CB-C37-K1

Hole No.CB-C37-K1

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 55.43 Ft.	SHEET 2 OF 2
PROJECT KISSIMMEE UPPER BASIN	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
32.9	22.5					32.9	
		░		47	16	SPLIT SPOON 31.4	3 7 8
		░		80	17	SPLIT SPOON 29.9	2 6 8
		░		67	18	SPLIT SPOON 28.4	2 4 5
		░		53	19	SPLIT SPOON 26.9	1 1 1
		░		40	20	SPLIT SPOON 25.4	2 4 6
		░		67	21	SPLIT SPOON 23.9	WASHED WASHED WASHED
		░		47	22	SPLIT SPOON 22.4	WASHED WASHED WASHED
		░		80	23	SPLIT SPOON 20.9	4 4 6
		░		93	24	SPLIT SPOON 19.4	4 3
19.4	36.0		Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

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MAR 71

PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C37-K1

Hole No.CB-C37-K2

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION *(Coordinates or Station)* X=385,725 Y=1320,456
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C37-K2
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 36 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER 50.01
16. DATE HOLE STARTED 8/31/92 COMPLETED 8/31/92
17. ELEVATION TOP OF HOLE 56.01 Ft.
18. TOTAL CORE RECOVERY FOR BORING 80 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
56.0	.0					*56.0*		0
			SAND, fine-medium grain, quartz, tan, damp, trace clay, tan, trace roots. (SP)	87	1	SPLIT SPOON *54.5*	2 3 2	
				87	2	SPLIT SPOON *53.0*	3 5 6	2.5
53.0	3.0		Color change to brown. Moist to slightly wet.	100	3	SPLIT SPOON *51.5*	4 5 5	
				80	4	SPLIT SPOON *50.0*	3 3 2	5
49.8	6.2		PEAT, black, damp, trace to little clay, (PT)	87	5	SPLIT SPOON *48.5*	1 1 1	7.5
				100	6	SPLIT SPOON *47.0*	1 1 1	
47.0	9.0		CLAY, gray, wet, soft, little sand. (CH)	80	7	SPLIT SPOON *45.5*	1 2 4	10
				100	8	SPLIT SPOON *44.0*	4 6 5	
44.0	12.0		SAND, fine-medium grain, quartz, brown, wet (SP), trace clay.	60	9	SPLIT SPOON *42.5*	13 14 23	12.5
				73	10	SPLIT SPOON *41.0*	8 14 11	15
41.0	15.0		Slightly calcareous, trace coarse grain sand (quartz).	87	11	SPLIT SPOON *39.5*	4 4 2	
				67	12	SPLIT SPOON *38.0*	1	17.5
				73	13	SPLIT SPOON *36.5*	2 3 5	
				73	14	SPLIT SPOON *35.0*	3 3 5	20
				47	15	SPLIT SPOON *33.5*	4 9 26	22.5

(continued)

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MAR 71

PROJECT KISSIMMEE UPPER BASIN

HOLE NUMBER CB-C37-K2

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.01 Ft.

SHEET 2 OF 2

PROJECT KISSIMMEE UPPER BASIN

INSTALLATION Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
33.5	22.5					33.5	
32.0	24.0	░		47	16	SPLIT SPOON 32.0	5 10 12
		░	SAND, fine-medium grain, quartz, wet, brown, trace coarse grain sand (quartz), trace clay. (SP)	67	17	SPLIT SPOON 30.5	3 8 12
		░		67	18	SPLIT SPOON 29.0	5 11 28
		░		100	19	SPLIT SPOON 27.5	WASH 20 20
26.0	30.0	░		100	20	SPLIT SPOON 26.0	3 8 20
		▨	SAND, fine-medium grain, quartz, wet, brown with little to some clay (SC)	80	21	SPLIT SPOON 24.5	2 5 4
23.0	33.0	▨		87	22	SPLIT SPOON 23.0	1 9 13
21.5	34.5	▨	Trace weathered sandstone fragments below 33.0', little clay.	73	23	SPLIT SPOON 21.5	5 6 13
20.0	36.0	▨	Trace-little clay below 34.5.	100	24	SPLIT SPOON 20.0	9 7 13
			Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

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PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C37-K2

Hole No.CB-C37-K3

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station) X=383,665 Y=1321,846
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C37-K3
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 36 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 2
15. ELEVATION GROUND WATER 51.58
16. DATE HOLE STARTED 8/28/92 COMPLETED 8/28/92
17. ELEVATION TOP OF HOLE 56.58 Ft.
18. TOTAL CORE RECOVERY FOR BORING 65 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
56.6	.0					56.6	
			SAND, fine-medium grain, quartz, tan, trace roots, (SP)	80	1	SPLIT SPOON 55.1	1 1 3
				80	2	SPLIT SPOON 53.6	1 2 4
				87	3	SPLIT SPOON 52.1	3 4 5
				87	4	SPLIT SPOON 50.6	3 2 2
50.1	6.5		Color change to brown.	67	5	SPLIT SPOON 49.1	1 1 1
				100	6	SPLIT SPOON 47.6	1 2 1
48.3	8.3		PEAT, black, damp, trace sand, little clay. (PT) NATURAL GROUND	73	7	SPLIT SPOON 46.1	W.O.H. W.O.H. 3
46.1	10.5		SAND, fine-medium grain, quartz, wet, brown, (SP)	67	8	SPLIT SPOON 44.6	5 8 14
				60	9	SPLIT SPOON 43.1	6 12 7
				60	10	SPLIT SPOON 41.6	5 8 10
				67	11	SPLIT SPOON 40.1	3 5 6
40.1	16.5		Trace clay below 16.5'	40	12	SPLIT SPOON 38.6	7 10 14
				73	13	SPLIT SPOON 37.1	5 7 13
				13	14	SPLIT SPOON 35.6	2 4 5
				87	15	SPLIT SPOON 34.1	3 6 9

(continued)

Hole No.CB-C37-K3

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 56.58 Ft.	SHEET 2 OF 2
PROJECT KISSIMMEE UPPER BASIN	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
34.1	22.5					34.1	
				80	16	SPLIT SPOON 32.6	1 1 5
				13	17	SPLIT SPOON 31.1	3 5 6
				93	18	SPLIT SPOON 29.6	4 4 5
				67	19	SPLIT SPOON 28.1	2 3 5
				7	20	SPLIT SPOON 26.6	4 9 14
				33	21	SPLIT SPOON 25.1	2 4 3
23.9	32.7			87	22	SPLIT SPOON 23.6	7 7 4
22.1	34.5		SAND, fine-medium grain, quartz, tan, wet, with little clay occasionally in layers up to 2" thick. (SC)	80	23	SPLIT SPOON 22.1	3 5 6
20.6	36.0		SAND, predominantly fine grain, quartz, tan, damp (SP).	67	24	SPLIT SPOON 20.6	3 4 12
			Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

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MAR 71

PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C37-K3

Hole No.CB-C37-K4

DRILLING LOG
DIVISION South Atlantic
INSTALLATION Jacksonville District
SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION *(Coordinates or Station)* X=381,662 Y=1323,258
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. *(As shown on drawing title and file number)* CB-C37-K4
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 36 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 2
15. ELEVATION GROUND WATER 53.31
16. DATE HOLE STARTED 8/26/92 COMPLETED 8/27/92
17. ELEVATION TOP OF HOLE 56.31 Ft.
18. TOTAL CORE RECOVERY FOR BORING 73 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
56.3	.0				*56.3*		0
		SAND, fine-medium grain, quartz, tan, slightly damp, trace roots upper .5'. (SP)	80	1	SPLIT SPOON *54.8*	3 5 6	
			87	2	SPLIT SPOON *53.3*	3 5 9	2.5
			67	3	SPLIT SPOON *51.8*	3 3 6	
			87	4	SPLIT SPOON *50.3*	3 5 7	5
			87	5	SPLIT SPOON *48.8*	3 7 3	
48.8	7.5	PEAT, black, damp, soft, trace to little sand. (PT) NATURAL GROUND	73	6	SPLIT SPOON *47.3*	1 1 3	7.5
			100	7	SPLIT SPOON *45.8*	1 1 1	10
45.2	11.1	SAND, fine-medium grain, quartz, wet, tan, trace coarse grain, trace of peat, (SP)	80	8	SPLIT SPOON *44.3*	W.O.H. W.O.H. 1	
			33	9	SPLIT SPOON *42.8*	1 2 1	12.5
			80	10	SPLIT SPOON *41.3*	1 2 23	15
			47	11	SPLIT SPOON *39.8*	3 13 24	
39.8	16.5	No PEAT below 16.5'.	93	12	SPLIT SPOON *38.3*	4 7 14	17.5
			100	13	SPLIT SPOON *36.8*	4 8 14	
			33	14	SPLIT SPOON *35.3*	4 15 14	20
34.4	21.9	Slightly calcareous below 21.9	100	15	SPLIT SPOON *33.8*	4 6 10	22.5

(continued)

Hole No.CB-C37-K4

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE	56.31 Ft.
SHEET 2 OF 2	
PROJECT	KISSIMMEE UPPER BASIN
INSTALLATION	Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
33.8	22.5					33.8	
				20	16	SPLIT SPOON 32.3	4 8 14
				67	17	SPLIT SPOON 30.8	5 7 9
				No Recovery	18	SPLIT SPOON 29.3	9 10 13
				100	19	SPLIT SPOON 27.8	4 5 5
				100	20	SPLIT SPOON 26.3	4 5 5
				100	21	SPLIT SPOON 24.8	6 5 5
				60	22	SPLIT SPOON 23.3	3 5 7
				80	23	SPLIT SPOON 21.8	6 6 9
				87	24	SPLIT SPOON 20.3	5 6 8
20.3	36.0		Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

-22.5 -25 -27.5 -30 -32.5 -35 -37.5 -40 -42.5 -45 -47.5 -50

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MAR 71

PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C37-K4

Hole No.CB-C37-K5

DRILLING LOG

DIVISION
South Atlantic

INSTALLATION
Jacksonville District

SHEET 1
OF 2

1. PROJECT
KISSIMMEE UPPER BASIN

2. LOCATION *(Coordinates or Station)*
X=379,708 Y=1324,767

3. DRILLING AGENCY
Corps of Engineers

4. HOLE NO. *(As shown on drawing title and file number)* CB-C37-K5

5. NAME OF DRILLER
R. Gordon

6. DIRECTION OF HOLE
☒ VERTICAL ☐ INCLINED

7. THICKNESS OF BURDEN 0 Ft.

8. DEPTH DRILLED INTO ROCK 0 Ft.

9. TOTAL DEPTH OF HOLE 36 Ft.

10. SIZE AND TYPE OF BIT Vibracore

11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*
NGVD

12. MANUFACTURER'S DESIGNATION OF DRILL
Failing 1500

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN
disturbed: 0 undisturbed: 0

14. TOTAL NUMBER OF CORE BOXES 1

15. ELEVATION GROUND WATER 49.78

16. DATE HOLE STARTED 8/23/92 COMPLETED 8/23/92

17. ELEVATION TOP OF HOLE 54.98 Ft.

18. TOTAL CORE RECOVERY FOR BORING 76 %

19. SIGNATURE OF GEOLOGIST
M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
55.0	.0					55.0		0
			SAND, fine-medium grain, quartz, brown, slightly damp, trace clay, trace to little roots. (SP)	67	1	SPLIT SPOON 53.5	3 4 6	
				93	2	SPLIT SPOON 52.0	7 7 7	2.5
				80	3	SPLIT SPOON 50.5	9 8 11	
				80	4	SPLIT SPOON 49.0	3 4 5	5
48.0	7.0		Sand (SP) with little trace peat in layers, 6.5' - 7.0'.	80	5	SPLIT SPOON 47.5	 1	
46.5	8.5		PEAT, black, moist, with trace clay. (PT) NATURAL GROUND	100	6	SPLIT SPOON 46.0	1 2 12	7.5
			SAND, fine-medium grain, quartz, wet, brown, trace silt, trace coarse to gravel size sand (quartz). (SP) (Peat layer at 8.9')	100	7	SPLIT SPOON 44.5	3 7 9	10
				100	8	SPLIT SPOON 43.0	5 5 7	
				100	9	SPLIT SPOON 41.5	8 8 8	12.5
				100	10	SPLIT SPOON 40.0	2 2 2	15
				87	11	SPLIT SPOON 38.5	3 4 9	
37.0	18.0			80	12	SPLIT SPOON 37.0	4 19 50	17.5
			Color change to reddish-brown	73	13	SPLIT SPOON 35.5	19 30 45	
				80	14	SPLIT SPOON 34.0	7 22 27	20
33.3	21.7		Color change to dark brown	100	15	SPLIT SPOON 32.5	7 16 19	22.5
						(continued)		

Hole No.CB-C37-K5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 54.98 Ft.

SHEET 2 OF 2

PROJECT KISSIMMEE UPPER BASIN

INSTALLATION Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
32.5	22.5					32.5	
31.0	24.0		Slightly calcareous, tan-light brown	47	16	SPLIT SPOON 31.0	3 12 17
				60	17	SPLIT SPOON 29.5	3 4 8
28.0	27.0		Slightly calcareous Tan below depth 27.0	No Recovery	18	SPLIT SPOON 28.0	3 4 8
26.5	28.5		Samples no longer calcareous below 28.5'	93	19	SPLIT SPOON 26.5	3 9 12
				47	20	SPLIT SPOON 25.0	7 6 10
23.5	31.5		predominantly fine grain below 31.5'	73	21	SPLIT SPOON 23.5	W.O.H. 7 6
				47	22	SPLIT SPOON 22.0	4 8 12
				40	23	SPLIT SPOON 20.5	7 7 7
19.0	36.0			100	24	SPLIT SPOON 19.0	13 10 13
			Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

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PROJECT KISSIMMEE UPPER BASIN

HOLE NUMBER CB-C37-K5

Hole No.CB-C37-K6

DRILLING LOG
DIVISION South Atlantic
INSTALLATION Jacksonville District
SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station) X=379,166 Y=1325,211
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C37-K6
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 36 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER 51.17
16. DATE HOLE STARTED 8/20/92 COMPLETED 8/21/92
17. ELEVATION TOP OF HOLE 55.47 Ft.
18. TOTAL CORE RECOVERY FOR BORING 75 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER		REMARKS Bit or Barrel	BLOWS/ .5'	
55.5	.0					55.5			0
		░	SAND, fine-medium grain, quartz, lt. brown, trace clay and roots. (SP) Damp, color changing from dark brown to white.	73	1	54.0	SPLIT SPOON	3 2 3	
		░		80	2	52.5	SPLIT SPOON	2 3 5	2.5
		░	Color change to brown. Wet last .5'.	100	3	51.0	SPLIT SPOON	3 3 2	
50.6	4.9	▨	SAND, fine to medium grain, quartz, wet, little-some clay, soft-firm (SC).	67	4	49.5	SPLIT SPOON	3 3 4	5
49.0 48.5	6.5 7.0	▨ ░	Color change grey to brown below 6.5' SAND, fine-medium grain, quartz, brown, wet, trace clay. (SP)	87	5	48.0	SPLIT SPOON	1 1 7	7.5
47.4	8.1	▨	SAND, fine to medium grain, quartz, wet little-some clay, gray. (SC)	80	6	46.5	SPLIT SPOON	3 3 3	
46.5	9.0	░	SAND, fine to medium grain, quartz, brown, wet, trace clay. (SP)	100	7	45.0	SPLIT SPOON	1 1 2	10
		░	Trace coarse grain size sand (quartz) last 1.0'.	100	8	43.5	SPLIT SPOON	4 5 7	
		░		73	9	42.0	SPLIT SPOON	3 7 10	12.5
41.5	14.0	░	Color change to orange brown at 14.0'.	60	10	40.5	SPLIT SPOON	10 20 34	15
		░		60	11	39.0	SPLIT SPOON	4 7 10	
		░		60	12	37.5	SPLIT SPOON	3 10 12	17.5
37.5	18.0	░	Color change to tan.	73	13	36.0	SPLIT SPOON	13 17 14	
		░		53	14	34.5	SPLIT SPOON	6 9 13	20
		░		87	15	33.0	SPLIT SPOON	5 7 10	22.5

(continued)

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.
PROJECT KISSIMMEE UPPER BASIN
HOLE NUMBER CB-C37-K6

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 55.47 Ft.	SHEET 2 OF 2
PROJECT KISSIMMEE UPPER BASIN	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
33.0	22.5					33.0	
		░		87	16	SPLIT SPOON 31.5	4 7 14
		░		47	17	SPLIT SPOON 30.0	9 10 19
		░		100	18	SPLIT SPOON 28.5	5 12 14
		░		27	19	SPLIT SPOON 27.0	4 6 9
		░		73	20	SPLIT SPOON 25.5	5 10 15
		░		100	21	SPLIT SPOON 24.0	5 17 15
		░		67	22	SPLIT SPOON 22.5	4 10 WASH
		░		75	23	SPLIT SPOON 19.5	9 15 21 23
19.5	36.0		Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

22.5
25
27.5
30
32.5
35
37.5
40
42.5
45
47.5
50

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MAR 71

PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C37-K6

Hole No.CB-C37-K7

DRILLING LOG
DIVISION South Atlantic
INSTALLATION Jacksonville District
SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station) X=378,885 Y=1326,319
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C37-K7
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 2
15. ELEVATION GROUND WATER 49.01
16. DATE HOLE STARTED 8/19/92 COMPLETED 8/20/92
17. ELEVATION TOP OF HOLE 56.31 Ft.
18. TOTAL CORE RECOVERY FOR BORING 75 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
56.3	.0					56.3	
			SAND, fine-medium grain, quartz, brown, trace clay, trace roots. (SP)	80	1	SPLIT SPOON 54.8	2 3 2
			Damp.	87	2	SPLIT SPOON 53.3	3 3 4
53.1	3.2		Color change to tan.	100	3	SPLIT SPOON 51.8	4 4 3
				87	4	SPLIT SPOON 50.3	3 2 2
50.8	5.5		PEAT, black, wet, soft, trace to little clay, (PT) trace roots. (Natural Ground)	100	5	SPLIT SPOON 48.8	PUSH
				100	6	SPLIT SPOON 47.3	1 1
				100	7	SPLIT SPOON 45.8	PUSH 1
				100	8	SPLIT SPOON 44.3	PUSH
44.3	12.0		Little sand below depth 12.0'	67	9	SPLIT SPOON 42.8	W.O.H. W.O.H. W.O.H.
42.8	13.5		SAND, fine-medium grain, dark gray, quartz, wet. (SP)	53	10	SPLIT SPOON 41.3	5 4 4
				47	11	SPLIT SPOON 39.8	4 7 11
			Occasional thin PEAT layers from 16.8' - 19.0'.	67	12	SPLIT SPOON 38.3	1 1 9
			Trace coarse-gravel size sand (quartz) below 18.0'.	87	13	SPLIT SPOON 36.8	4 7 11
				33	14	SPLIT SPOON 35.3	14 12 9
				100	15	SPLIT SPOON 33.8 (continued)	4 10 19

Hole No.CB-C37-K7

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 56.31 Ft.	SHEET 2 OF 2
PROJECT KISSIMMEE UPPER BASIN	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
33.8	22.5					33.8	
				33	16	SPLIT SPOON 32.3	3 8 15
32.3	24.0		Tan below depth 24.0'				
				73	17	SPLIT SPOON 30.8	4 4 6
31.3	25.0		SAND, tan, fine-medium grain, trace coarse grain, wet, quartz, little clay, trace to little shell. (SC)	80	18	SPLIT SPOON 29.3	6 5 14
				73	19	SPLIT SPOON 27.8	10 10 12
				33	20	SPLIT SPOON 26.3	5 10 10
26.3	30.0						

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

-22.5
-25
-27.5
-30
-32.5
-35
-37.5
-40
-42.5
-45
-47.5
-50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
KISSIMMEE UPPER BASIN	CB-C37-K7

Hole No.CB-C37-K8

DRILLING LOG
DIVISION South Atlantic
INSTALLATION Jacksonville District
SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station) X=378,024 Y=1328,515
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C37-K8
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 1
15. ELEVATION GROUND WATER 53.50
16. DATE HOLE STARTED 8/18/92 COMPLETED 8/19/92
17. ELEVATION TOP OF HOLE 56.30 Ft.
18. TOTAL CORE RECOVERY FOR BORING 82 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'	
56.3	.0					56.3		0
			SAND, fine-medium grain, quartz, tan, with trace clay and trace roots. (SP)	100	1	SPLIT SPOON 54.8	1 2 3	
				87	2	SPLIT SPOON 53.3	2 3 3	2.5
			SAND, predominantly medium grain, moist to wet. (SP)	73	3	SPLIT SPOON 51.8	8 1 2	
51.5	4.8		PEAT, black, trace-little clay, soft. (PT) Natural Ground.	100	4	SPLIT SPOON 50.3	1 1 2	5
				87	5	SPLIT SPOON 48.8	1 2	
			7.7' - 8.0' - Some sand, (SP)	80	6	SPLIT SPOON 47.3	3 3 2	7.5
			Some clay, very soft.	80	7	SPLIT SPOON 45.8	1 1	10
45.8	10.5		CLAY, grey, wet, some silt. (CH)	100	8	SPLIT SPOON 44.3	W.O.H 1	
43.4	12.9		SAND, fine-medium grain, wet, quartz, tan-hard brown, trace clay. (SP)	100	9	SPLIT SPOON 42.8	W.O.H 11 15	12.5
				73	10	SPLIT SPOON 41.3	5 8 9	
				87	11	SPLIT SPOON 39.8	5 5 5	15
				80	12	SPLIT SPOON 38.3	2 3 5	17.5
38.3	18.0		At 18.0' grain size changes from fine-medium to medium-course grain.	80	13	SPLIT SPOON 36.8	2 2 5	
36.8	19.5		Color change to brown.	93	14	SPLIT SPOON 35.3	3 4 1	20
			Trace gravel size quartz (sand).	73	15	SPLIT SPOON 33.8	1	
						(continued)		22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT KISSIMMEE UPPER BASIN
HOLE NUMBER CB-C37-K8

Hole No.CB-C37-K8

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 56.30 Ft.	SHEET 2 OF 2
PROJECT KISSIMMEE UPPER BASIN	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ .5'
33.8	22.5					33.8	
				87	16	SPLIT SPOON 32.3	2 3 5
32.3	24.0		Below depth 24.0', fine to medium grain, trace coarse grain, quartz, brown, trace clay with silt. (SP)	87	17	SPLIT SPOON 30.8	2 10 20
				60	18	SPLIT SPOON 29.3	11 36 50
				67	19	SPLIT SPOON 27.8	30 22 23
				47	20	SPLIT SPOON 26.3	10 11 17
26.3	30.0						
			Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

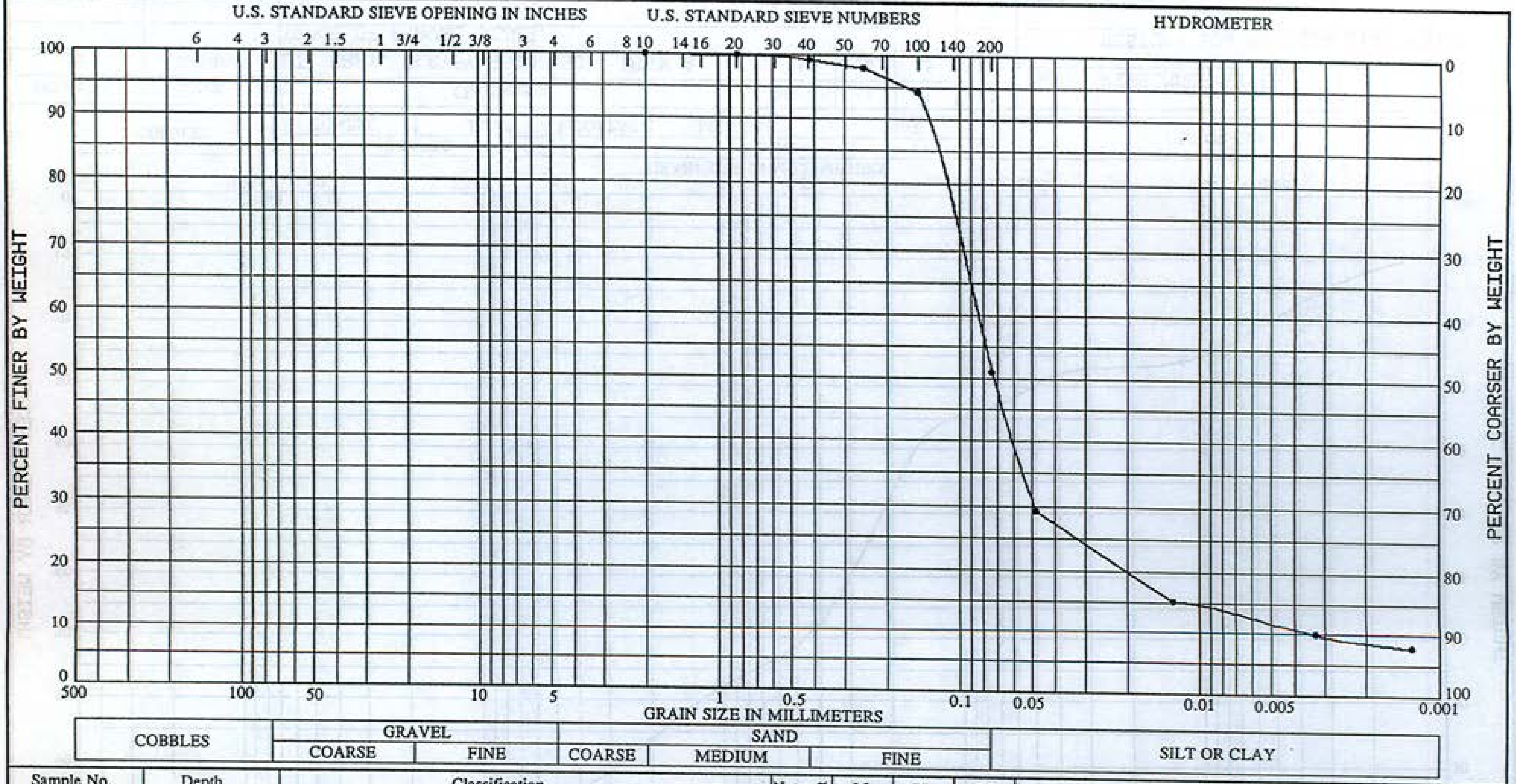
22.5
25
27.5
30
32.5
35
37.5
40
42.5
45
47.5
50

APPENDIX C-2

LABORATORY TEST DATA

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
18	27.0-28.5'	(VISUAL) GRAY, CLAYEY SAND (SC).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6547

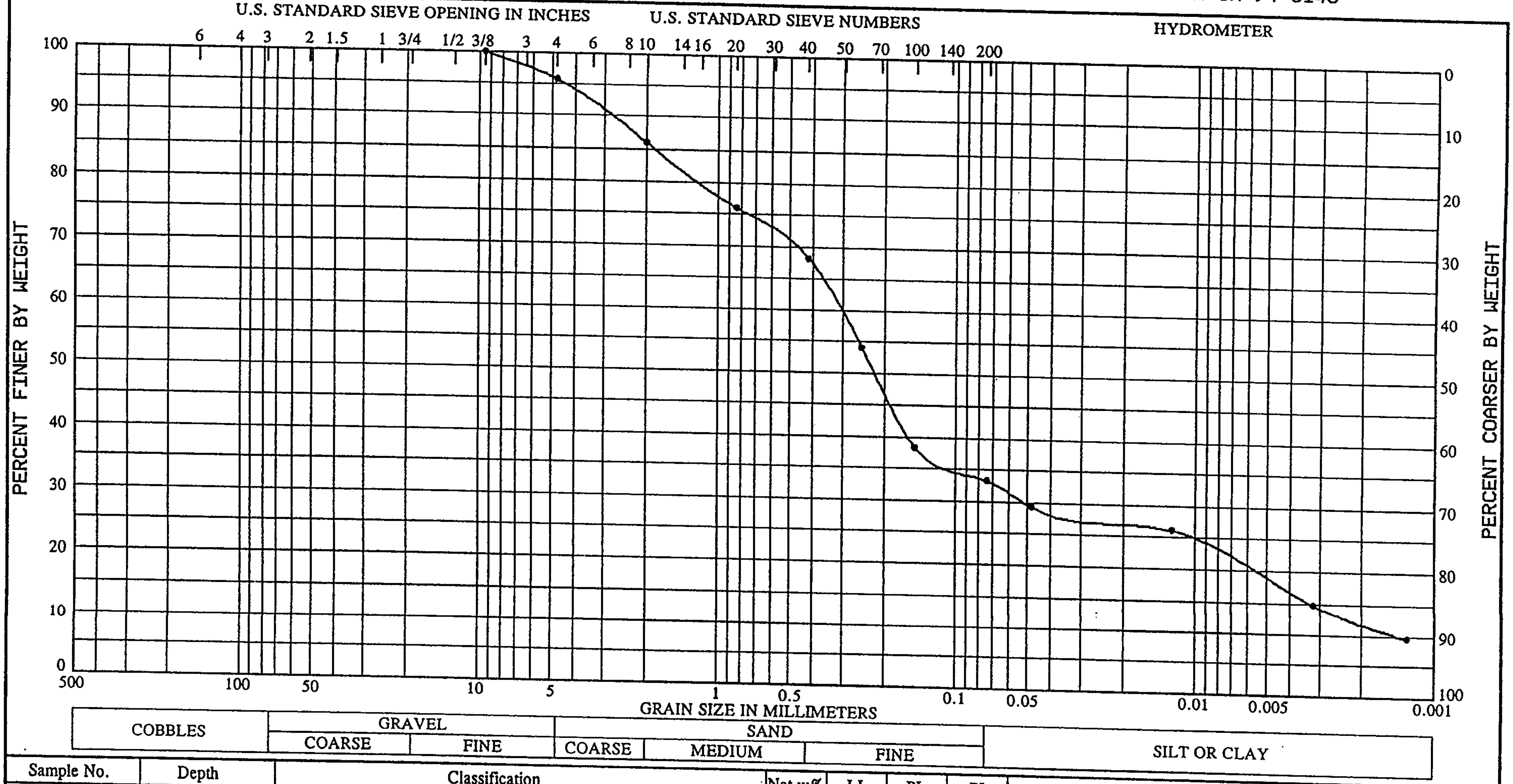
Boring No. CB-S65K-9

Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
26	37.5-39.0'	LT. GRAY, CLAYEY SAND (SC), WITH A	25.9	32	15	17
		TRACE OF GRAVEL SIZES.				
		SP. GRAVITY = 2.70				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6548

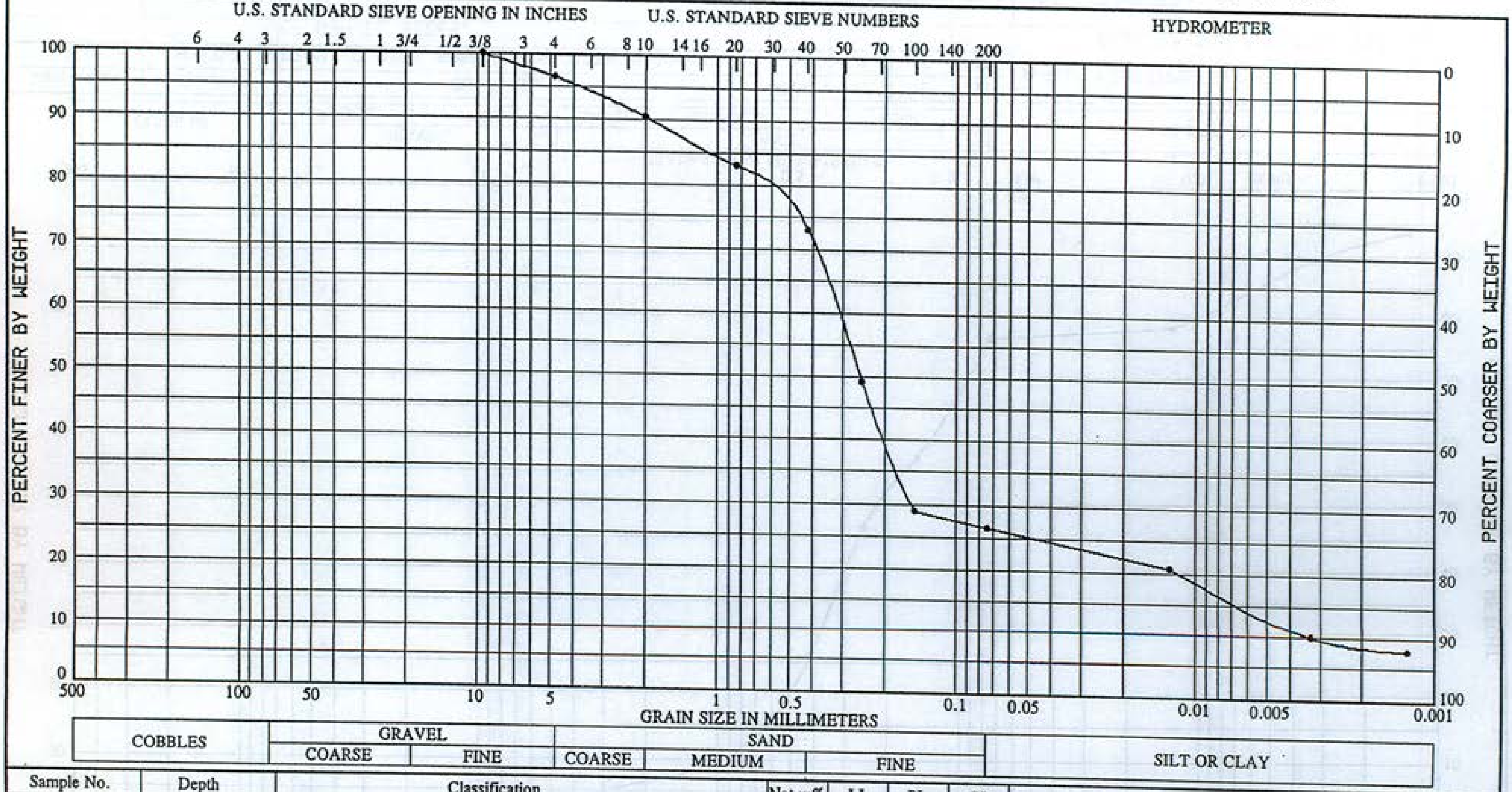
Boring No. CB-S65K-9

Date 08/19/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



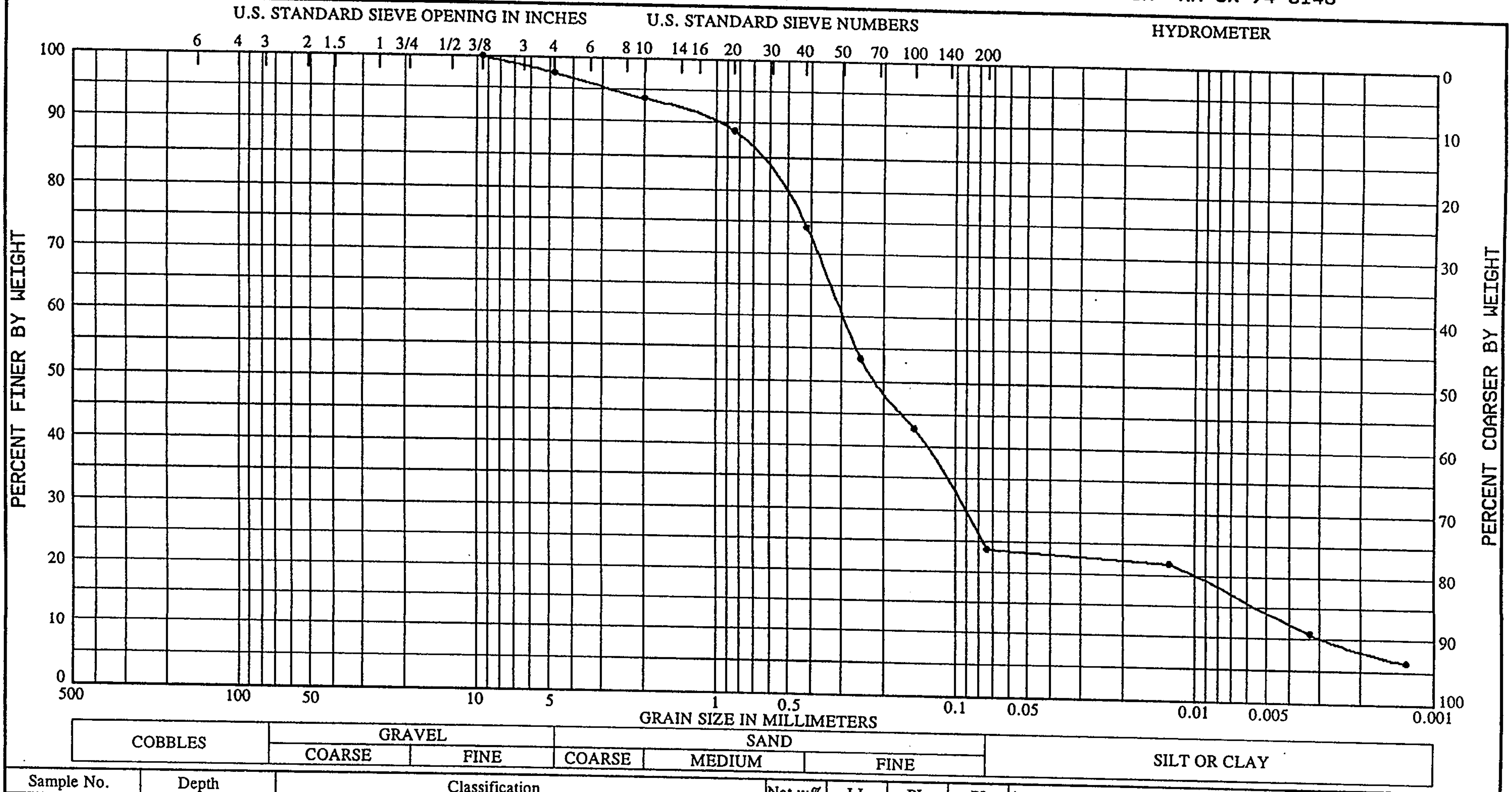
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
34	49.5-51.0'	(VISUAL) LT. GRAY, CLAYEY SAND (SC), WITH A TRACE OF GRAVEL SIZES.				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6549
Boring No. CB-S65K-9
Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



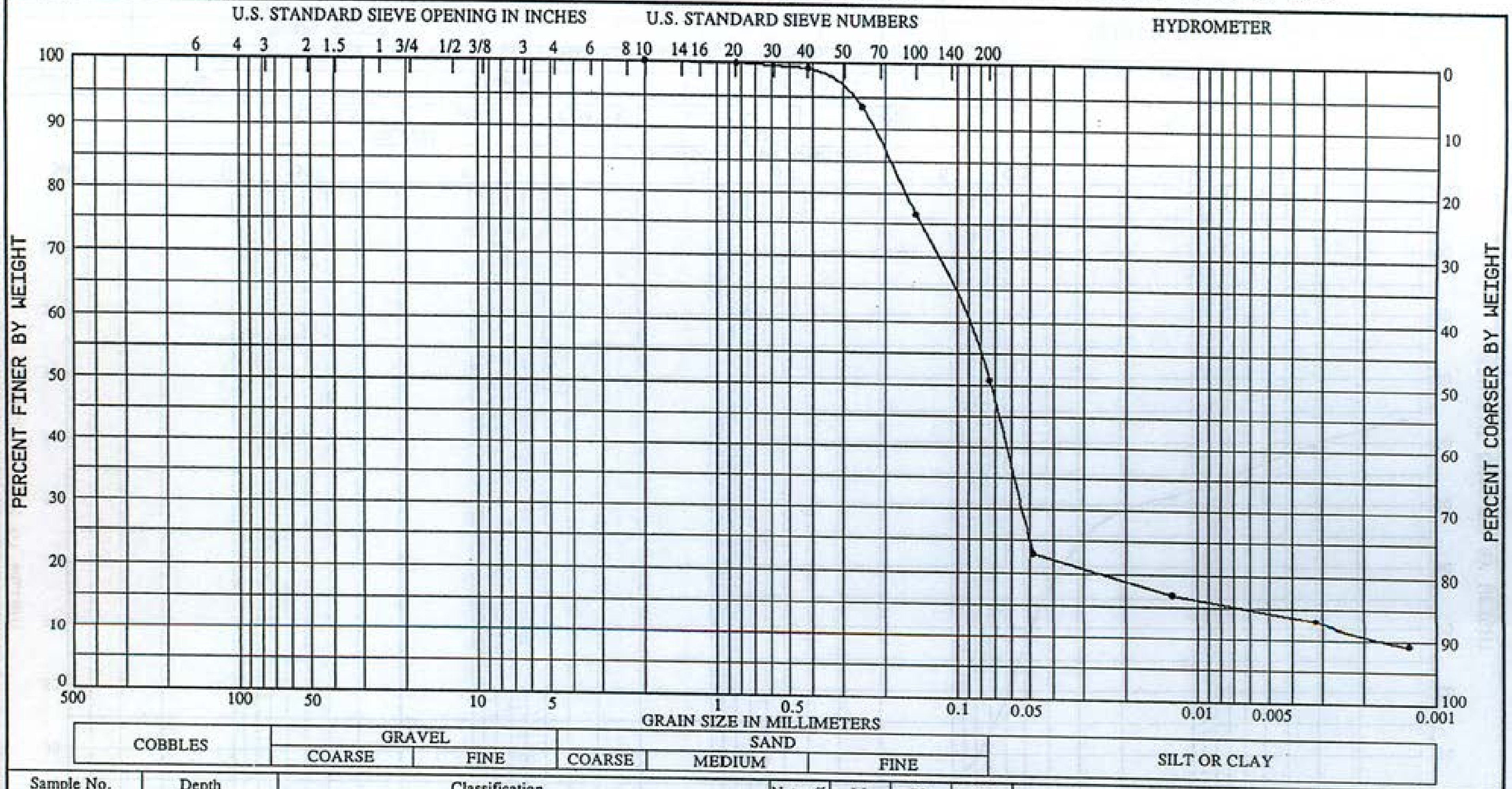
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
37	54.0-55.5'	GRAY, CLAYEY SAND (SC), WITH A TRACE	33.5	28	17	11
		OF GRAVEL SIZES.				
		SPECIFIC GRAVITY = 2.63.				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6550
Boring No. CB-S65K-9
Date 08/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



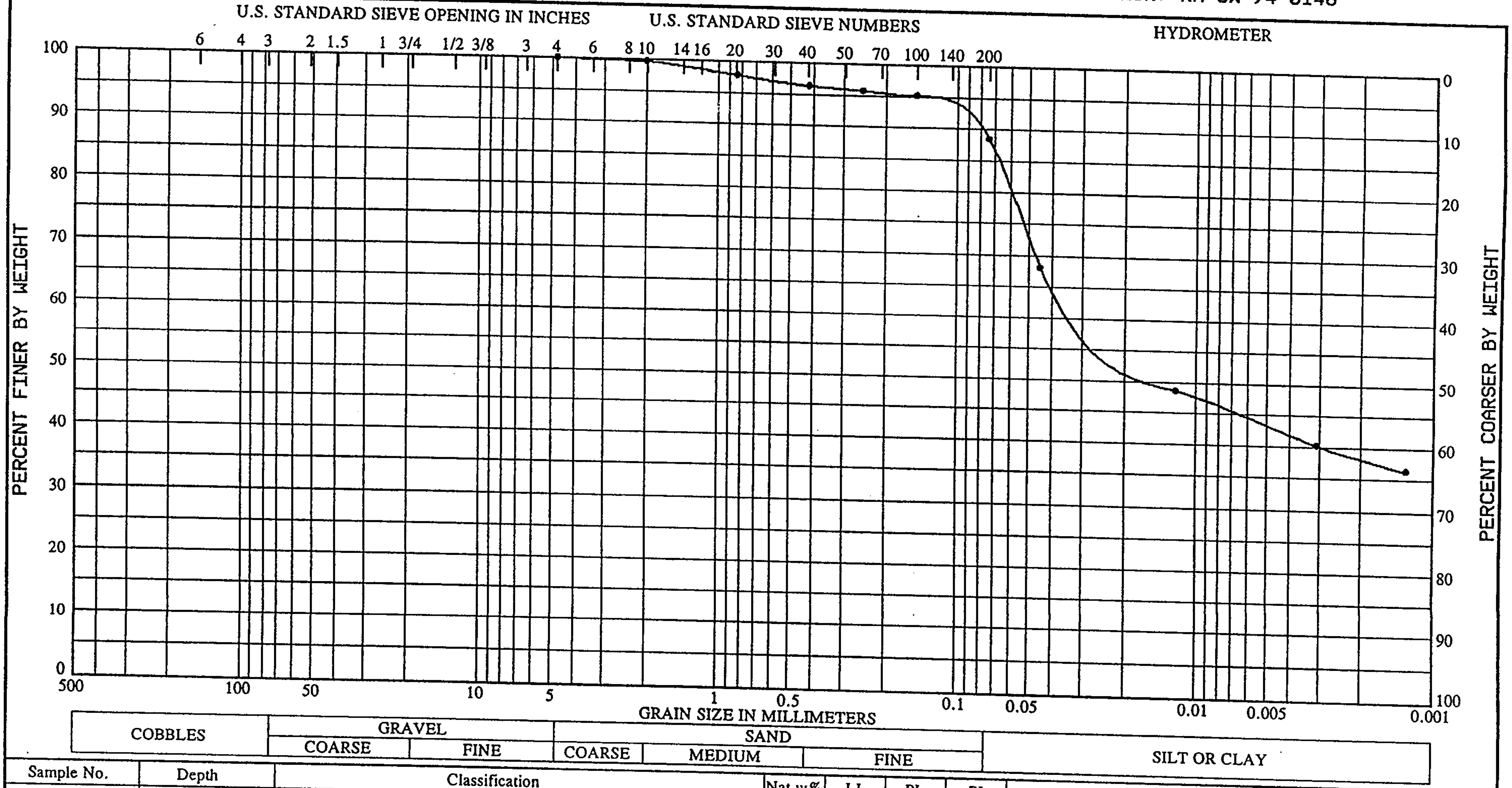
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
18	27.3-28.5'	(VISUAL) DK. GRAY, CLAYEY SAND (SC).				

GRADATION CURVES

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6551
Boring No. CB-S65K-10
Date 09/20/94

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



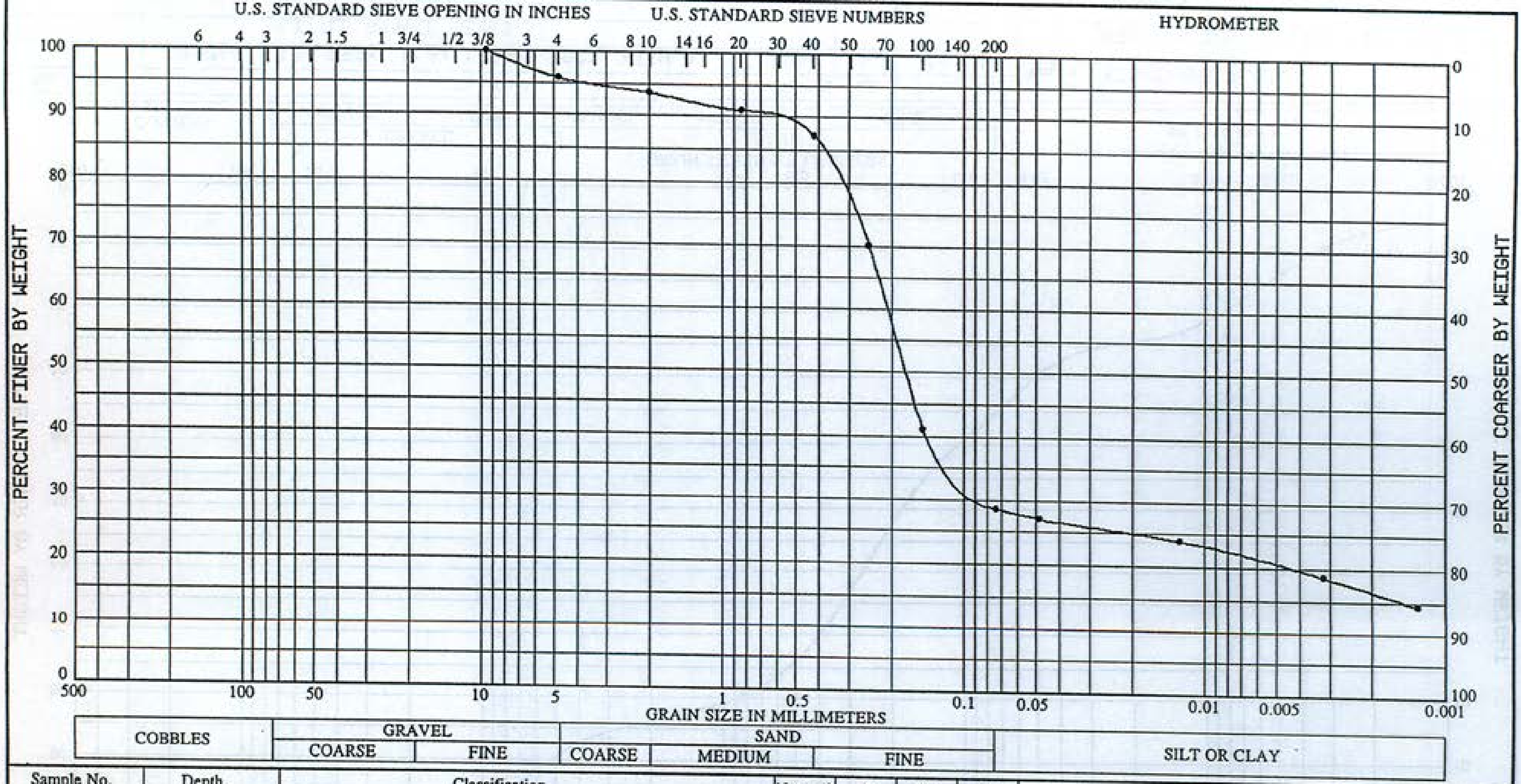
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
23	34.5-36.0'	LT GRAY, FAT CLAY (CH), WITH A LITTLE	67.5	101	22	79
		SAND SIZES.				
		SP GRAVITY = 2.65				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6552
Boring No. CB-S65K-10
Date 08/19/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



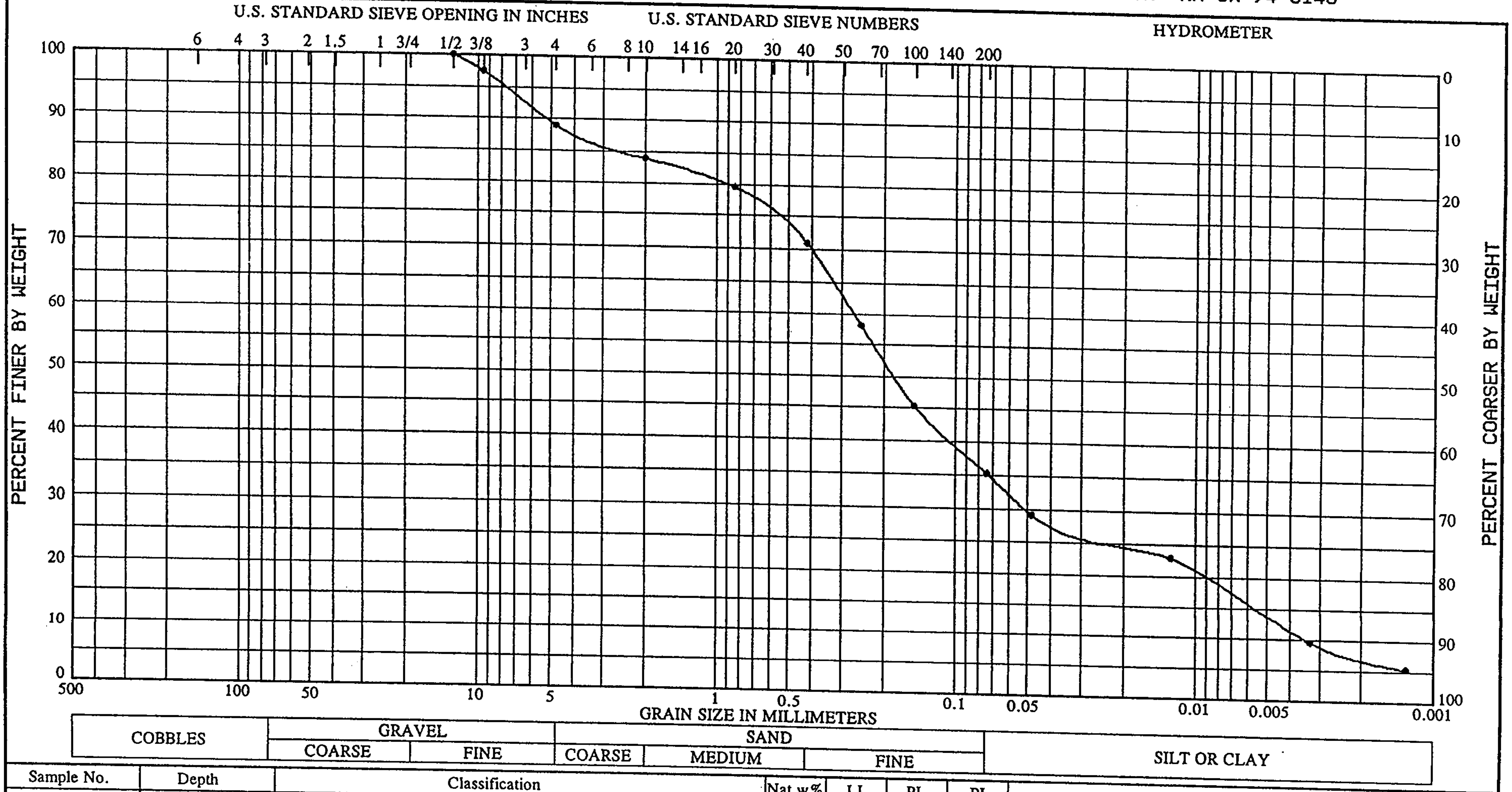
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
28	43.5-45.0'	(VISUAL) LT. GRAY, CLAYEY SAND (SC), WITH A TRACE OF GRAVEL SIZES.				

GRADATION CURVES

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6553
Boring No. CB-S65K-10
Date 09/20/94

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



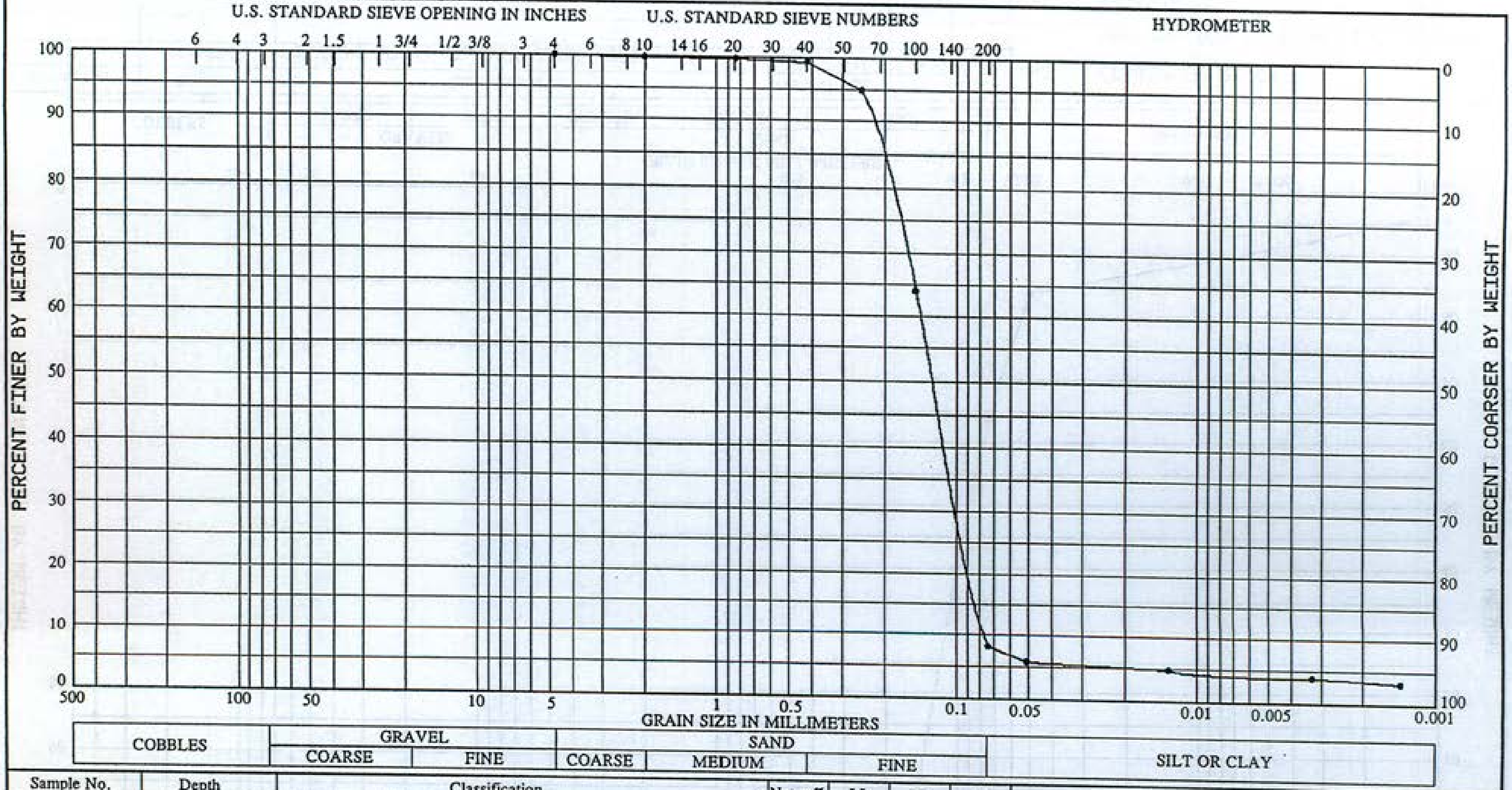
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
34	52.5-54.0'	LT. GRAY, CLAYEY SAND (SC), WITH A	25.1	31	17	14
		LITTLE GRAVEL SIZES.				
		SP GRAVITY = 2.70				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6554
Boring No. CB-S65K-10
Date 08/19/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
3	3.0-4.5'	(VISUAL) LT. BROWN, POORLY GRADED SILTY SAND (SP-SM).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6555

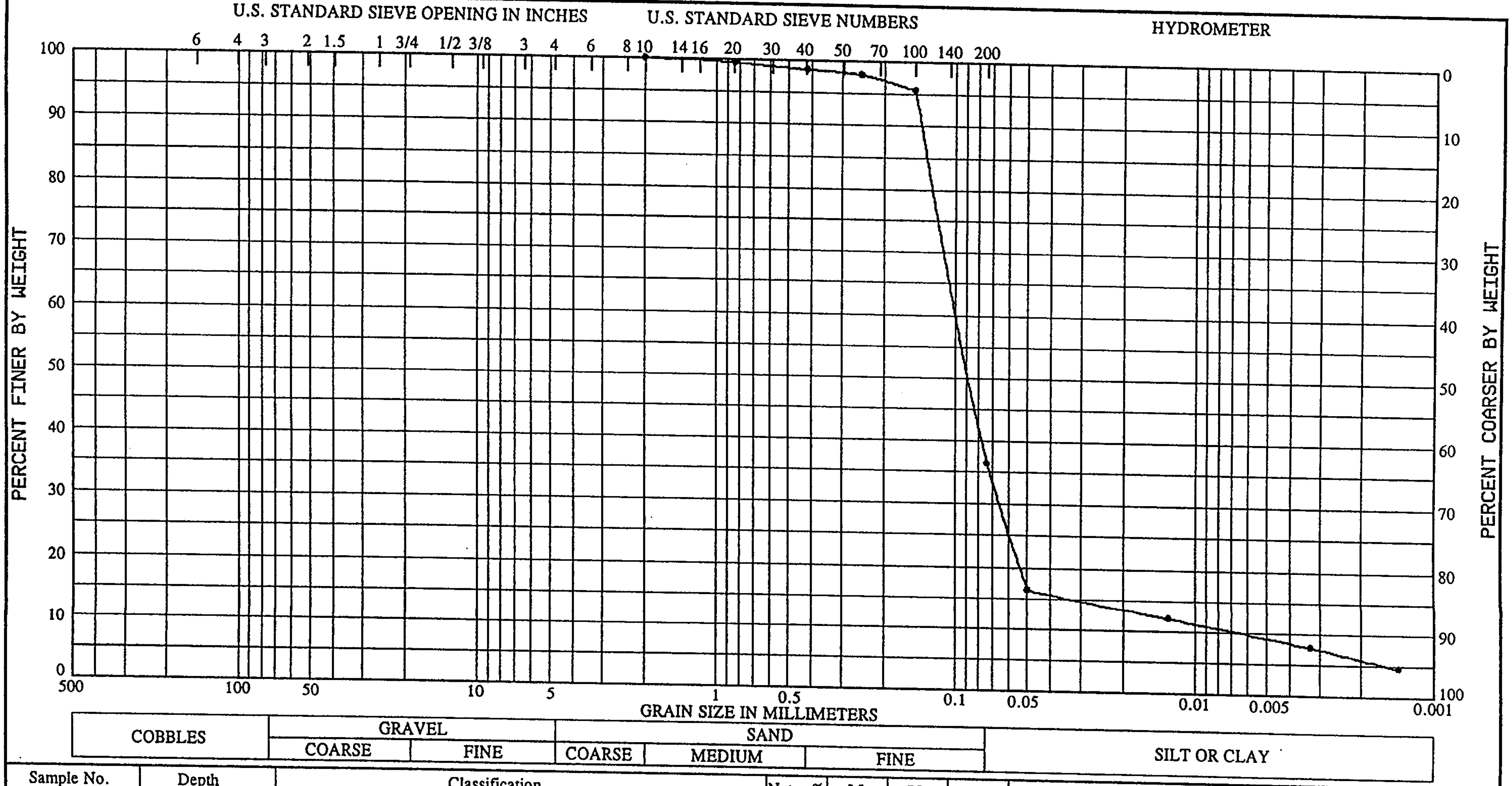
Boring No. CB-S65K-11

Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



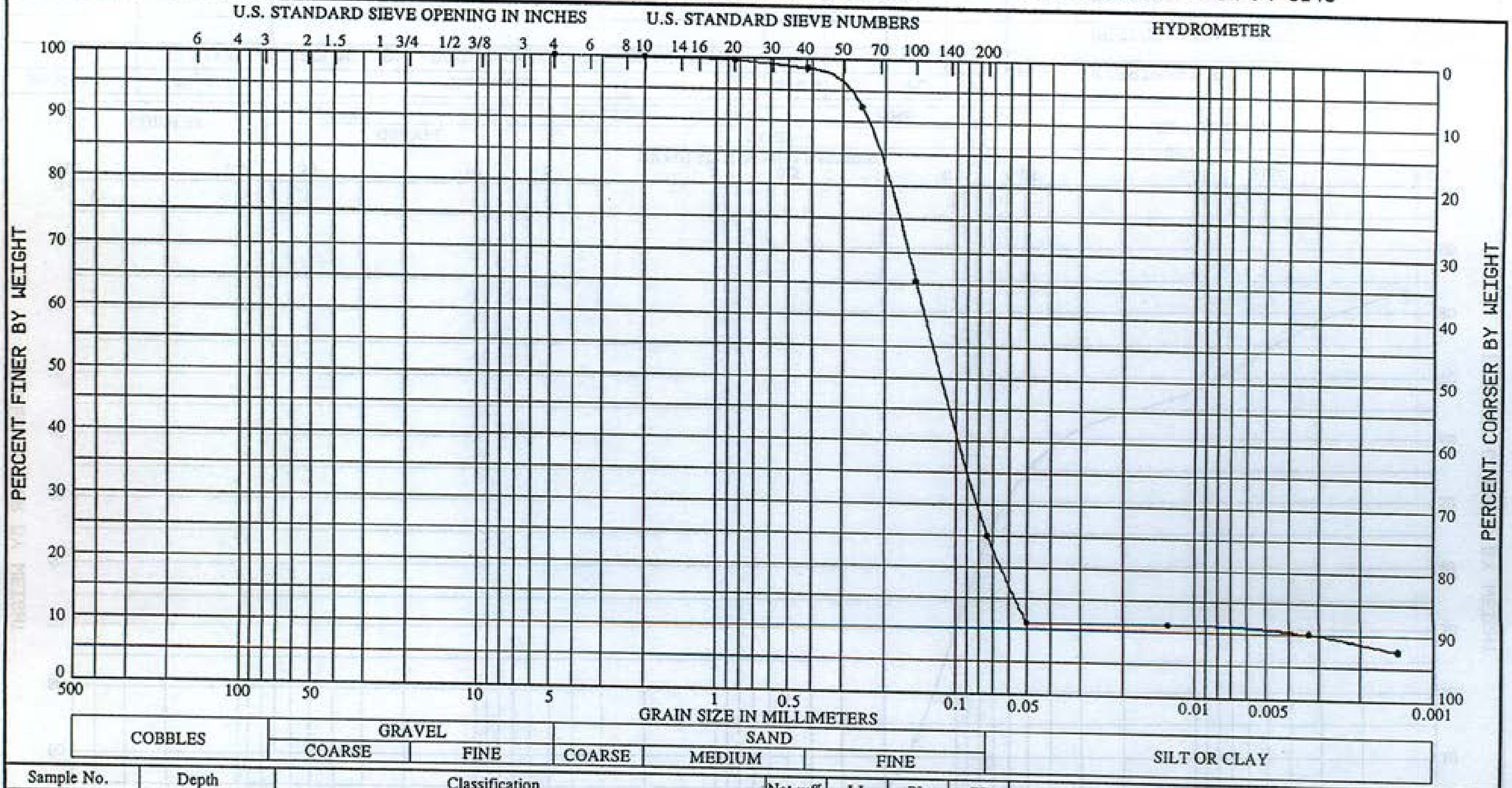
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
17	21.0-22.5'	TANNISH GRAY, CLAYEY SAND (SC).	32.4	34	20	14

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6556
Boring No. CB-S65K-11
Date 08/19/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



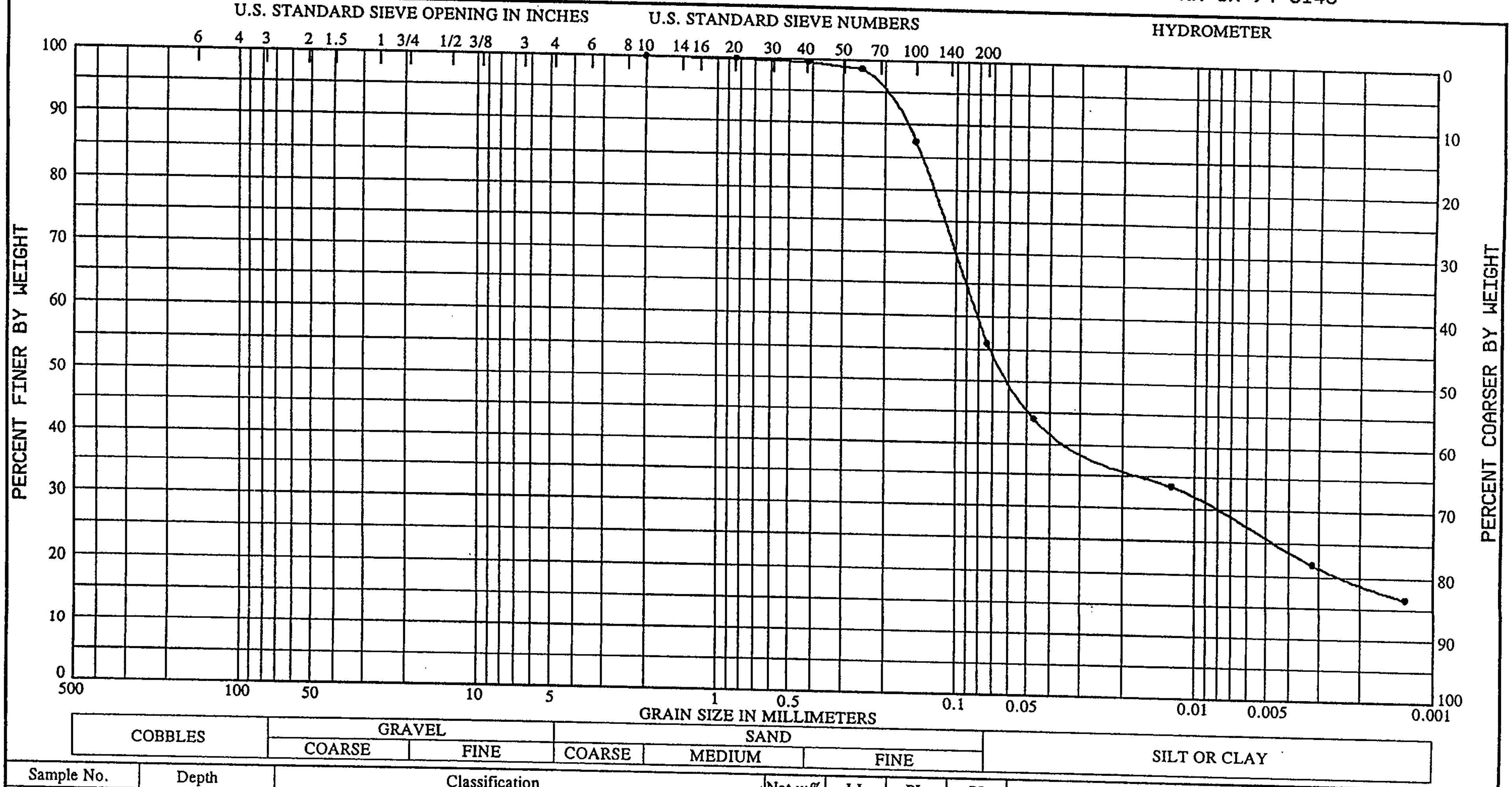
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
2	1.5-3.0'	(VISUAL) LT. BROWN, CLAYEY SAND (SC).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6557
Boring No. CB-S65K-12
Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



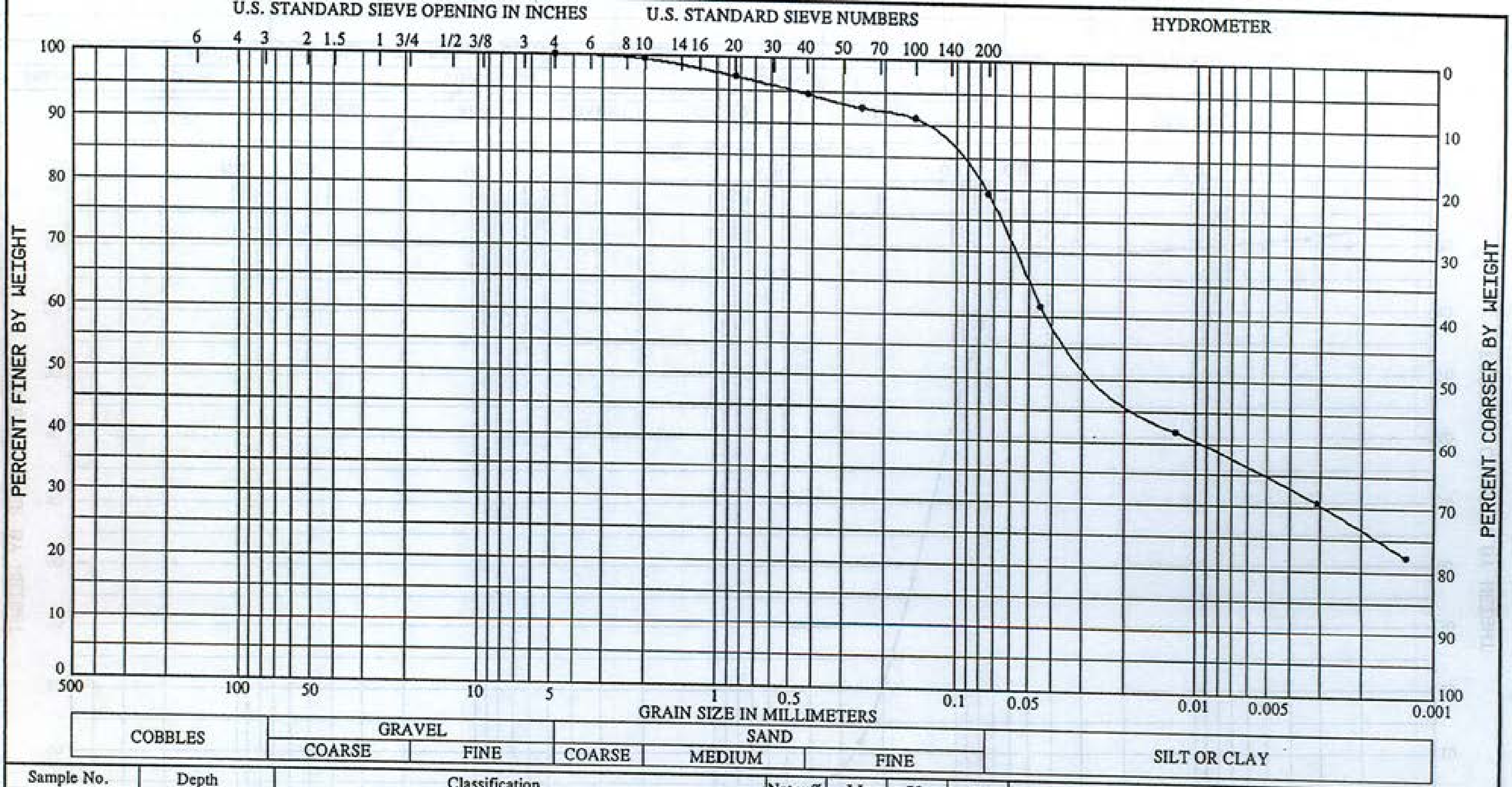
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
11	12.0-13.5'	(VISUAL) DK. BROWN SANDY FAT CLAY (CH).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6558
Boring No. CB-S65K-12
Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
23	27.0-27.9'	LT. GRAY, FAT CLAY (CH), WITH SOME SAND SIZES.	48.3	70	19	51
		SP. GRAVITY = 2.63				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6559

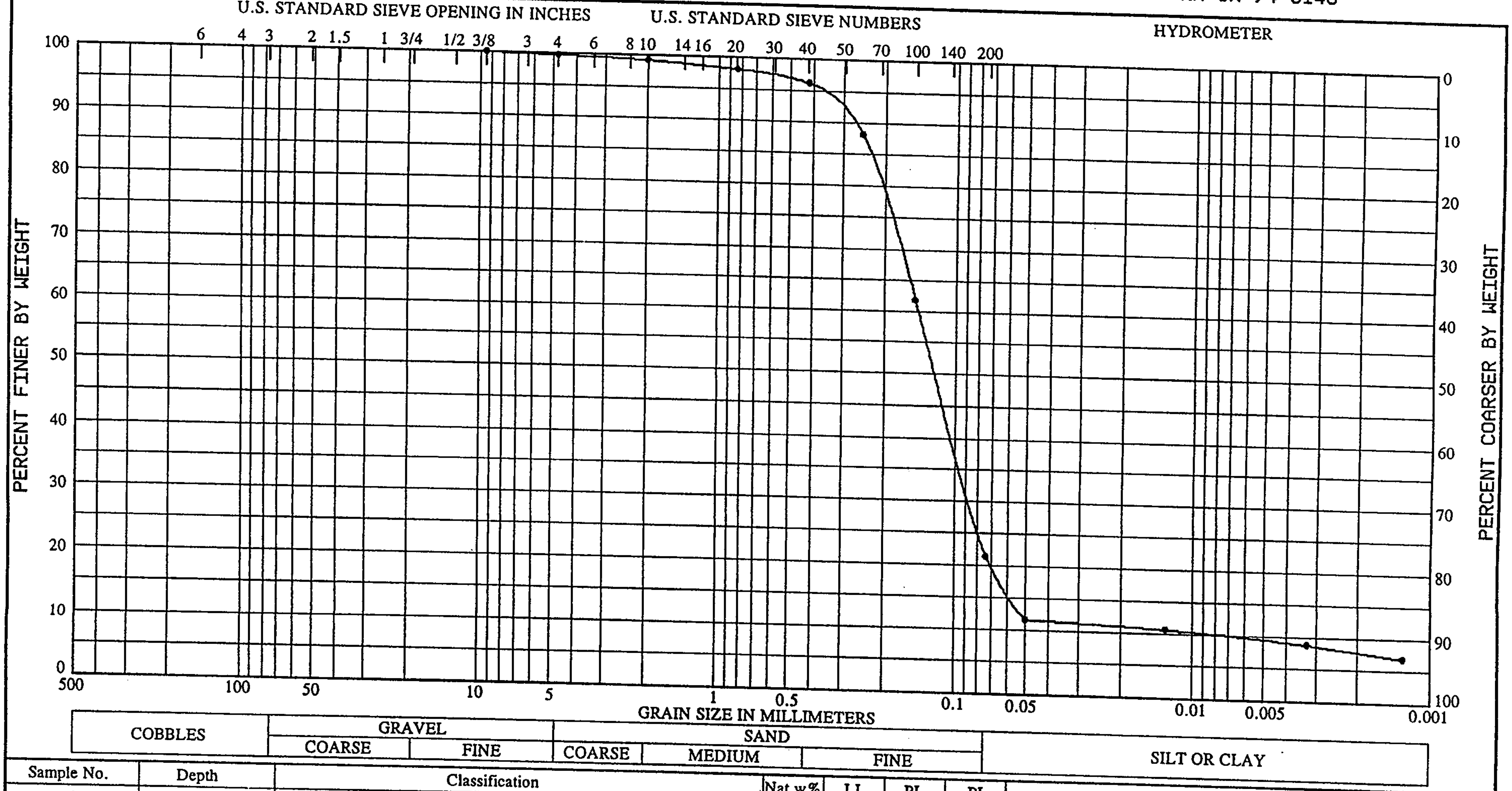
Boring No. CB-S65K-12

Date 08/19/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



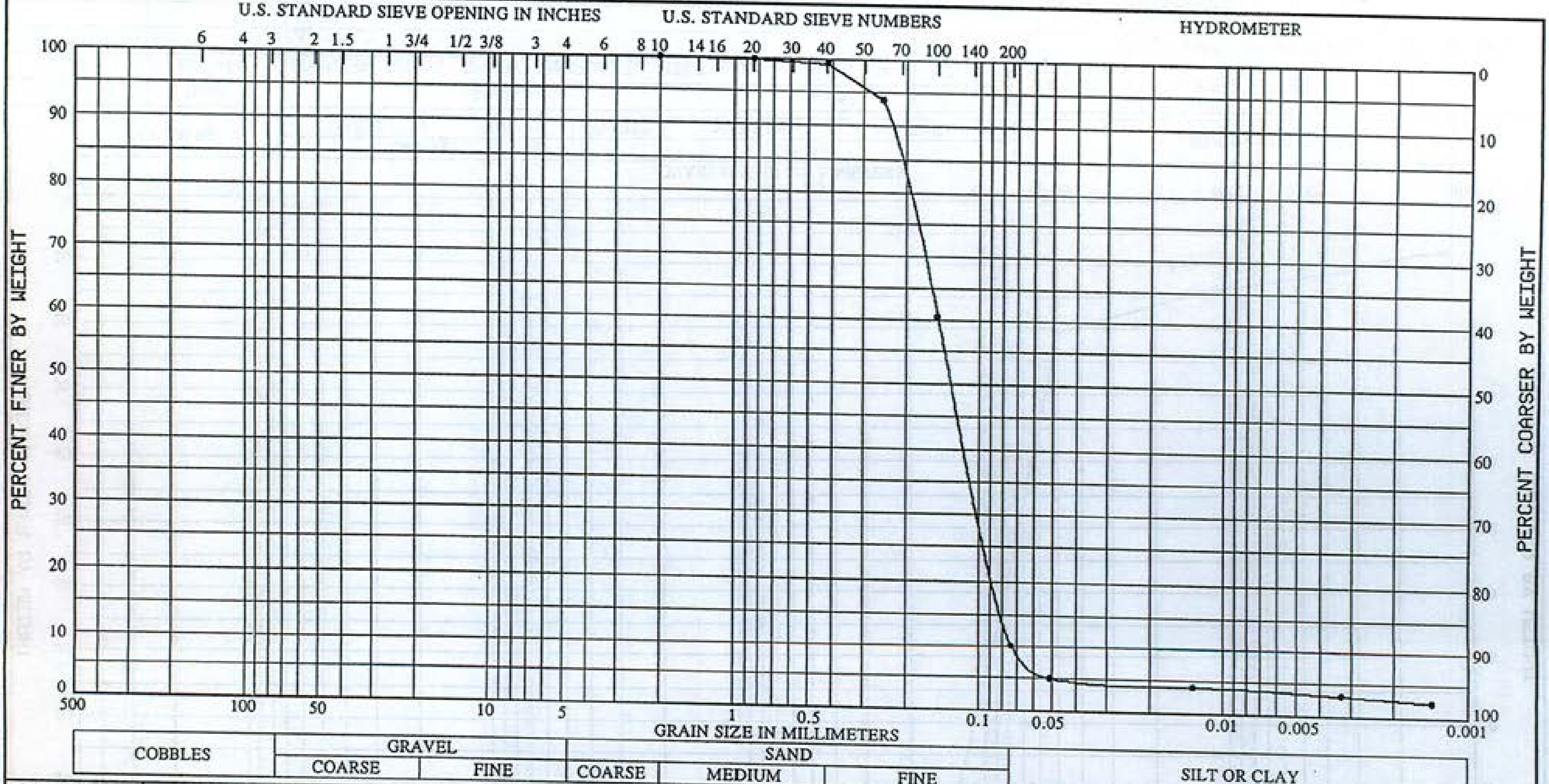
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
6	7.5-9.0'	(VISUAL) LT. BROWN CLAYEY SAND (SC).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6560
Boring No. CB-S65K-13
Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



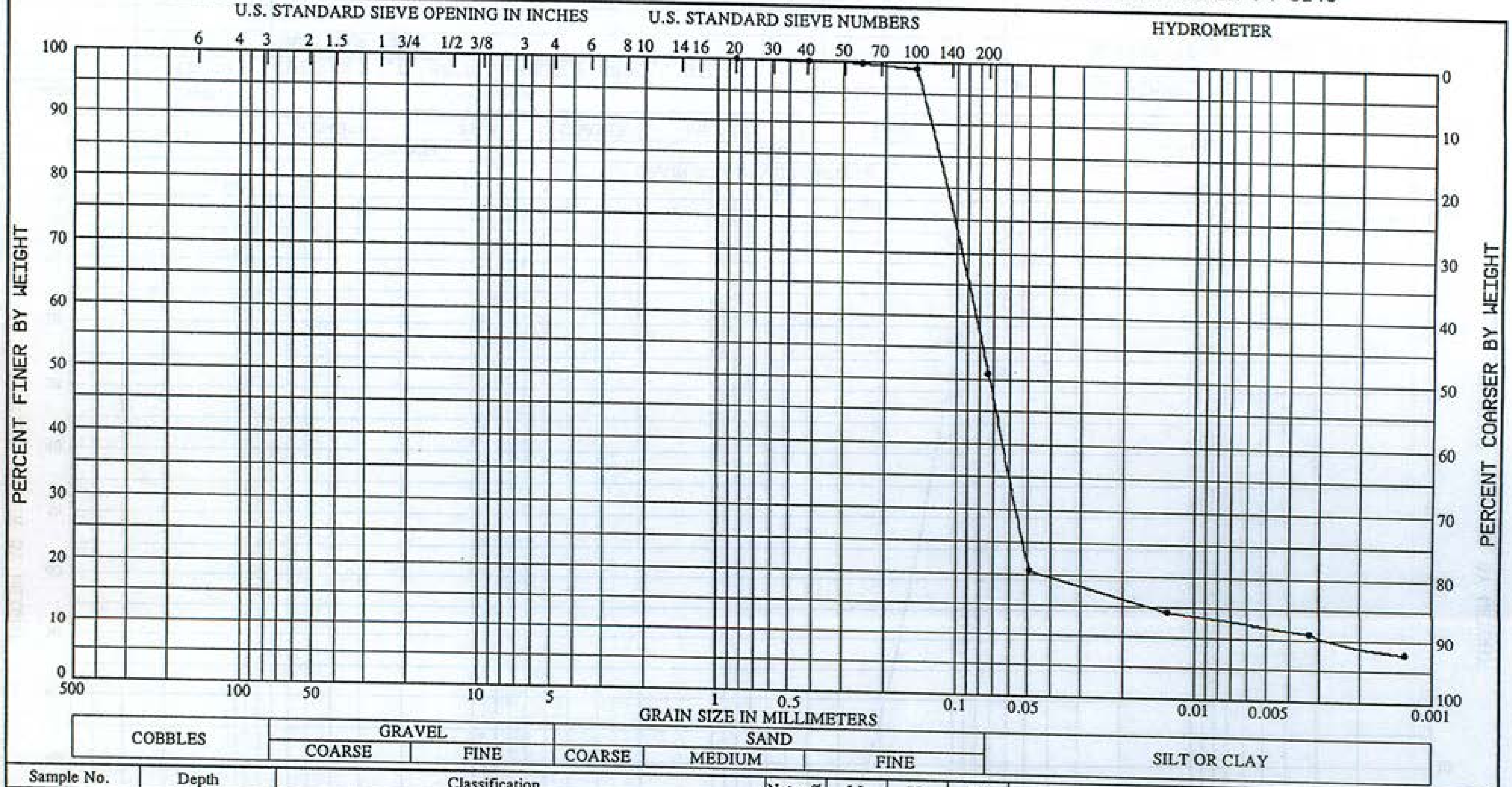
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
13	18.0-19.5'	(VISUAL) LT. BROWN, POORLY GRADED SILTY SAND (SP-SM).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6561
Boring No. CB-S65K-13
Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
28	36.0-37.5'	TANNISH GRAY, SANDY INORGANIC SILT LOW LL (ML).	30.2	34	27	7

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6562

Boring No. CB-S65K-13

Date 08/19/94

GRADATION CURVES

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX D

DESIGN AND COST ESTIMATES

Appendix D
Design and Cost Estimates

Table of Contents

Appendix D
Design and Cost Estimates

Table of Contents

Appendix D
Design and Cost Estimates

PLATES

TABLES

Appendix D
Design and Cost Estimates

A. INTRODUCTION

1. General. The Kissimmee River Headwaters Revitalization Plan calls for increased lake storage capacity of the Upper Basin chain of lakes (those north of spillway structure S-65). Because of the higher water levels in the lakes, in particular Lake Kissimmee, a major modification to the existing S-65 control structure is required. The spillway modification takes the form of an additional, smaller spillway of the same design adjacent to the original. Analysis of the effects of the higher water indicate that the combined spillways will be able to adequately handle the necessary flow increases expected through the structure. Other design interests incorporated in this appendix include stability analysis for S-61 and S-63A, mechanical and electrical considerations of the new spillway, some minor levee construction, and canal maintenance work. This appendix discusses all of the pertinent design considerations utilized to establish a basis for the construction cost estimate. General design parameters, specifications, and basic construction methods are also included.

B. DESIGN AND CONSTRUCTION

2. Canals.

a. General. Under the Kissimmee River Headwaters project proposed in this report, there are three canals C-35, C-36, C-37 that require excavation work. The canal excavations are necessary in order to increase the flow capacities to acceptable levels, thus preventing excessive flooding in times of high water. The excavation within the original construction design template is considered maintenance work and all excavation material outside of the original canal limits is considered new work. The canal requirements are different for each canal. Within canal C-35 only maintenance dredging is to occur, within C-36 and C-37 both maintenance and new work is planned. The disposal mounds for the excavation material will be roughly in the same location as the original spoil mounds, except that the berm width leading from the canal edge to the spoil mound will be approximately 25 feet for all of the canals (see Plate D-1 for details), and all deposits will be within existing right-of-ways.

b. C-37 Construction. C-37 will be dredged to the original design depth which varies in elevation from +26.6' to +27.6' on the canal bottom. The canal will also be widened from the original design width of 70 feet to a project width of 90 feet as shown on Plate D-1. The side slope on the additional cut (or new work excavation) will be 1v:2.5h. The bottom elevation varies from +26.6' to +27.6' between stations 18+23 and 179+60. Between Sta. 0+00 to 18+23 and Sta. 79+60 to 210+07 the canal is sloped upwards to about elevation +45' due to the higher bottom elevations of Lake Hatchineha to the north and Lake Kissimmee to the south. It is estimated that 703,000 cubic yards of material (373,000 maintenance & 330,000 new work) is required to be removed from the canal and placed into a spoil location on the east bank of the canal. The spoil mound begins 25 feet from the crest of the canal and maintains 1v:2.5h side slopes and a top width of about 85 feet. The top of the mound will rise no higher than elevation +65'. The spoil mound dimensions may vary slightly depending on the condition of the existing mound.

c. C- 36 Construction. C-36 will also require both maintenance dredging and new work excavation. The project bottom elevation is a constant +31.3' elevation between Sta. 23+85 and 164+83. Outside of these stations, the bottom elevation increases to about +45' due to the higher lake bottom elevations of Lake Hatchineha to the south and Lake Cypress to the north. The bottom width of the canal is 60 feet, which includes 48 feet from the original design template and an additional 12 feet as new work (see Plate D-1). The side slope on the east side of the canal will be 1v:2.5h and 1v:2h on the west side. The estimated total volume of material for removal is 285,000 cubic yards (160,000 maintenance & 125,000 new work). The spoil mound begins 25 feet from the crest of the canal and maintains 1v:2.5h side slopes and a top width of about 15 feet. The top of the mound will rise no higher than elevation +65'. Again the spoil mound may vary depending on the condition of the existing mound.

d. C-35 Construction. C-35 is to be maintenance dredged only. The design from Sta. 35+00 to Sta. 221+00 calls for a bottom width of 20 feet at elevation +30.6' with 1v:2h side slopes. Between Sta. 0+00 and 35+00 and Sta. 221+00 and 223+00 the canal bottom is sloped upwards to compensate for the higher lake bottom elevations of Lake Tohopekaliga to the north and Lake Cypress to the south. The spoil material is to be placed on the west side of the canal and the mound shall have a top width of 40 feet with 1v:2h side slopes. The approximate volume of material to be removed from the canal is 170,000 cubic yards. Existing conditions may alter spoil disposal specifications.

3. Local Levee Degradation.

a. General. As a significant aspect of the Headwaters Revitalization Project, five locally constructed levees will be partially degraded and restored to natural ground elevations. The levees will have a series of gaps cut into them at regular intervals over their entire length (see Plate D-3). The intent behind the gap construction is to allow unimpeded water flow up to the +54' elevation, thereby achieving full project storage capacity within the Upper Basin chain of lakes. When the lake elevations rise and fall according to the regulation schedule, the gaps should permit flood waters to flow around the remaining levees without unnatural obstruction.

b. Design. The five levees within the upper chain of lakes to be degraded are Lake Kissimmee Levee, Cypress Lake Levee, Sparks Chandler Levee, Rolling Meadows Levee, and Oasis Levee. The respective estimated volumes of material and number of cuts to be removed from each levee are 12,500 cy - 10 cuts; 15,000 cy - 10 cuts; 15,000 cy - 14 cuts; 30,000 cy - 19 cuts; and 2,000 cy - 2 cuts. Exposition Levee, to the east of Lake Hatchineha, will not require degradation as originally planned as it was determined to be unjustifiable due to the limited benefits expected from its construction. The levees were constructed from material taken from adjacent borrow canals, and thus the degraded material will be used to backfill the borrow canals, and therefore no offsite disposal is required. The gaps will be one hundred feet wide at the natural ground elevation and will be spaced approximately 1000 feet apart. Variations in the gap spacing may occur due to the presence of heavily vegetated areas found periodically atop the levees as shown by aerial photography. The vegetation growth may serve as upland habitat to local wildlife and thus these areas should remain intact. The gap specifications also call for cuts with 1v:3h side slopes. See plate D-3 for local levee construction details.

4. Structural Modifications and Analysis of S-65, S-63A, & S-61.

a. General. The proposed plan requires the construction of a new two bay spillway structure, S-65X, adjacent to the existing S-65 structure. A retaining wall near the Lock Operator's dwelling at the same location will be constructed to stabilize embankment fill near that facility. Construction of a new generator house will be required. Structure S-61 and S-63A will not require modifications as a result of this project but will instead have a stability analysis done. The results of the stability analysis on these structures discussed below.

b. Excavation/Fill. The soil behind the northeast wingwall of the existing S-65 structure will be excavated to an elevation sufficient to reduce the lateral load on the wingwall prior to the construction of the cofferdam. After construction is completed on the new structure, the space between the new and old structures, upstream and downstream, will be closed by adding new sheet pile. The area will between the two structures will be backfilled to the required elevation.

c. Removal/Relocation.

(1) General. There is a generator house 60 feet west of the Operator's dwellings at the S-65 site. The generator house will be relocated as a result of the embankment modifications for the new spillway. The location of the new generator house will be determined during plans and specifications (P&S) phase. The location of the antenna tower, at the southwest corner of the Operator's dwelling, will be reviewed during P&S to determine if the guy wires can be relocated or if the antenna must be relocated.

(2) Existing S-65 Spillway. A portion of the northeast (upstream) wingwall, the entire adjoining tieback wall and tierods will be removed prior to construction of the cofferdam. A new sheet pile wall will be constructed with the new spillway structure and will be connected to the existing sheet pile wall. The southeast (downstream) sheet pile wingwall of the existing spillway structure will be connected to the downstream sheet pile wingwall of the new structure.

(3) Safety Barrier. The eastern anchor pile dolphins of the existing S-65 safety barriers, upstream and downstream of the structure, will be removed and the barriers extended eastward as needed to accommodate both structures. Intermediate dolphins may be required.

d. Software. The sheet pile cofferdam for S-65X was designed using the "CWALSHT" and "CWALSSI" programs for design of sheet pile walls. Corps program X0031 - "CWALSHT" uses the classical method to design or analyze cantilevered or anchored sheet pile walls. Corps program X0070 - "CWALSSI" incorporates the soil-structure interaction method to the design of sheet pile walls. The steel grid support system inside the cofferdam, including the steel columns, was designed using the "STAAD-III" computer program. STAAD-III is a structural analysis program that allows three dimensional frame modeling. The structural steel grid system was modeled in this manner to more accurately determine moments and shears in the system. S-65X will be designed in accordance with EM 1110-2-2400, "Structural Design of Spillways and Outlet Works" and EM 1110-2-1603, "Hydraulic Design of Spillways". Existing structures S-61 and S-63A were analyzed using the Corps program X0075 - "C-Slide". This program assesses the sliding stability of concrete structures using the criteria set forth in ETL 1110-2-256, "Sliding Stability for Concrete Structures".

e. Dewatering. Dewatering for Structure S-65X will be accomplished using a cofferdam as shown in plate nos. S-4 & S-5. The cofferdam will enclose an area of approximately 7,100 square feet. A ten foot deep tremie concrete seal, placed inside the cofferdam, will serve as the foundation for the structure. The top of the tremie seal will be at elevation 29.5 ft. and will be secured against uplift using 31.5 ft. helical soil anchors. The interior walls of the cofferdam will be supported by a two layer structural steel grid system supported by steel piles. The upper layer of the grid system will be located at elevation 55.0 ft. The lower layer will be located at elevation 45.0 ft. The ground surface adjacent to the existing structure is at elevation 63.0 feet. The sheet pile of the cofferdam however, was modeled at 58.0 feet, reducing the lateral loads on the sheet pile walls. The supporting piles will be removed when construction is complete.

f. Design Criteria. The structural design is based on standard practice as set forth by the engineering technical letters and design manuals of the U. S. Army Corps of Engineers, subject to modifications indicated by engineering judgement and experience.

Unit Weights and Measures at Structure S-65X

Weight of saturated soil = 100 - 125 pcf
Weight of moist backfill = 95 - 120 pcf
Weight of concrete = 140 pcf

(1) Reinforced Concrete. Design of S-65X was based on the requirements of ETL 1110-2-312, "Strength Design Criteria for Reinforced Concrete Hydraulic Structures", and EM 1110-2-2104, "Strength Design for Reinforced-Concrete Hydraulic Structures".

Cast-in-Place Concrete......................fc' = 3,500 psi
Reinforcing Steel (Grade 60)............fy = 60,000 psi

(2) Steel Sheet Pile at S-65X. The steel sheet pile wingwalls of the spillway structure will be size PZ-27 on the upstream side and PZ-40 on the downstream side. The sheet pile for the cofferdam, plate no. S-5, will be 60 feet long and of size PZ-40. After construction, the cofferdam sheet pile will be cut off at the top of the tremie seal. The lower section will remain in place to allow for seepage protection.

(3) Stability Analysis. The critical stability loading cases for the S-65X spillway structure were analyzed as described in paragraph 4.f.(3).a. "Stability Loading Conditions". The structure was analyzed for overturning in

accordance with EM 1110-2-3104, "Structural and Architectural Design of Pumping Stations". The structure was designed with the uplift forces assumed to act over 100 percent of the base of the structure, varying from 100 percent of headwater to 100 percent of tailwater with consideration for hydraulic jump. Construction of the spillway structure will be in monolithic sections. The concrete stilling basin slab was designed for flotation stability in accordance with ETL-1110-2-307, "Flotation Stability Criteria for Concrete Hydraulic Structures". Structures S-61 and S-63A. were analyzed for overturning, sliding and overstressing of the foundation. Monolithic analyses were used for the structures as shown on plates nos. S-10, S-11 and S-12. The existing S-65 structure is founded on piles and should not be affected by the partial excavation required for the new structure.

a. Stability Loading Conditions. The reinforced concrete spillway structure, S-65X, was analyzed for four loading conditions. 1) Normal Operating Condition (Case I) - Structure operating to discharge routine floods over a range of exterior flood levels (Usual). 2) Maintenance Condition (Case II) - Maximum design water level in one bay with the other bay dewatered (Unusual). Upstream WSEL at 52.5 ft. and downstream at 49.07 ft. 3) Standard Project Flood Condition (Case III) - Maximum flood levels upstream and downstream of structure (Extreme). This condition incorporates hydraulic jump. Upstream WSEL at 58.0 ft. and downstream at 48.2 ft. 4) Hurricane Condition (Case IV) - Hurricane loading including wind tide (Extreme). Upstream WSEL at 64.7 ft. and downstream at 56.35 ft.. Structures S-61 and 5-63A were analyzed for the following load conditions 1) Normal Operating Condition - Same as above (Usual); 2) Dewatered - Same as Maintenance Condition above (Unusual.); and 3) Optimum - Similar to Normal Operating Condition with different headwater and tailwater elevations.

b. Stability Results. All structures were determined to be stable for all loading conditions, with all resultants falling within the base. Table I provides the stability criteria as stated in EM 1110-2-3104. Table II shows the calculated results of the design data for S-65X. Table III shows the calculated results for S-61 and S-63A.

Table I

STABILITY CRITERIA			
Aspect	Usual	Unusual	Extreme
% Base in Compression	100	75	0
Sliding Safety Factor	2	2	1.33
Flotation S.F.	1.5	1.3	1.1

Table II

COMPUTED FACTORS OF SAFETY FOR S-65X				
	Case I	Case II	Case III	Case IV
SLIDING	5.25	3.29	1.47	1.72
FLOTATION	1.86	1.57	1.30	1.50

Table III

SLIDING FACTOR OF SAFETY			
	Case I	Case II	Case III
S-61	5.16	4.86	2.62
S-63a	4.92	4.29	3.02

c. Structural Analysis.

(1) Reinforced Concrete Stilling Basin. The stilling basin slab will be located on the downstream side of the structure measuring 57'-3" wide. The 34 foot length of the basin. will be redesigned during plans and specifications to 48 feet. The slab will be 4-1/2 feet thick and will have 11 baffle blocks arranged in two rows to reduce the maximum velocities of water leaving the structure. The baffle blocks will be standard shape baffle measuring 3'-6" high x 4'-5" wide x 4'-11" deep (Plate no. S-2). Anchors will be used to preclude downstream movement by water forces due to spillway discharge. The size of

the baffle blocks will also be reevaluated during plans and specifications due to the change in basin length. The end sill for the stilling basin will have a top elevation of 36.5 feet and the training wall elevation will be 49.0 feet.

(2) Gates. The new spillway gates for S-65X are of the same type, size and construction as the existing gates on structure S-65. The gates will be vertical lift gates constructed of structural steel channels and faced with a 3/8" skin plate. The exterior frame will be continuous steel members with intermediate members welded at uniform spacings. The skin plate will be welded to the upstream side of the gates. The gates will measure 27 ft. wide by 14.2 ft. high. Gate seals will be provided to protect against leakage.

(3) Retaining Wall. The steel sheet pile wall adjacent to the west wall of the Operator's dwelling will be approximately 113 feet long, 19 feet deep and of size PZ-22. The wall, constructed in three sections, will serve as a retaining wall to ensure the integrity of the embankment near the Operator's dwelling. The wall was designed for three loading conditions; usual, unusual, and extreme, using Corps program X0031 - CWALSHT.

5. Mechanical Design for the S-65 Addition.

a. Existing Spillway Structure. The existing S-65 three-bay spillway structure was built in the early 1960's and continues to operate satisfactorily. Hoisting equipment is used to raise and lower the 27-foot by 14.2-foot, 30,000-pound gate. The existing hoisting system includes a 1-inch, 6 x 37 IWRC stainless steel wire rope, with a hydraulic system comprised of a cylinder with a 12-inch bore and a 5 1/2-inch rod that has a stroke of 83 inches. The operating pressure of the existing system is 1300 psi. The total hoist load (weight of gate and friction due to hydraulic loading) is 45,000 pounds. Although the equipment is operating satisfactorily, the wire rope and sheaves are sized smaller than they would be by today's standards. While wire ropes used for lifting spillway gates are normally sized today with a minimum safety factor of 5.0, the existing 1-inch wire rope offers a safety factor of 3.44. There are no plans to change the operating equipment for this structure.

b. Additional Spillway Structure. The new spillway structure at S-65 will have two bays and gate operating machinery and related equipment as shown on plates ME-1 and ME-2. Each vertical lift gate will be raised and lowered by means of a horizontal hydraulic cylinder connected to a two-part sheave block assembly over which each of two 1-1/4-inch cables run. One end of each cable will be fastened to the gate, and the other will be connected to the base of the hoist unit. Hydraulic fluid from a new motor-driven hydraulic-power unit, which is located in the control room on the side of the new S-65 spillway structure addition, shall be used to operate each hydraulic cylinder. Each hydraulic cylinder will be located on the operating platform as a part of the hoist unit. Gate hoist capacity, operating load, and hydraulic pressure will be as shown on plate ME-1. Each hydraulic cylinder will have a 12-inch bore and a 5-1/2-inch rod with a stroke of one-half of the gate travel. A flow control valve will be used to set the speed at which the gate may be raised to 6 inches per minute. Each gate opening will be manually operated to maintain optimum headwater elevations and to provide the regulation discharge when required. Existing commercial power will be used to operate the hoist equipment. During commercial power failure, the existing stand-by 30-kilowatt LP gas-fired generator (located in the existing generator building) will be used for operating the hoist equipment. A gate position indicator will be located at each of the gates. Upstream and downstream water levels will be recorded via the existing stilling wells located in the control room on the side of the existing S-65 spillway structure. No new water level monitoring system will be required for the new spillway.

c. Relocations. The construction of the new channel and spillway structure at S-65 will require the relocation of a number of existing items at the site. The generator building, which contains the generator, pumps, tank, step-up transformer, other, will be moved to in front of the lock master's house in a location as indicated in the site plan on plate ME-4. The underground LP gas storage tank and the water treatment tank (part of the potable water system) will also be relocated adjacent to the relocated generator building. The lawn sprinkler system (piping and pump) will need to be redesigned and relocated to avoid the new channel. The aboveground fuel storage tank located adjacent to the existing storage building will be removed from the site.

6. Electrical Design for the S-65 Addition.

a. General. Electrical installation for the S-65 addition will be provided as shown on plate ME-3.

b. Power Supplies. The local power company, Peace Electric Utility, has an overhead 14 KV, single phase power line along the Levee. A service pole, with step down transformer located adjacent to the generator building, provides a 120/240 volt, single phase, 200 Amp. 60 hertz, three wire underground electrical service to the existing generator building. The power is distributed to the lock master's residence, and to the existing spillway and adjacent lock. The residence requires 120/240 volt, single phase service. The lock and spillway service is stepped up to 480 volts at the generator building to reduce voltage drop. The underground feeder from the generator building feeds power to the spillway and lock structures and is stepped down to 120/240 volts at these structures. The existing service will be upgraded to 300 amps. to feed the existing and new structures. The manual transfer switch, step up transformer, and associated equipment and feeder will be modified to take the additional electrical load. Approximate location of the service is shown on plate ME-4. An existing 30 KW engine-generator set will be upgraded by SFWMD to 60 KW and would provide emergency power to existing and new structures in case of failure of the commercial service. A transfer switch would be provided to start the engine-generator unit upon failure of the commercial service, thus providing continuous service for the structures.

c. Power Distribution. A control center would be connected to the distribution panel in the generator building. The distribution panel is connected to the load side of the Transfer Switch. The control center will house a main breaker, combination starter for 3 Hp motor, lighting panel, relay compartment and a circuit for exterior lighting.

d. Gate and Motor Controls. Duplicate open-close push button stations in the control house and at the spillway structure would be provided for manual gate control. Necessary open, close, control relays, and limit switches would be incorporated in the gate control circuit. A time delay relay would provide a 5-second energization delay to a dumping solenoid valve to permit unloaded start of the hydraulic power unit motor. Existing water level recorders at existing spillway will be used. Therefore, new water level recorders will not be required. Gate position recorders will be of the mechanical type and will not require electrical power or controls.

e. Lighting. Industrial fluorescent fixtures would be provided for control house lighting. Exterior lighting for security purposes would be automatically controlled by a photo-electric relay. Exterior lighting would consist of lighting the spillway operating platform, safety barriers, warning signs and pole mounted HPS area lighting.

f. Wiring. Insulated copper conductors would generally be installed in either rigid galvanized steel conduit or schedule 40 rigid plastic conduit. Conductors would be rated for 600 volt insulation Types RHW, THW, THWN, OR XHHW. Conductors would be of copper except that aluminum conductors could be used as an equivalent for copper conductors of No. 6 AWG and larger. Aluminum conductors would have ampacity not less than the copper conductors.

g. Grounding. Ground rods and large embedded metallic masses would be utilized for a project main ground installation and would be tied together with "AWG No.1" ground wire. Frames or enclosures of electrical equipment would be bonded to the grounding system. Ground conductors would be bare, soft annealed copper cables and ground rods would be of copperclad type 3/4 inch in diameter by 8 feet long. Ground inserts with ground straps would be used for equipment ground connection.

f. Electrical Relocations.

(1) Electrical Lines. The power line relocation work will be done by Peace River Electric Coop. (PRE) at Government cost. To the south side of Highway 60, PRE Coop. has a 14 KV, 3-phase, 4-wire power line. The 3-phase, 14 KV power line will be extended to east side of the proposed levee as depicted on plate ME-4. To the east side of Structure-65, The Peace River Electric Coop. has a 14 KV, 1-phase, 2-wire aerial power line, tapped from the 3-phase power line, extending to the S-65 spillway and residence. The 1-phase, 14 KV power line, transformer, and associated hardware will be relocated to the east side of the proposed levee while considering appropriate sizing of the proposed load as depicted on plates ME-4 and ME-3 respectively. The power line will extend to the west side of residential driveway where it will terminate. Mr. James Swails at PRE has indicated the power line relocation and commercial transformer cost to be approximately $3,500.00. The 1-phase line terminates at a 25 KVA, 14 KV - 120/240 volt transformer. The 25 KVA, 14 KV - 120/240 volt transformer will be replaced with a 50 KVA, 14 KV - 120/240 volt transformer.

The 120/240 volt service feeds underground from the service pole to the generator building, to a meter socket and 200 amp disconnect. Downstream of the 200 amp disconnect is a 200 amp manual transfer switch which is connected to a 30 KW generator for emergency power. SFWMD proposes to upgrade the emergency generator to a 60 KW unit in 1-2 years. The residence has a 150 amp, 120/240 volt underground service fed from a sub-panel within the generator building. The relocation of the generator building will require relocation of the 120/240 volt underground residential service. The spillway and lock are fed from a 37.5 KVA, 240/600 volt transformer within the generator building. The 600 volt circuit is fed underground to the spillway and lock location. The spillway and lock have separate taps into the 600 volt feeder at a common junction box. The spillway is fed from a 10 KVA, 600/240 volt transformer. The lock is fed from a 25 KVA, 600/240 volt transformer. See plate ME-3 for one line diagram. The 600 volt underground circuit feeding the spillway and lock will require relocation with the proposed generator building. This new underground circuit will be sized to feed the existing lock and spillway and the proposed spillway.

(2) Telephone Lines. The telephone line relocation work will be done by General Telephone (GTE) Company at no cost to the Government. GTE has a 50-pair, copper cable sharing Peace River Electric Cooperative's utility poles as depicted on plate ME-4. The telephone cable will require relocation with Peace River Electric Cooperative's power line. The relocation work will require close coordination between GTE and Peace River Electric Coop. The underground telephone circuit to the residence will also require relocation. According to Mr. Joe Emery with GTE, this work will be done by GTE at their costs.

C. CONSTRUCTION PROCEDURE

7. General. The construction details are generally outlined in the Design and Cost Appendix, and they will be refined during plans & specifications.

D. COST ESTIMATES

8. General. The summary of the estimates for the first cost of construction for the recommended plan, including quantities, unit costs, contingencies, and reasons for contingencies is presented in Table T-1. The complete estimate will be incorporated into final draft.

9. Quantities. The quantities for canal excavation were developed from survey data taken in August 1991. No significant changes in estimated volumes are anticipated, and no future surveys of the canals are scheduled. Quantities for the grading of the local levees were basically rough estimates taken from average berm widths and side slopes, as determined from visual inspections of the levees. The earthwork volumes associated with the structural additions were provided by design engineers, and were best guess calculations. Detailed site surveys, cross-sections, and geotechnical information would be required prior to preparation of contract plans and specifications.

10. Cost Estimates. The estimate for the Headwaters Project was done using MCACES GOLD estimating software. The estimate details all costs to the government and to the local sponsor. The dollar values were calculated to include contingencies, current interest rates, and estimated inflation. Because this project study serves as a supplement to the 1991 Kissimmee River Feasibility Study, the cost factors (shown as percentages) for contingencies, planning, engineering and design, and construction management will be the same.

E. OPERATIONS AND MAINTENANCE

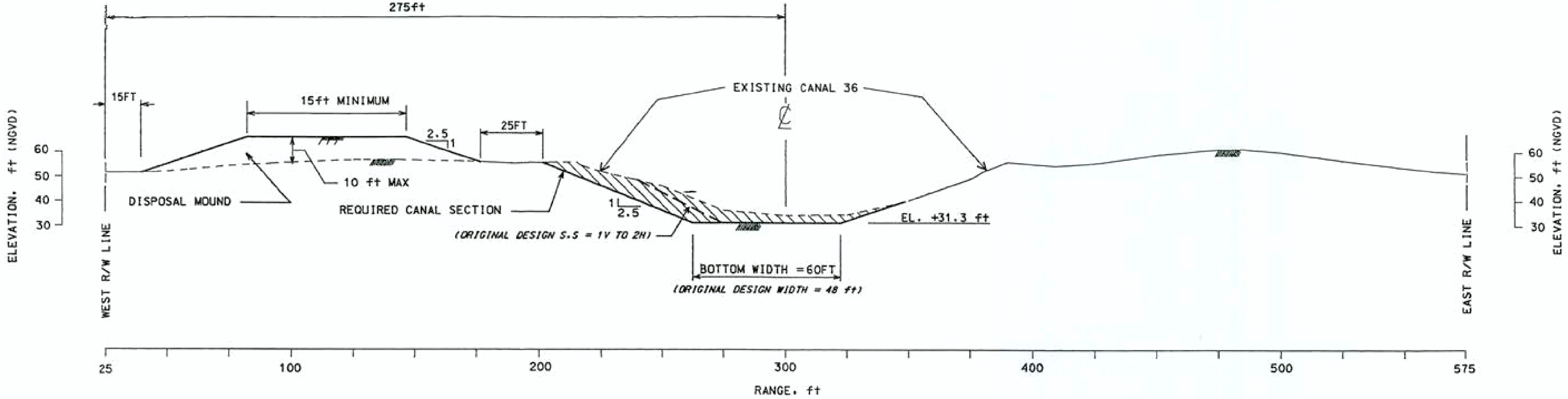
11. General. Maintenance and operation of the new spillway structure will be performed by the project sponsor. All applicable criteria for the existing spillway will apply to the new spillway. The contractor will be responsible for all maintenance required during the contract. Operation and Maintenance of the project facilities will be performed in accordance with the instructions prepared and incorporated into the "Operation and Maintenance Manual" which will be furnished to the project sponsor prior to turning the project over to the sponsor.

KISSIMMEE RIVER
HEADWATERS REVITALIZATION REPORT

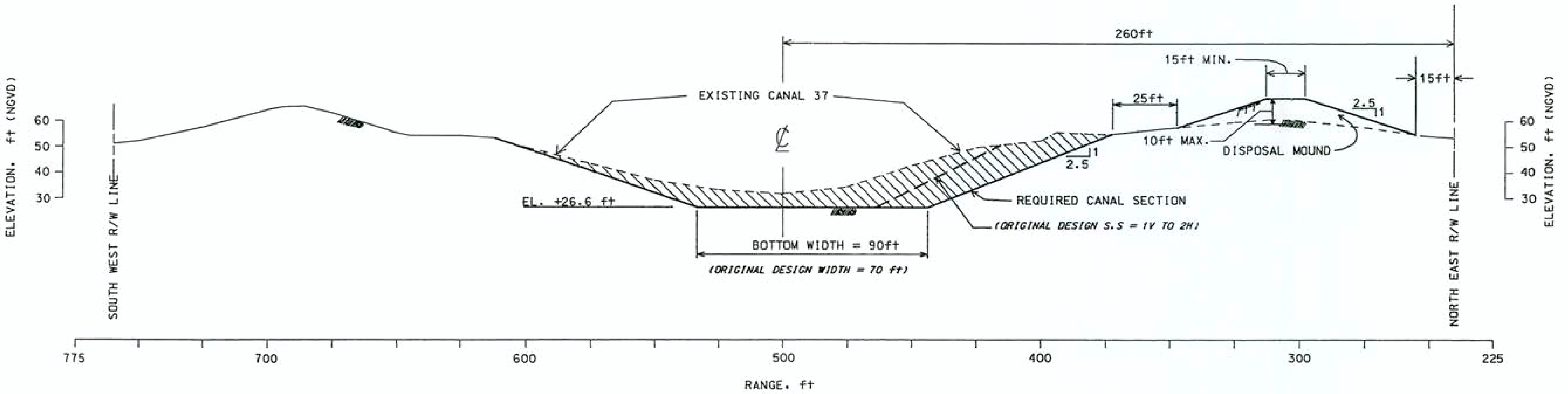
APPENDIX D

Design and Cost Estimates

PLATES



C-36 SECTION AT STA. 100+00



C-37 SECTION AT STA. 130+00

NOTES:

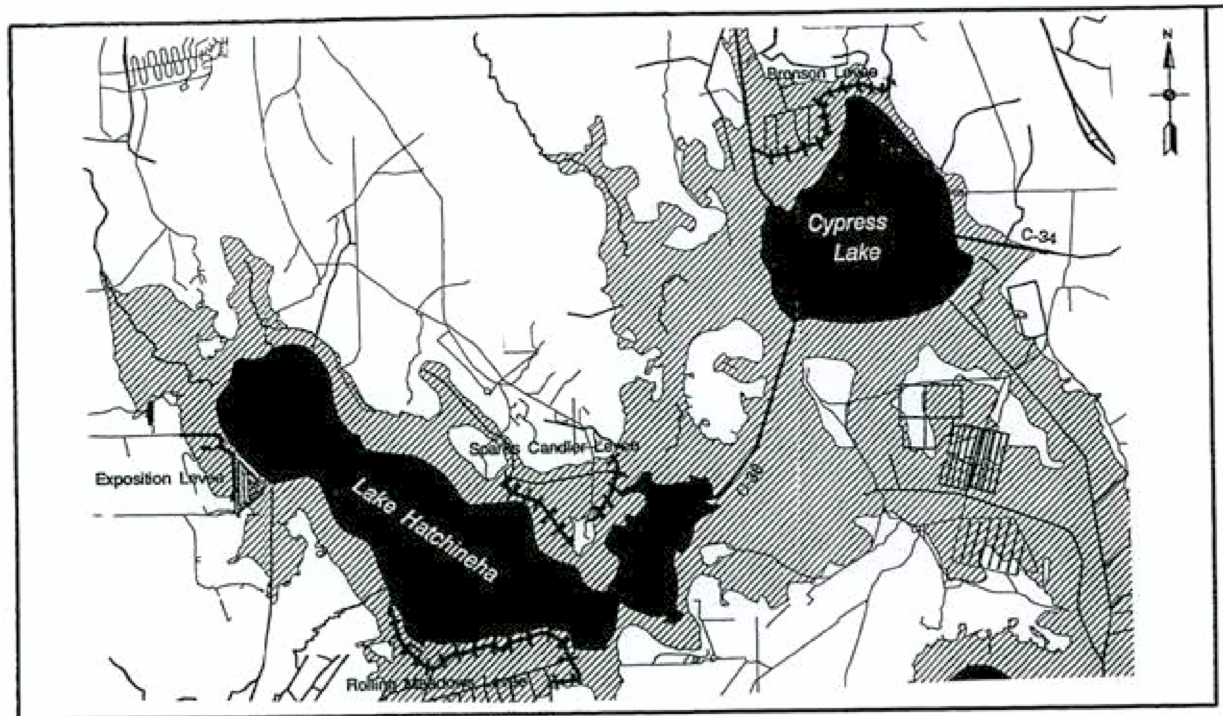
1. The area shown within the required canal section represents the material to be removed during both maintenance and widening operations.

CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION

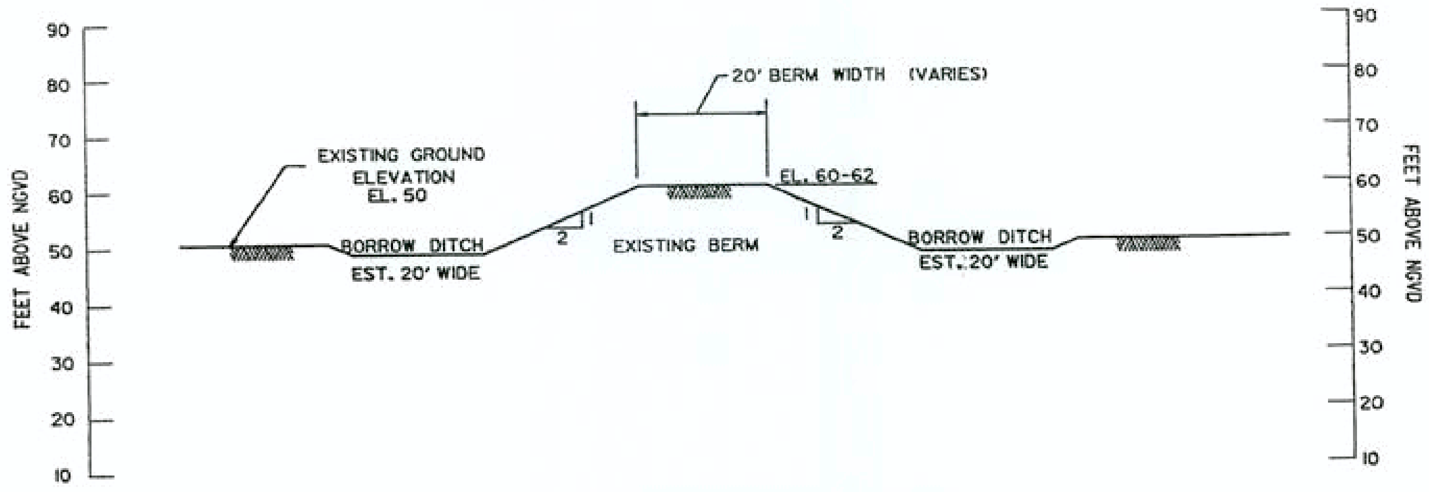
CONSTRUCTION FOR C-36 AND C-37

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 935 PROJECT MODIFICATION REPORT

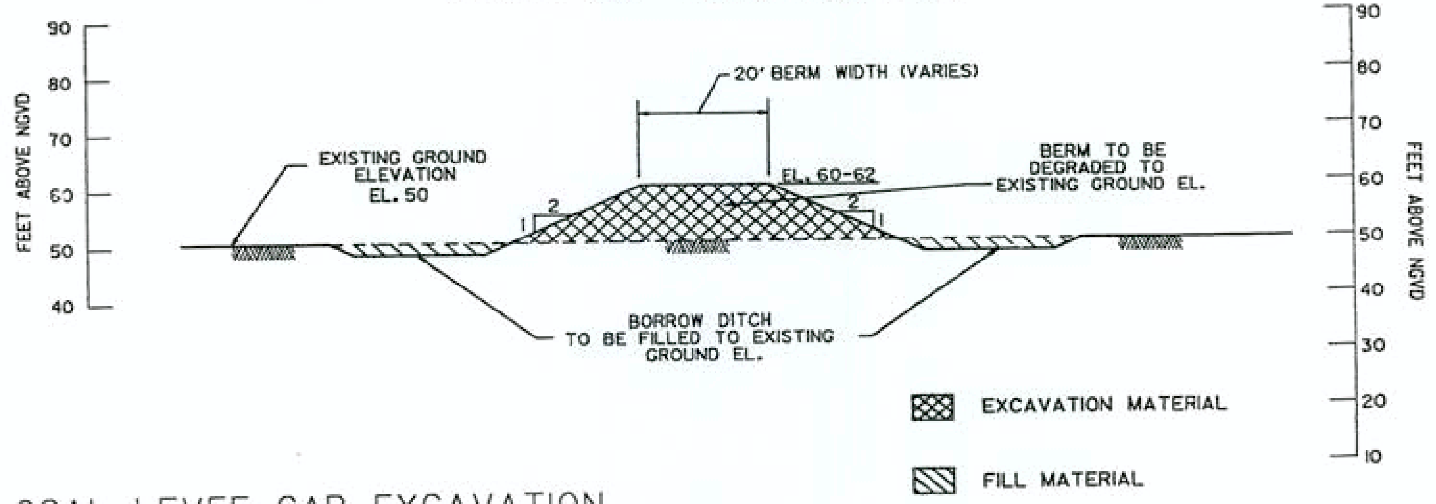
D.O. FILE NO. 400-36,826
DATE: JULY 1995

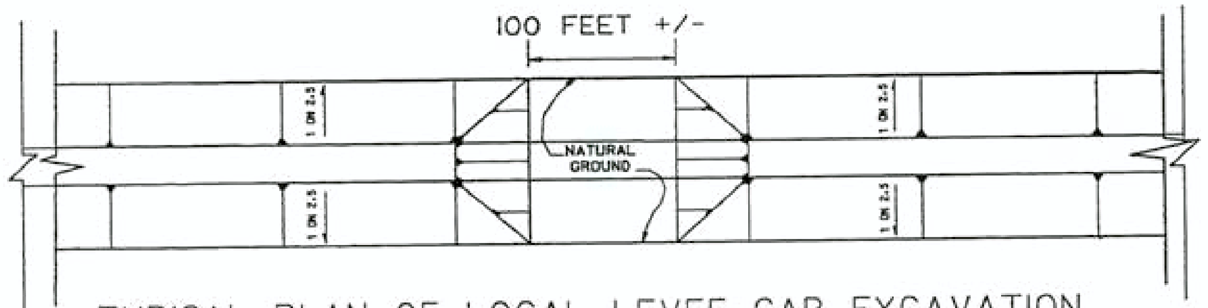


TYPICAL CROSS-SECTION OF LOCAL LEVEES



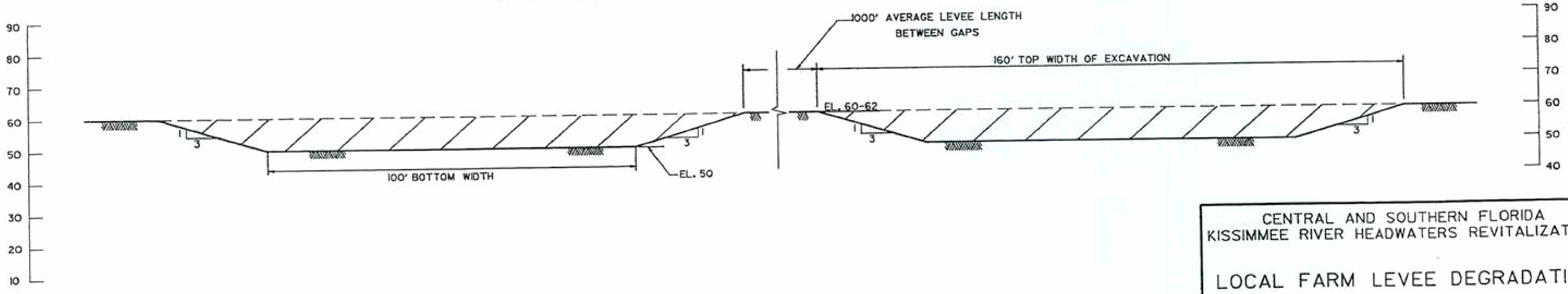
TYPICAL CROSS-SECTION OF LEVEE GAP CONSTRUCTION





TYPICAL PLAN OF LOCAL LEVEE GAP EXCAVATION

TYPICAL PROFILE OF LOCAL LEVEE GAP EXCAVATION



▨ SHADED REGION INDICATES MATERIAL TO BE EXCAVATED

CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION

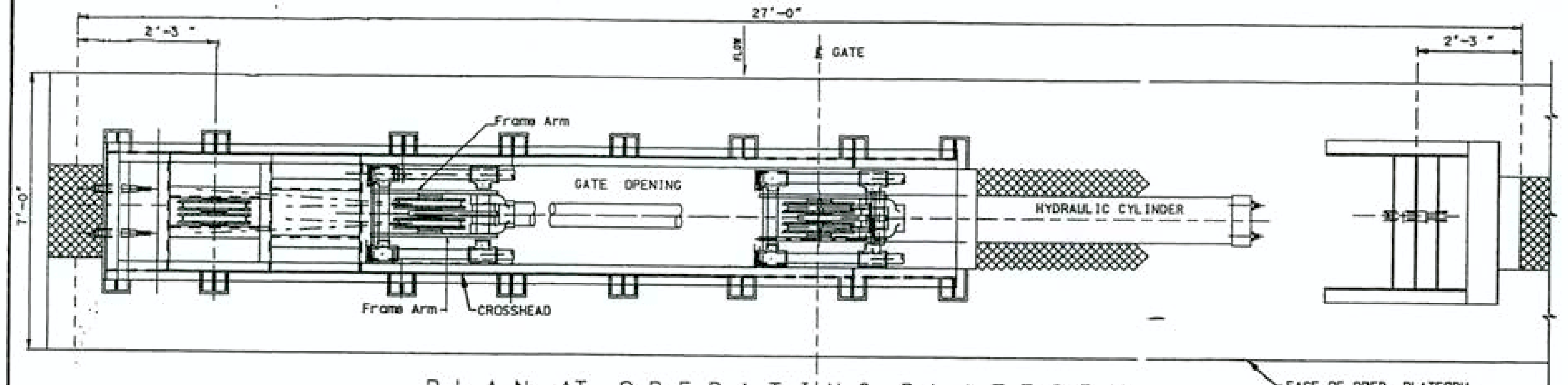
LOCAL FARM LEVEE DEGRADATION

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

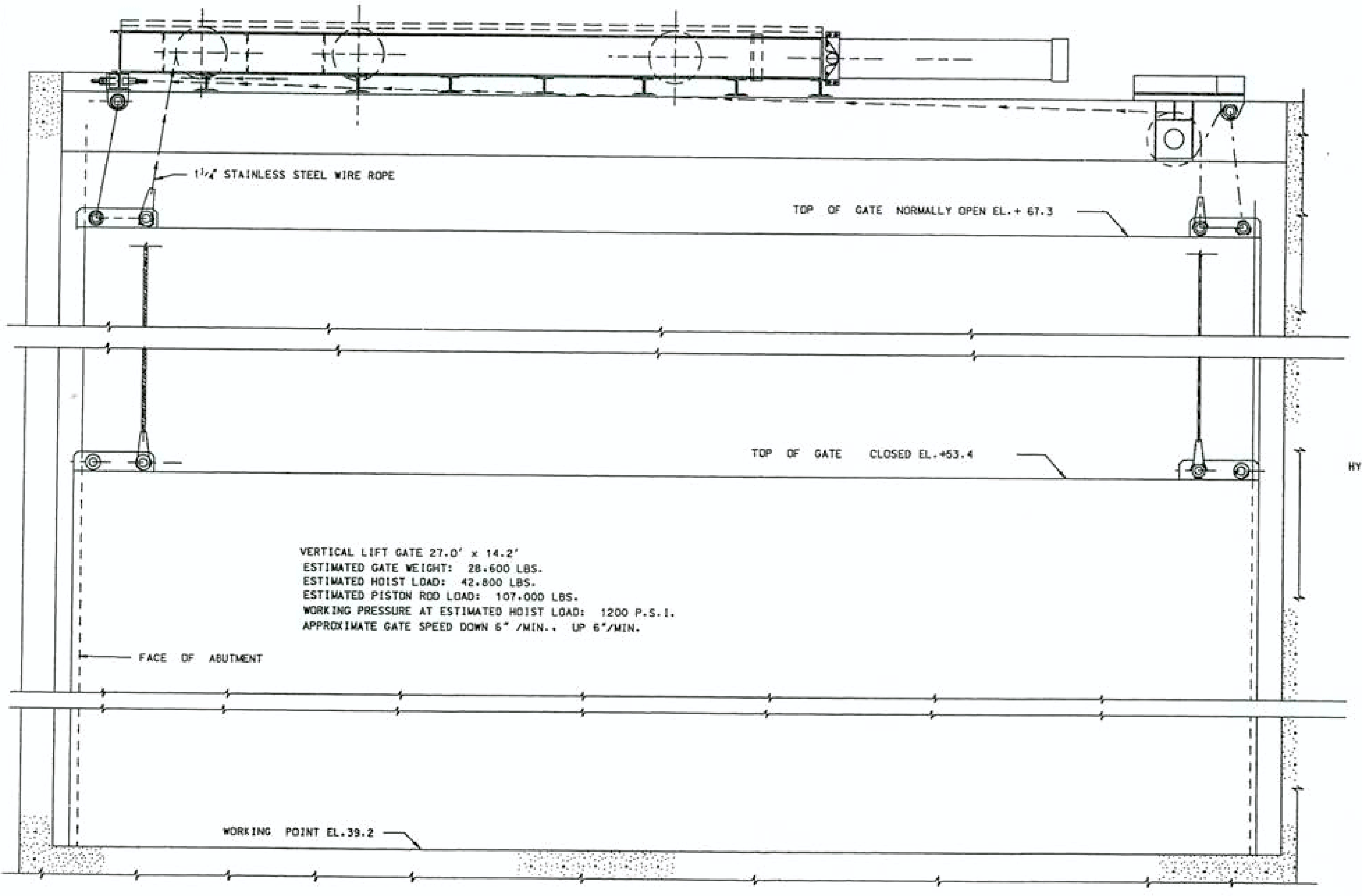
SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826
DATE: JULY 1995

PLATE D-2



PLAN AT OPERATING PLATFORM



VERTICAL LIFT GATE 27.0' x 14.2'
ESTIMATED GATE WEIGHT: 28,600 LBS.
ESTIMATED HOIST LOAD: 42,800 LBS.
ESTIMATED PISTON ROD LOAD: 107,000 LBS.
WORKING PRESSURE AT ESTIMATED HOIST LOAD: 1200 P.S.I.
APPROXIMATE GATE SPEED DOWN 6" /MIN., UP 6"/MIN.

SECTION ELEVATION

NOT TO SCALE

HOIST HYDRAULIC SYSTEM

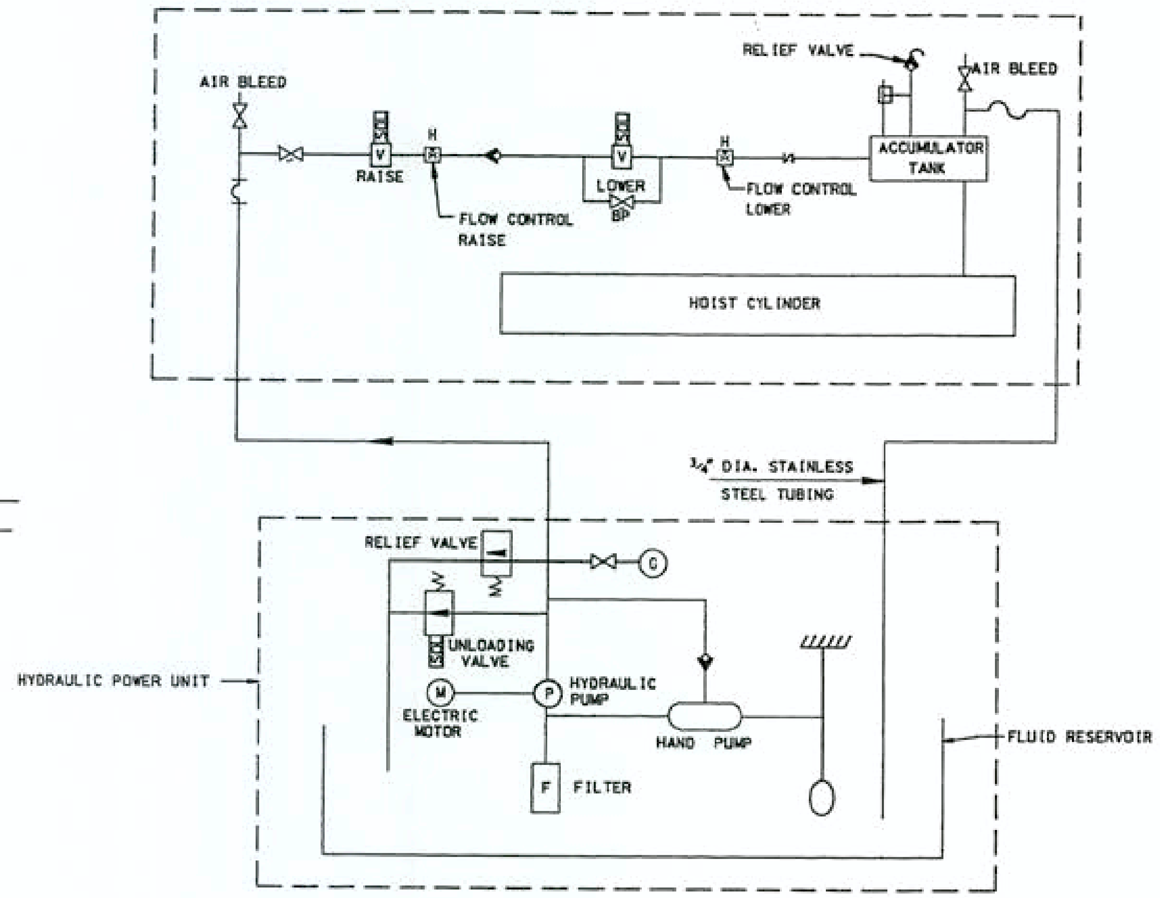
NOTES:

1. WITH THIS SYSTEM, OIL IS PUMPED TO THE CYLINDER WHEN GATE IS OPENED.
2. DRAIN LINES TO COMPONENTS REQUIRING SAME SHALL BE PROVIDED ALTHOUGH NOT SHOWN.
3. AIR BLEEDING VALVES SHALL BE PROVIDED AT HIGH POINTS OF SYSTEM.

LEGEND

1. HYDRAULIC HOIST CYL. 12" BORE, 5½" Ø ROD, 84" STROKE.
2. ALL PIPES SHALL BE STAINLESS STEEL TUBING WITH 0.065" WALL.

M ELECT. MOTOR 3HP, 230V, 1ϕ
P PUMP RATED AT 1.4 GPM AT 2000 P.S.I., 1800 R.P.M.
G PRESSURE GAGE, 0-3000 P.S.I.
BP BYPASS
V SOLENOID VALVE NORMALLY CLOSED.
H VARIABLE FLOW CONTROL VALVES PRESSURE COMPENSATED.



NOTE: THE UNLOADING VALVE IS SOLENOID OPERATED, TIME DELAYED, AND SPRING OFFSET

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION

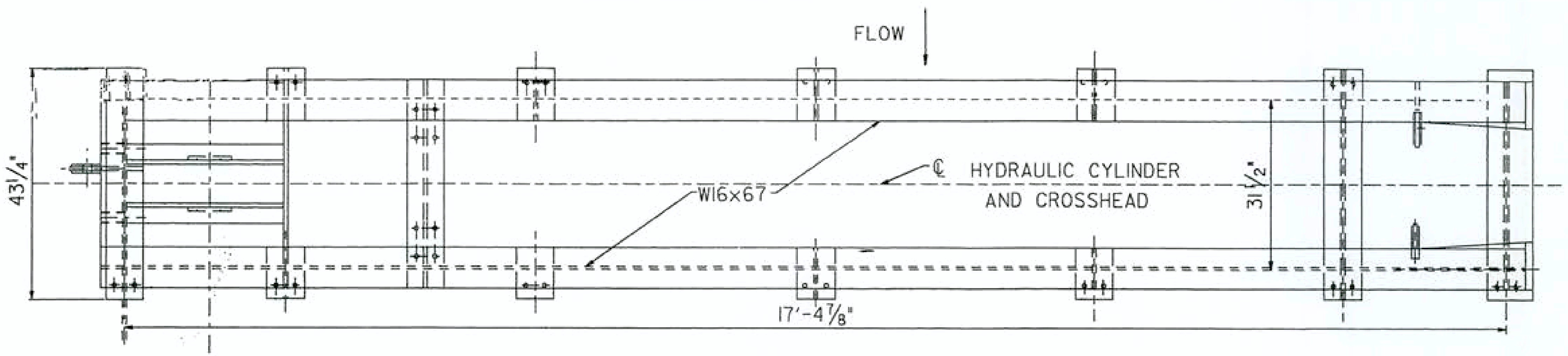
GATE HOIST

(SCALES AS SHOWN)

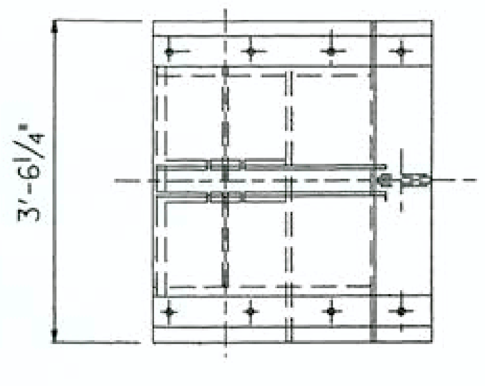
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

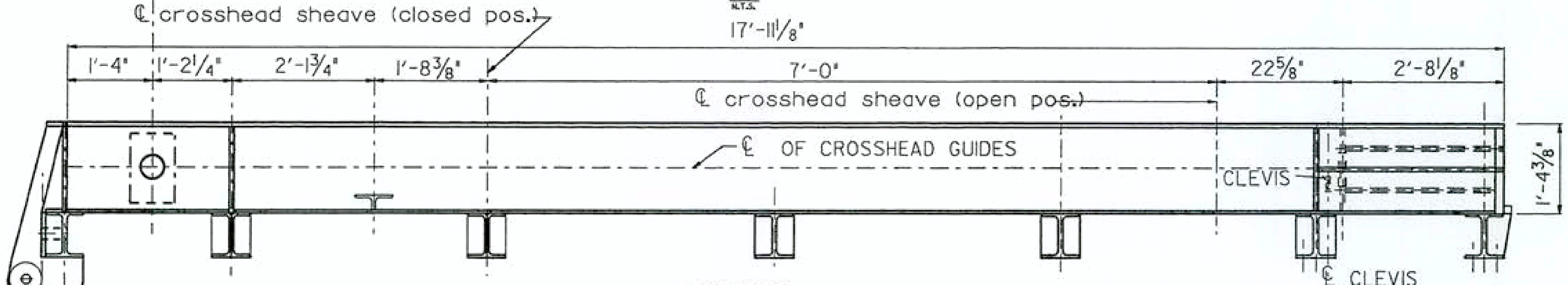
SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826

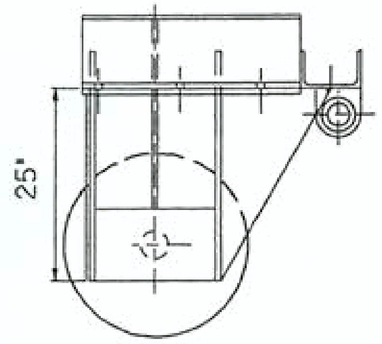


PLAN
N.T.S.

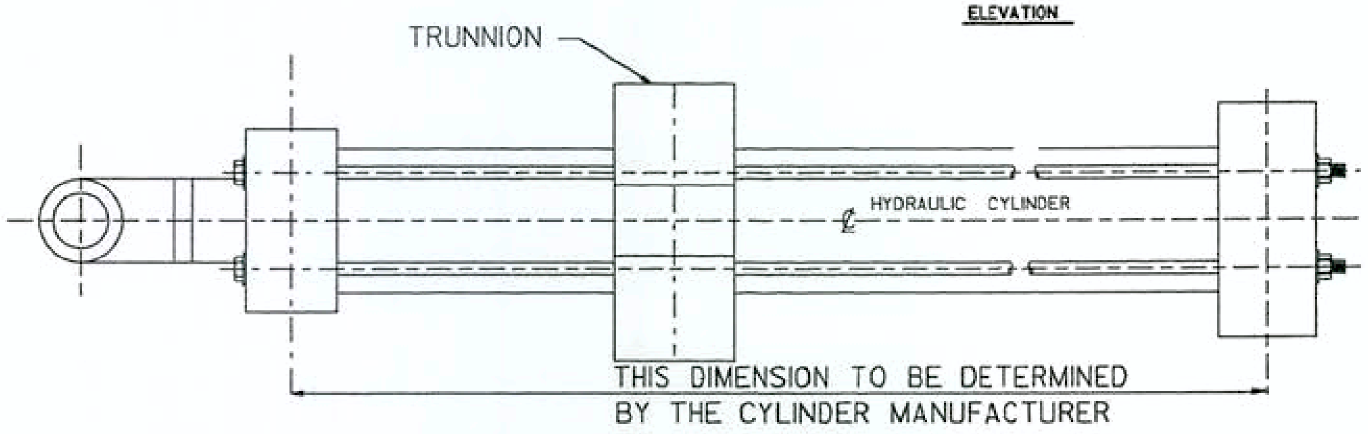




BASE ELEVATION

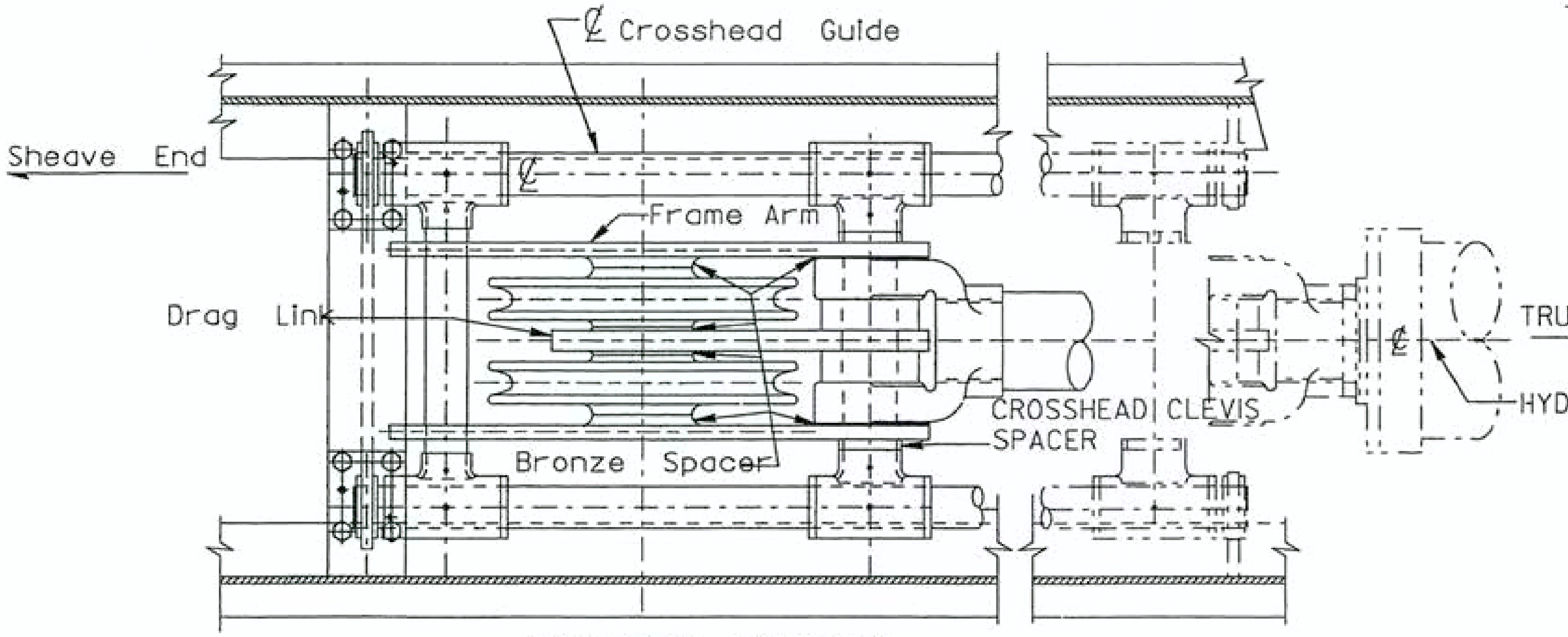


ELEVATION



NOTE: HYDRAULIC CYLINDER - 12" BORE, 5½" DIA. ROD & 84" WORKING STROKE

HYDRAULIC CYLINDER



CROSSHEAD ASSEMBLY

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

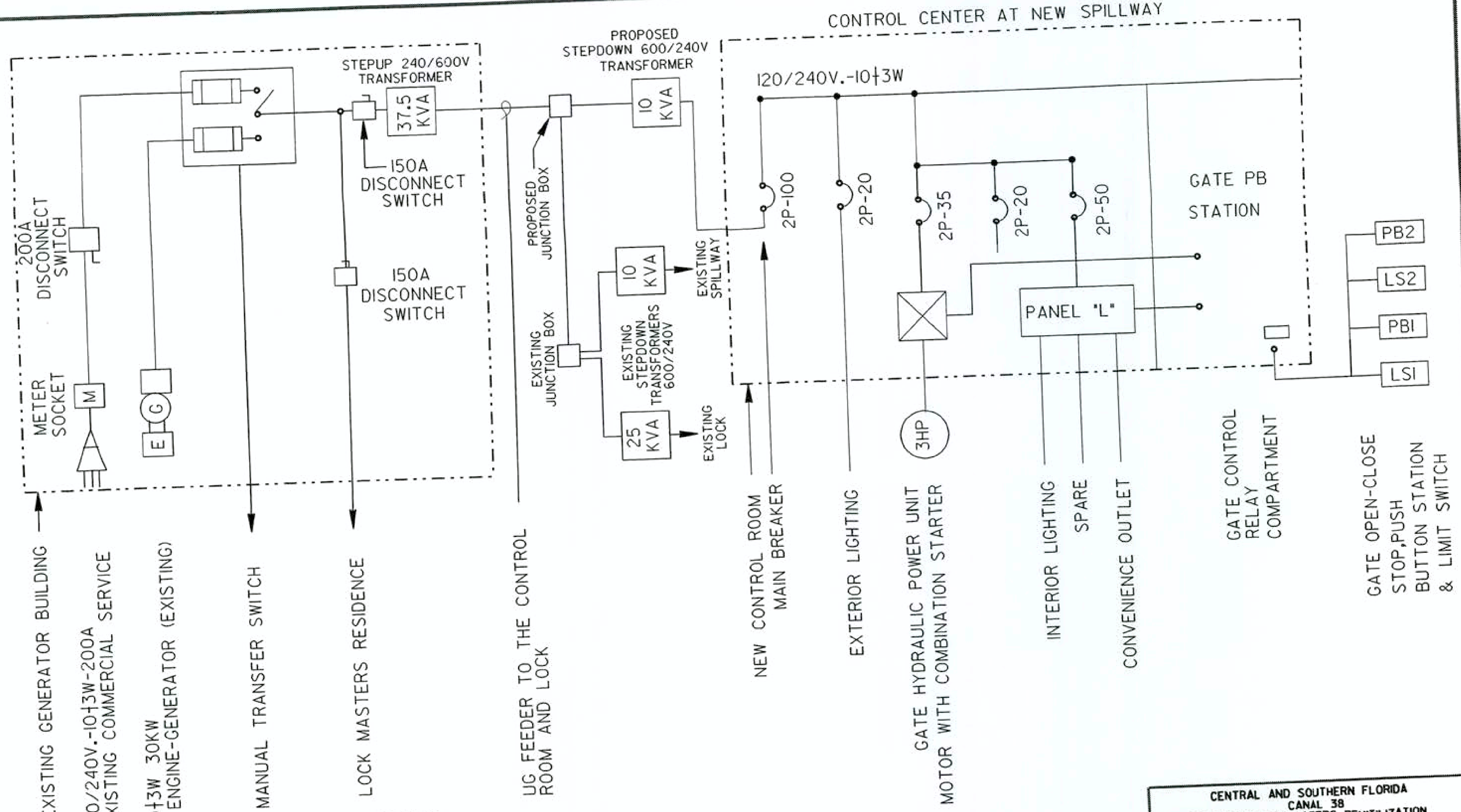
STRUCTURE S-65 ADDITION
GATE HOIST
MECHANICAL DETAILS

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826



NOTES

1. FOR NEW POWERLINE AND SERVICE POLE LOCATION SEE PLATE ME-4.
2. SFWMD PROPOSES TO UPGRADE THE EMERGENCY GENERATOR TO A 60KW UNIT IN 1-2 YEARS.
3. THE EXISTING ELECTRICAL SERVICE, FEEDERS, AND ASSOCIATED EQUIPMENT SHALL BE UPGRADED TO 300A CAPACITY.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

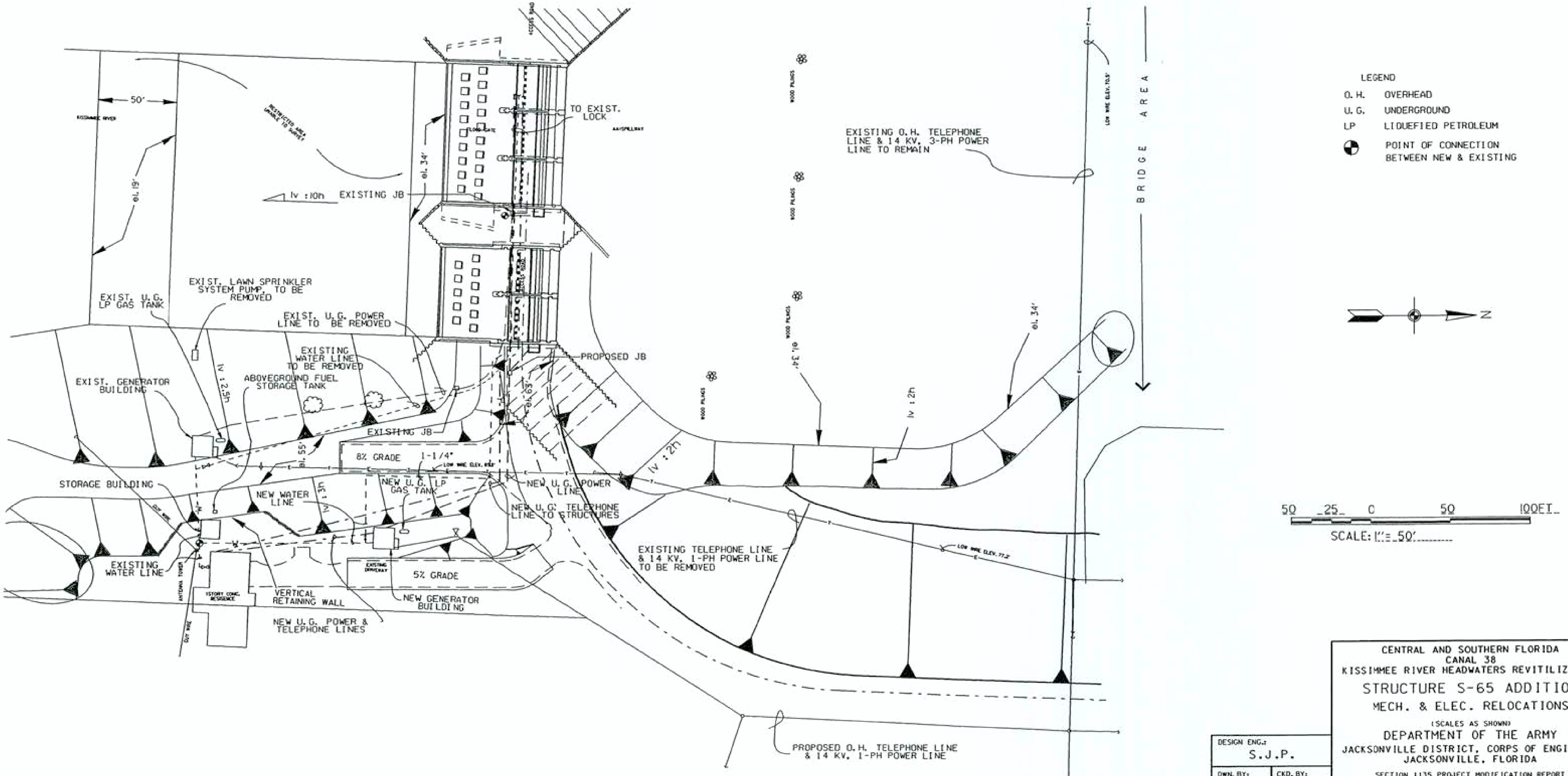
STRUCTURE S-65 ADDITION
ELECTRICAL SYS.-ONE LINE DIAGRAM
(NO SCALE)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT

DESIGN ENG.: S.M.	
DWN. BY: W.F.	CKD. BY: D.L.N.

D.O. FILE NO. 400-36,826
DATE: OCTOBER 1994

ME-3



CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION

MECH. & ELEC. RELOCATIONS

(SCALES AS SHOWN)

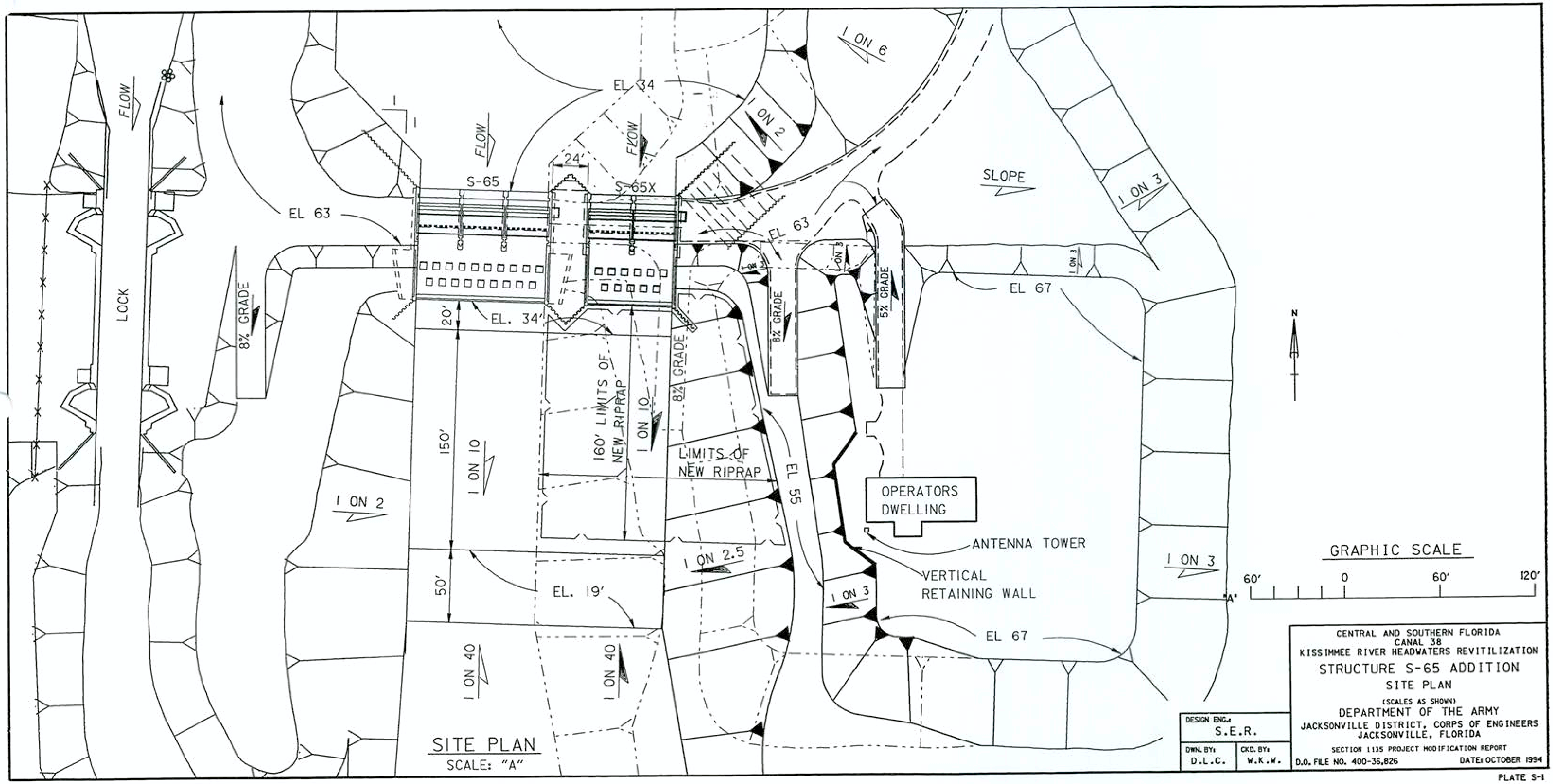
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

DESIGN ENG.: S.J.P.	
DWN. BY: S.J.P.	CKD. BY: S.M.

D.O. FILE NO. 400-36,826
DATE: JANUARY 1995

PLATE ME-



SITE PLAN
SCALE: "A"

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION
SITE PLAN
(SCALES AS SHOWN)

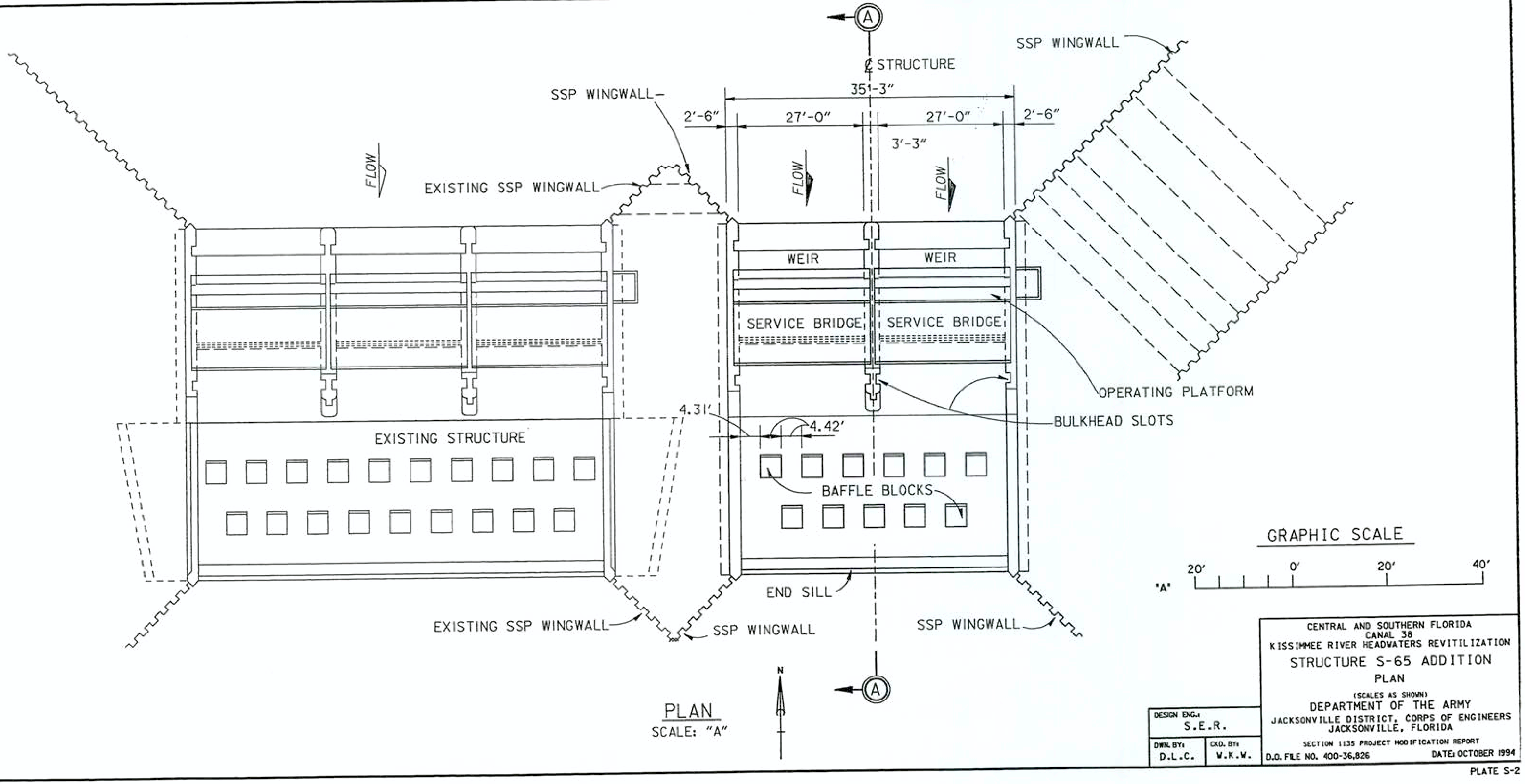
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826
DATE: OCTOBER 1994

DESIGN ENG.: S.E.R.
DWN. BY: D.L.C.
CKD. BY: W.K.W.

PLATE S-1



PLAN
SCALE: "A"

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

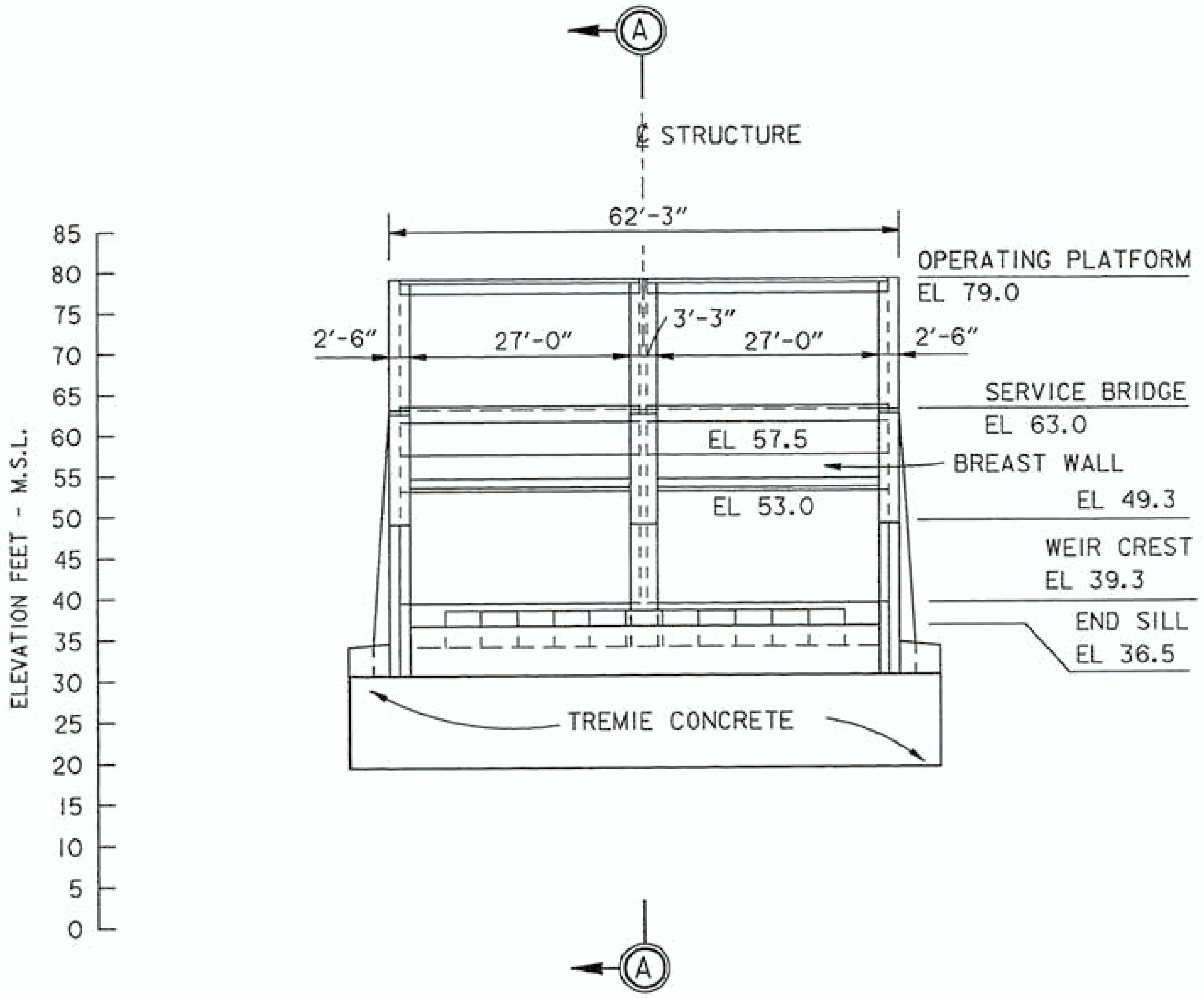
STRUCTURE S-65 ADDITION
PLAN
(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826
DATE: OCTOBER 1994

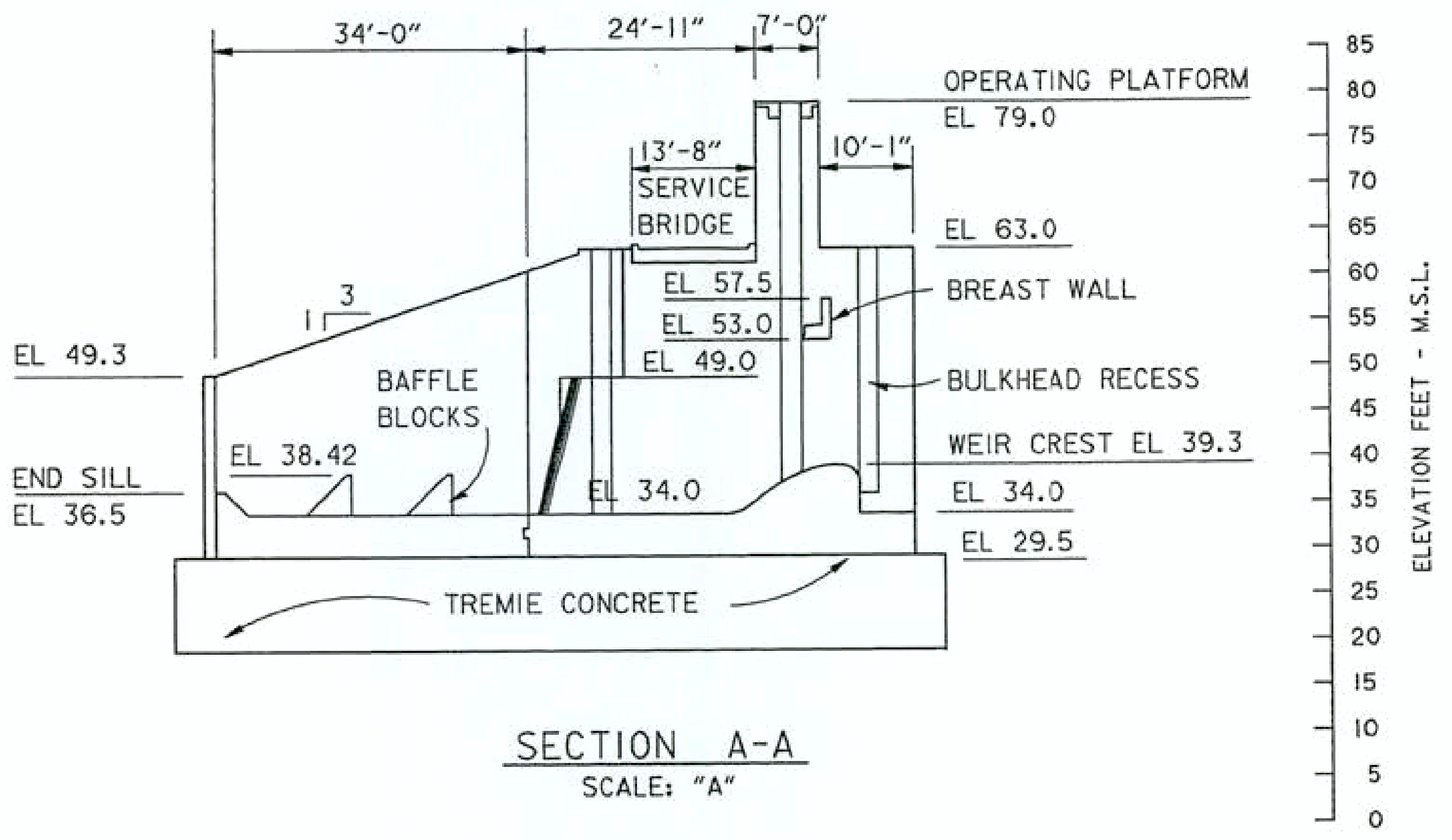
DESIGN ENG.: S.E.R.	
DWN. BY: D.L.C.	CKD. BY: W.K.W.

PLATE S-2



DOWNSTREAM ELEVATION

SCALE: "A"



SECTION A-A

SCALE: "A"

GRAPHIC SCALE

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION
ELEVATION AND SECTION
(SCALES AS SHOWN)

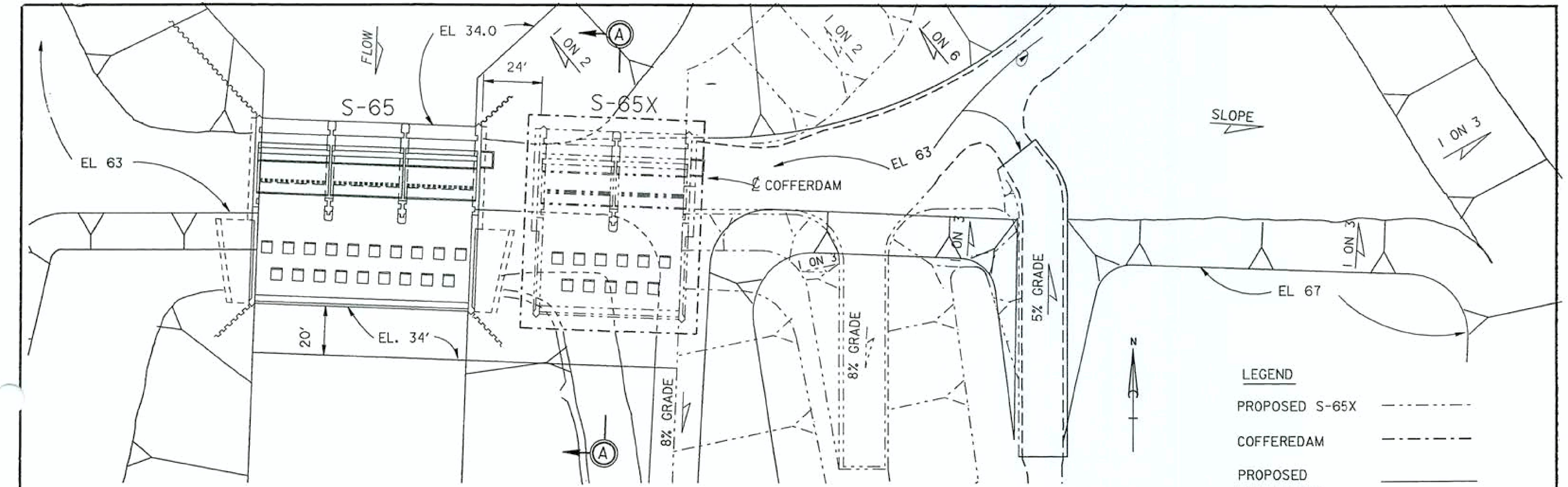
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826
DATE: OCTOBER 1994

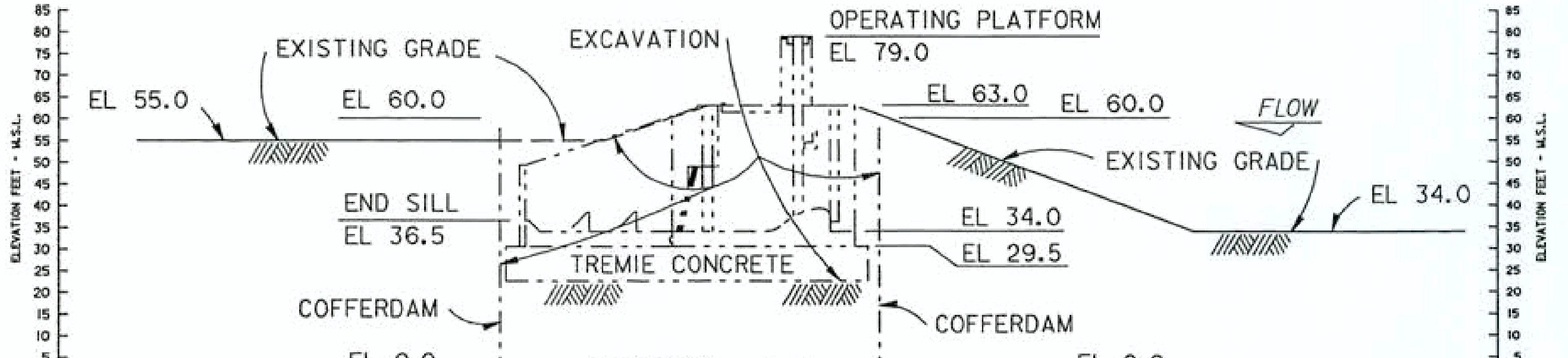
DESIGN ENG.: S.E.R.
DWN. BY: D.L.C.
CKD. BY: W.K.W.

PLATE S-3



CONSTRUCTION SITE PLAN

SCALE: "A"



SECTION A-A

SCALE: "A"

GRAPHIC SCALE

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION
CONSTRUCTION SITE PLAN AND SECTION

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

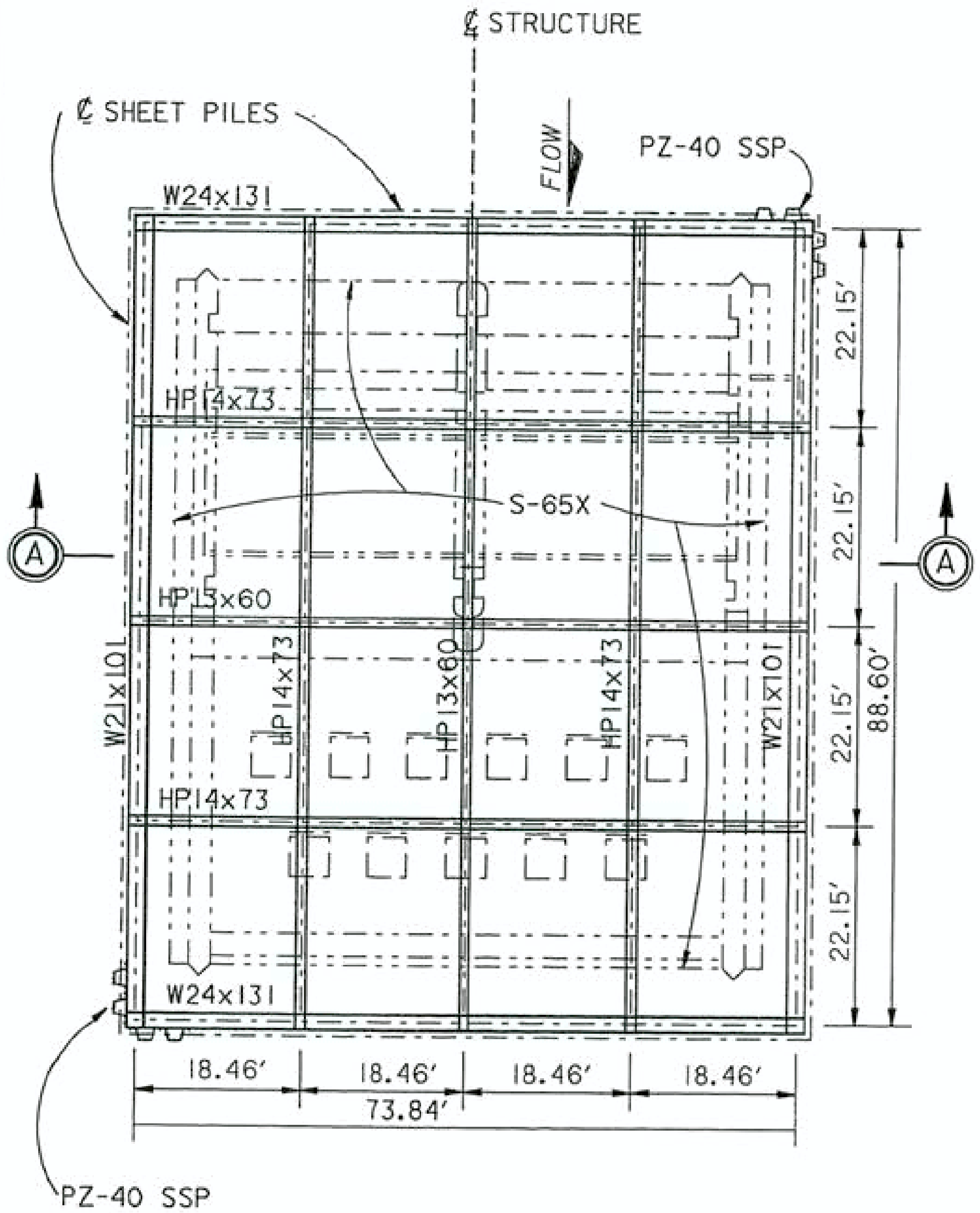
D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994

DESIGN ENG.: S.E.R.

DWN. BY: D.L.C.

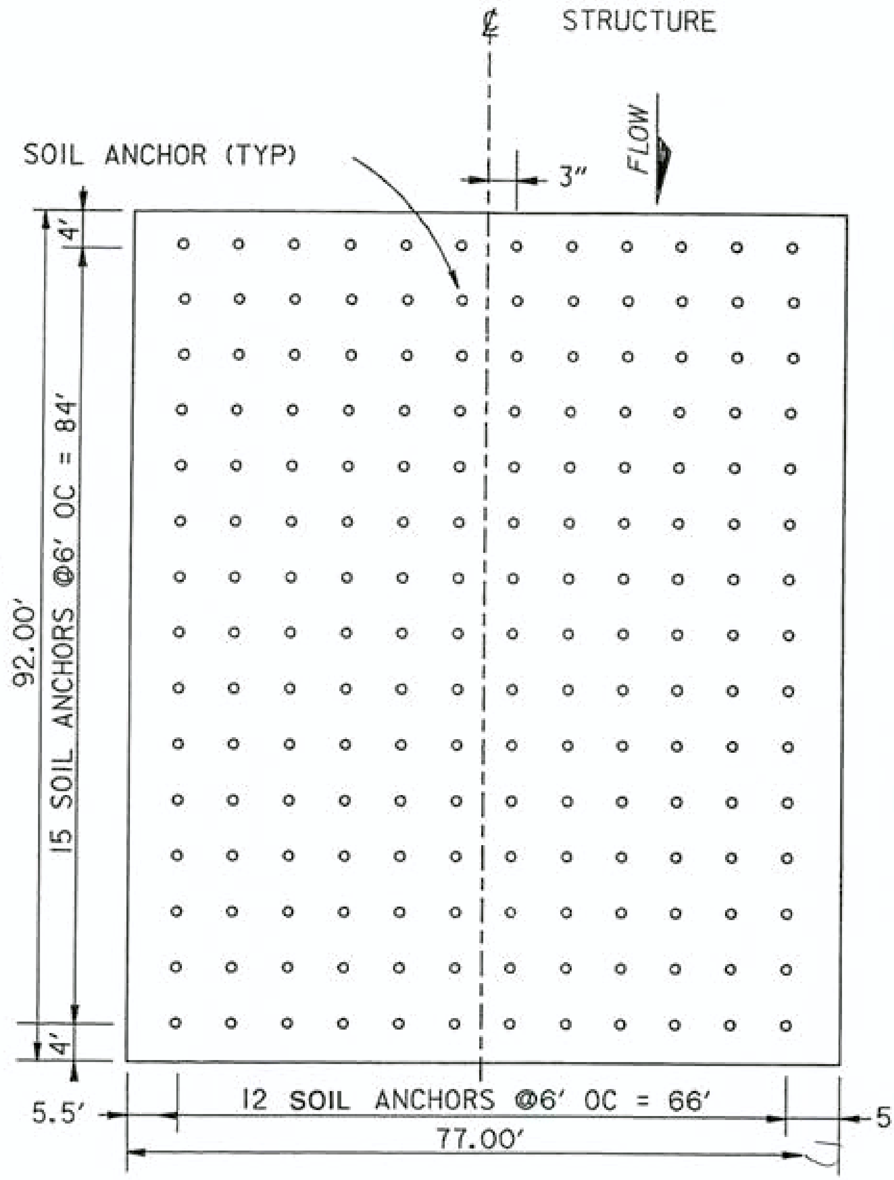
CKD. BY: W.K.W.

PLATE S-4



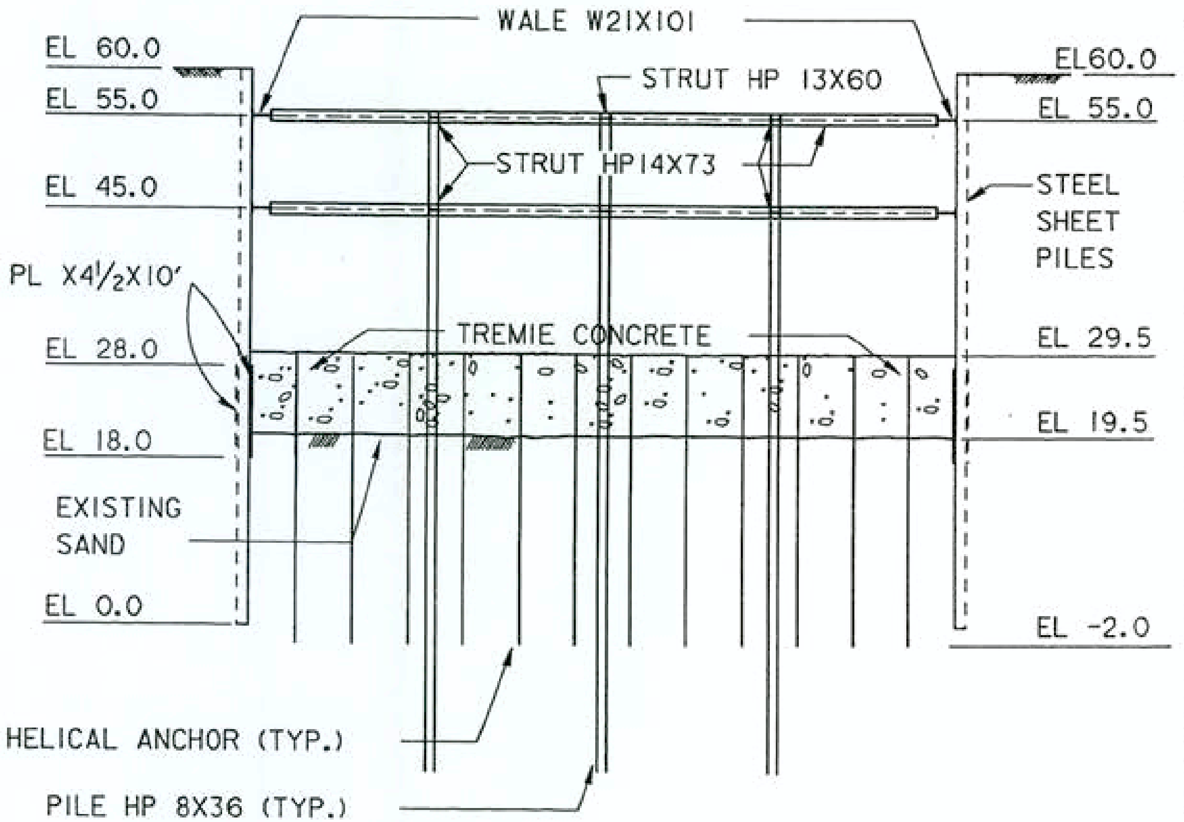
COFFERDAM PLAN

SCALE: "A"



SOIL ANCHOR PLAN

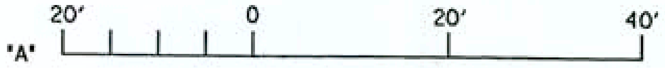
SCALE: "A"



SECTION A-A

SCALE: "A"

GRAPHIC SCALE



CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION
STRUCTURE S-65 ADDITION
DEWATERING COFFERDAM PLAN/SECTION
(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994

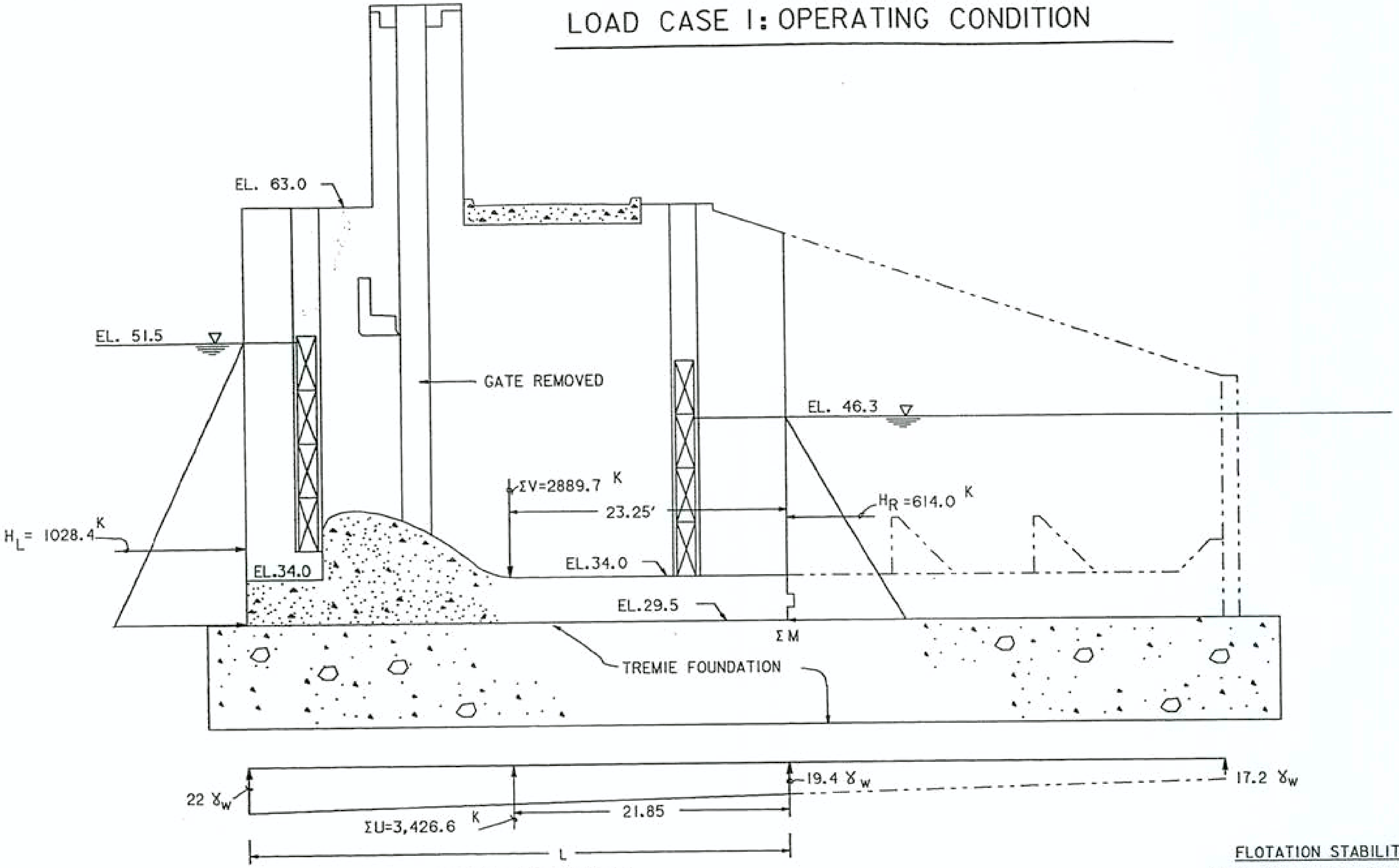
DESIGN ENG.: S.E.R.
DWN. BY: D.L.C.
CKD. BY: W.K.W.

PLATE S-5

LOAD CASE I: OPERATING CONDITION

NOTES:

1. ONE BAY DEWATERED AND THE CTHER BAY IN OPERATION.
2. STABILITY RESULTS ARE FOR CNTROL STRUCTURE ONLY. SEE PLATES FOR STABILITY RESULTS OF STILLING BASIN.



OVERTURNING STABILITY

BASE AREA IN COMPRESSION: 100%; e=0.67'
MINIMUM ALLOWADLE BASE AREA IN COMPRESSION: 75%

FLOTATION STABILITY

LOAD CASE I: S.F.=1.84 ≥ 1.5

SLIDING STABILITY

HORIZONTAL FAILURE PLANE DATA	
STRUCTURAL WEDGE	
TAN Ø; Ø=45 °	1.0
∝	0°
L (FT)	42.0
W (KIPS)	6,316.3
U (KIPS)	3,426.6
H_L (KIPS)	1,028.4
H_R (KIPS)	614.0
SLIDING S.F. = 6.97 > 2.0	

SYMBOL	SYMBOL DESCRIPTION
Ø	ANGLE OF OBLIQUITY
∝	INCLINATION ANGLE OF POTENTIAL FAILURE SURFACE
γ_W	UNIT WEIGHT OF WATER (0.0625 KCF)
W	TOTAL WEIGHT OF WATER, SOIL AND STRUCTURE
U	UPLIFT FORCE ON THE FAILURE SURFACE
H_L	HORIZONTAL LOAD APPLIED TO THE STRUCTURE
H_R	HORIZONTAL LOAD APPLIED TO THE STRUCTURE - OPPOSITE DIRECTION
L	LENGTH OF WEDGE ALONG THE FAILURE SURFACE

GRAPHIC SCALE

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION
STRUCTURE S-65 ADDITION
SLIDING, OVERTURNING AND FLOTATION
STABILITY ANALYSIS-LOAD CASE I
(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826
DATE: OCTOBER 1994

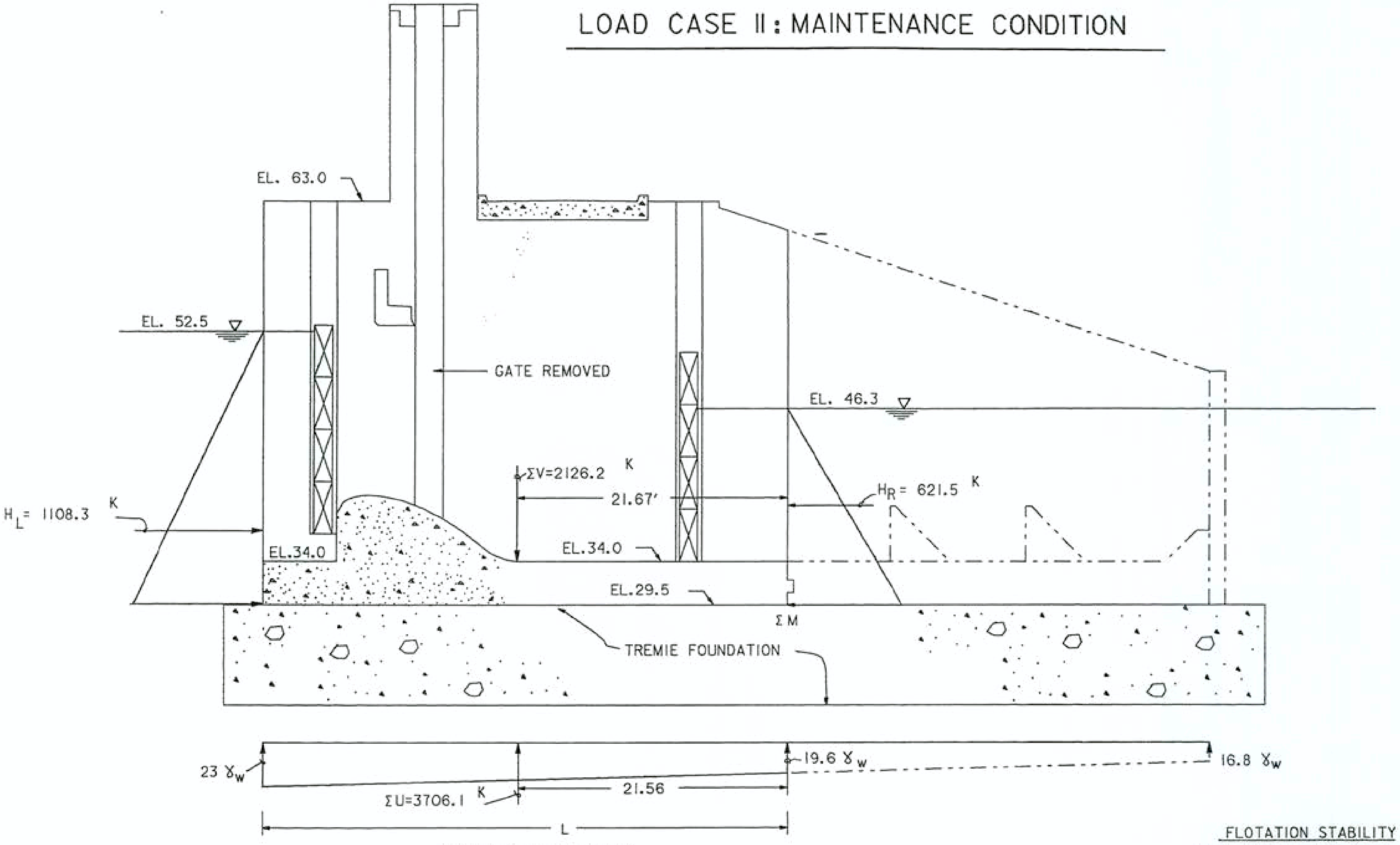
DESIGN ENG.: S.E.R.
DWN. BY: D.L.C.
CKD. BY: W.K.W.

PLATE S-6

LOAD CASE II: MAINTENANCE CONDITION

NOTES:

1. ONE BAY DEWATERED AND THE OTHER BAY IN OPERATION.
2. STABILITY RESULTS ARE FOR CNTROL STRUCTURE ONLY. SEE PLATES   FOR STABILITY RESULTS OF STILLING BASIN.



OVERTURNING STABILITY

BASE AREA IN COMPRESSION: 100%;   e=0.67'
MINIMUM ALLOWADLE BASE AREA IN COMPRESSION: 75%

FLOTATION STABILITY

LOAD CASE II: S.F.=1.57   1.3

SLIDING STABILITY

HORIZONTAL FAILURE PLANE DATA	
STRUCTURAL WEDGE	
TAN O; O=45 °	1.0
α	0°
L (FT)	42.0
W (KIPS)	5,832.3
U (KIPS)	3,706.1
H_L (KIPS)	1,108.3
H_R (KIPS)	621.5
SLIDING S.F. = 4.37 2.0	

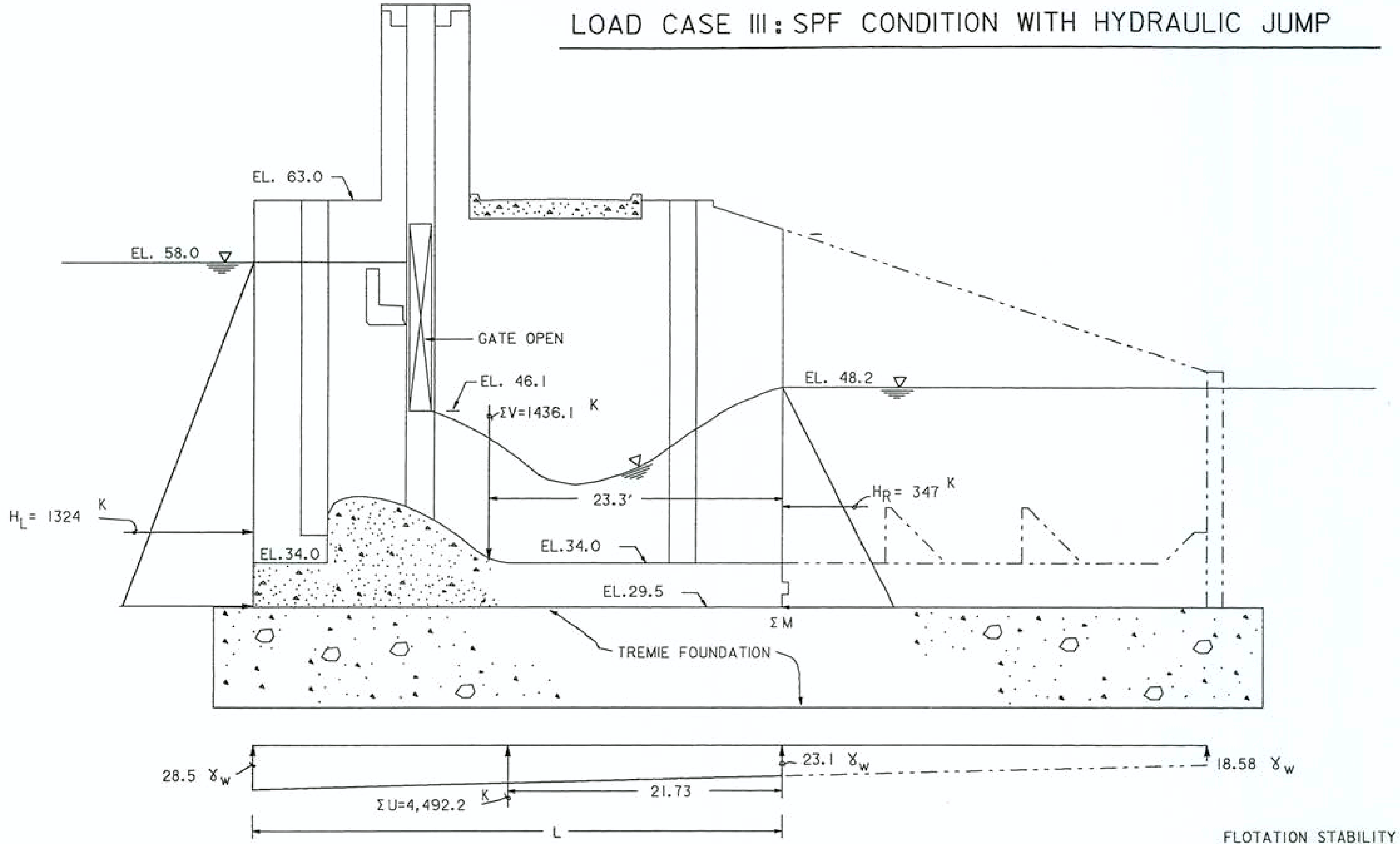
SYMBOL	SYMBOL DESCRIPTION
ϕ	ANGLE OF OBLIQUITY
α	INCLINATION ANGLE OF POTENTIAL FAILURE SURFACE
γ_w	UNIT WEIGHT OF WATER (0.0625 KCF)
W	TOTAL WEIGHT OF WATER, SOIL AND STRUCTURE
U	UPLIFT FORCE ON THE FAILURE SURFACE
H_L	HORIZONTAL LOAD APPLIED TO THE STRUCTURE
H_R	HORIZONTAL LOAD APPLIED TO THE STRUCTURE - OPPOSITE DIRECTION
L	LENGTH OF WEDGE ALONG THE FAILURE SURFACE

GRAPHIC SCALE

DESIGN ENG.: P.E.S.	
DWN. BY: D.L.C.	CKD. BY: W.K.W.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION
STRUCTURE S-65 ADDITION
SLIDING, OVERTURNING AND FLOTATION
STABILITY ANALYSIS-LOAD CASE II
(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826   DATE: OCTOBER 1994

LOAD CASE III: SPF CONDITION WITH HYDRAULIC JUMP



NOTE:

1. STABILITY RESULTS ARE FOR CNTROL STRUCTURE ONLY. SEE PLATES FOR STABILITY RESULTS OF STILLING BASIN.

FLOTATION STABILITY

LOAD CASE III: S.F.=1.32 1.1≥

OVERTURNING STABILITY

BASE AREA IN COMPRESSION: 100%; e=2.3′
MINIMUM ALLOWABLE BASE AREA IN COMPRESSION: 75%

SLIDING STABILITY

HORIZONTAL FAILURE PLANE DATA	
STRUCTURAL WEDGE	
TAN 0; 0=45 °	1.0
∝	0°
L (FT)	42.0
W (KIPS)	5,928.3
U (KIPS)	4,492.2
H_L (KIPS)	1,324.0
H_R (KIPS)	347
SLIDING S.F. = 1.47 1.3	

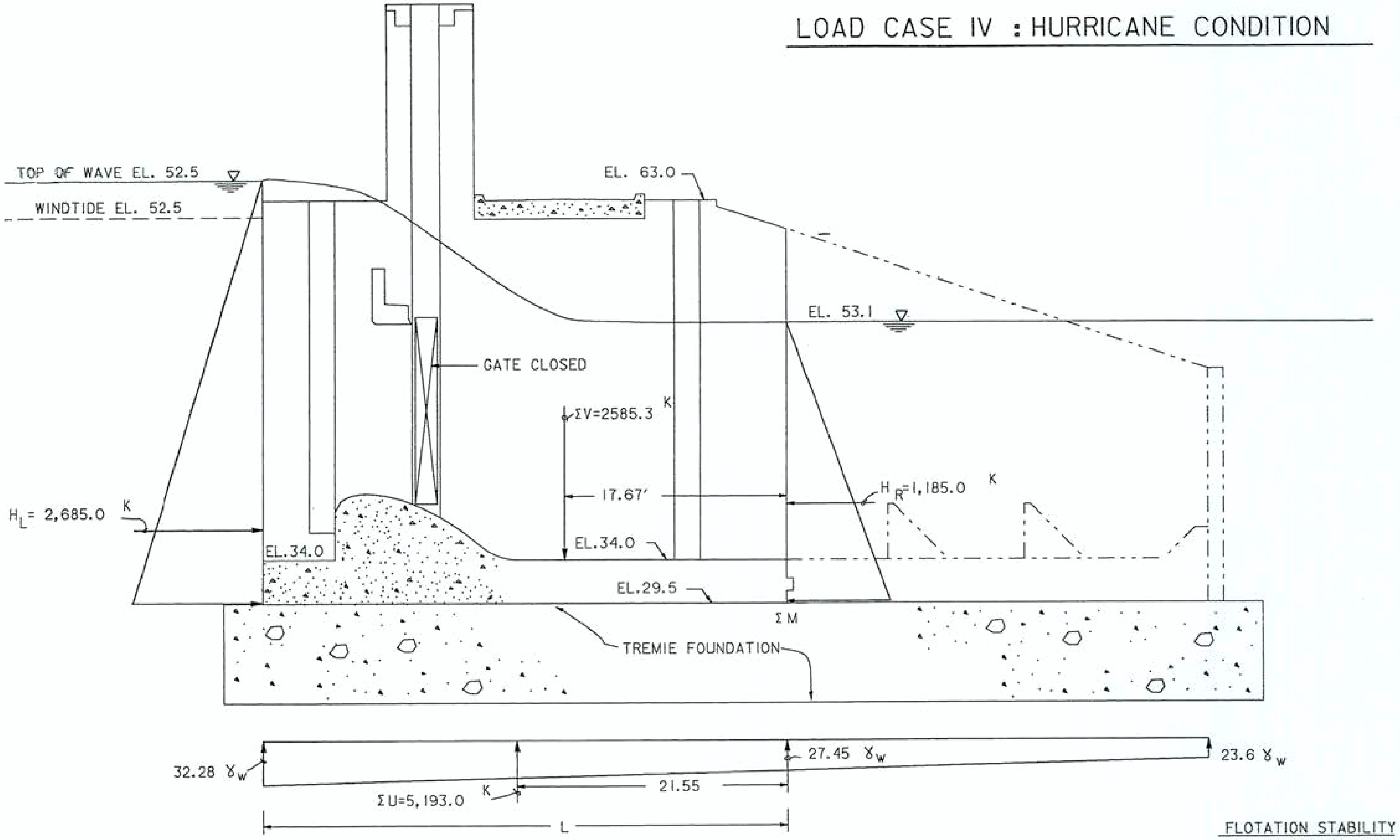
SYMBOL	SYMBOL DESCRIPTION
ø	ANGLE OF OBLIQUITY
∝	INCLINATION ANGLE OF POTENTIAL FAILURE SURFACE
γ_W	UNIT WEIGHT OF WATER (0.0625 KCF)
W	TOTAL WEIGHT OF WATER, SOIL AND STRUCTURE
U	UPLIFT FORCE ON THE FAILURE SURFACE
H_L	HORIZONTAL LOAD APPLIED TO THE STRUCTURE
H_R	HORIZONTAL LOAD APPLIED TO THE STRUCTURE - OPPOSITE DIRECTION
L	LENGTH OF WEDGE ALONG THE FAILURE SURFACE

GRAPHIC SCALE

DESIGN ENG.: P.E.S.
DWN. BY: D.L.C.
CKD. BY: W.K.W.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION
STRUCTURE S-65 ADDITION
SLIDING, OVERTURNING AND FLOTATION
STABILITY ANALYSIS-LOAD CASE III
(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994

LOAD CASE IV : HURRICANE CONDITION



NOTE:

1. STABILITY RESULTS ARE FOR CNTROL STRUCTURE ONLY. SEE PLATES FOR STABILITY RESULTS OF STILLING BASIN.

OVERTURNING STABILITY

BASE AREA IN COMPRESSION: 100%; e=3.33'
MINIMUM ALLOWABLE BASE AREA IN COMPRESSION: 75%

FLOTATION STABILITY

LOAD CASE IV: S.F.=1.50 ≥ 1.1

SLIDING STABILITY

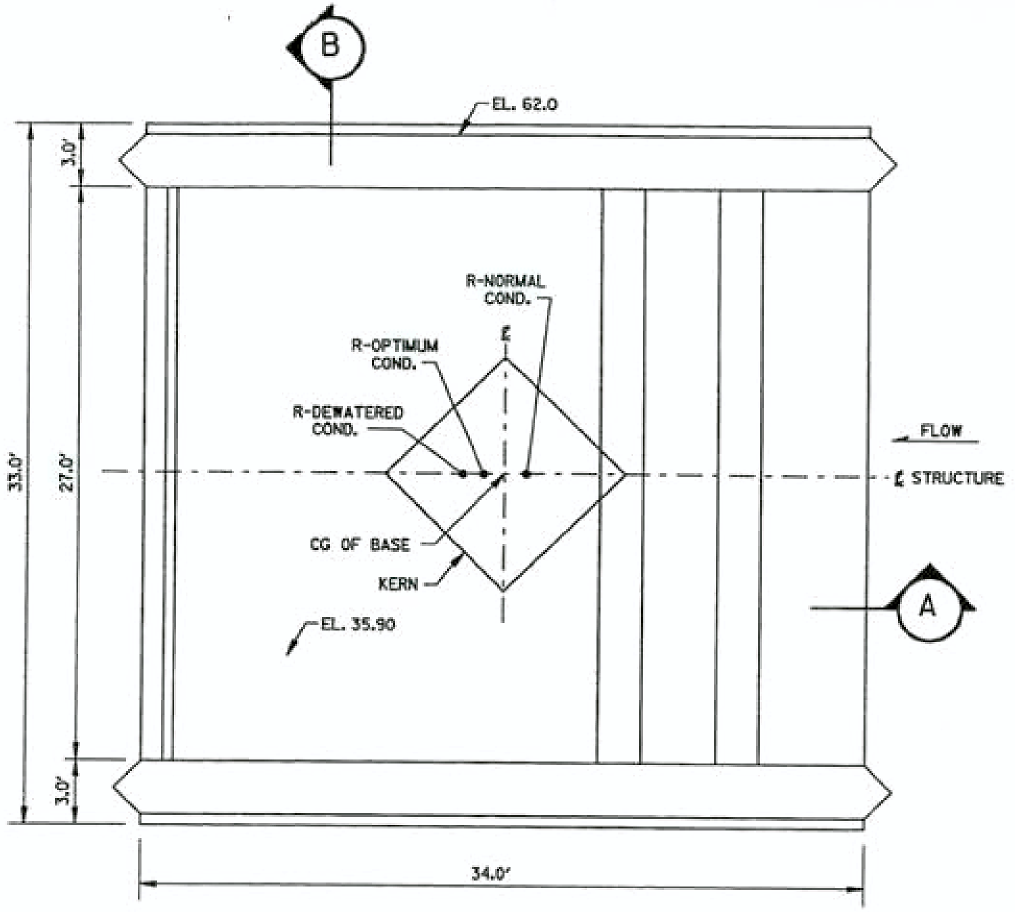
HORIZONTAL FAILURE PLANE DATA	
STRUCTURAL WEDGE	
TAN 0; 0=45 °	1.0
∝	0°
L (FT)	42.0
W (KIPS)	7,778.3
U (KIPS)	5,193.0
H_L (KIPS)	2,685.0
H_R (KIPS)	1,185.0
SLIDING S.F. = 1.72 > 1.3	

SYMBOL	SYMBOL DESCRIPTION
Ø	ANGLE OF OBLIQUITY
∝	INCLINATION ANGLE OF POTENTIAL FAILURE SURFACE
γ_W	UNIT WEIGHT OF WATER (0.0625 KCF)
W	TOTAL WEIGHT OF WATER, SOIL AND STRUCTURE
U	UPLIFT FORCE ON THE FAILURE SURFACE
H_L	HORIZONTAL LOAD APPLIED TO THE STRUCTURE
H_R	HORIZONTAL LOAD APPLIED TO THE STRUCTURE - OPPOSITE DIRECTION
L	LENGTH OF WEDGE ALONG THE FAILURE SURFACE

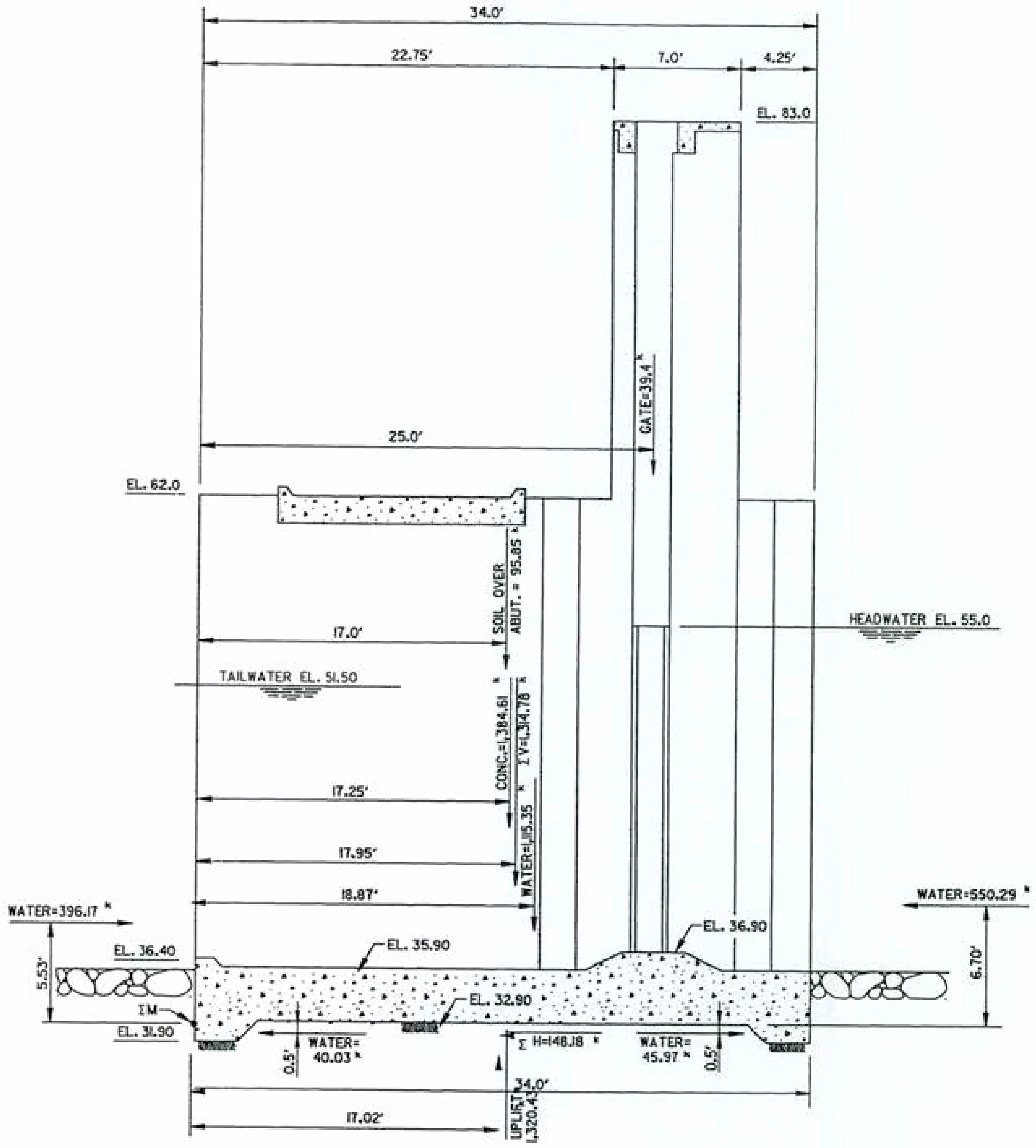
GRAPHIC SCALE

DESIGN ENG.: P.E.S.	
DWN. BY: D.L.C.	CKD. BY: W.K.W.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION
STRUCTURE S-65 ADDITION
SLIDING, OVERTURNING AND FLOTATION
STABILITY ANALYSIS-LOAD CASE IV
(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994

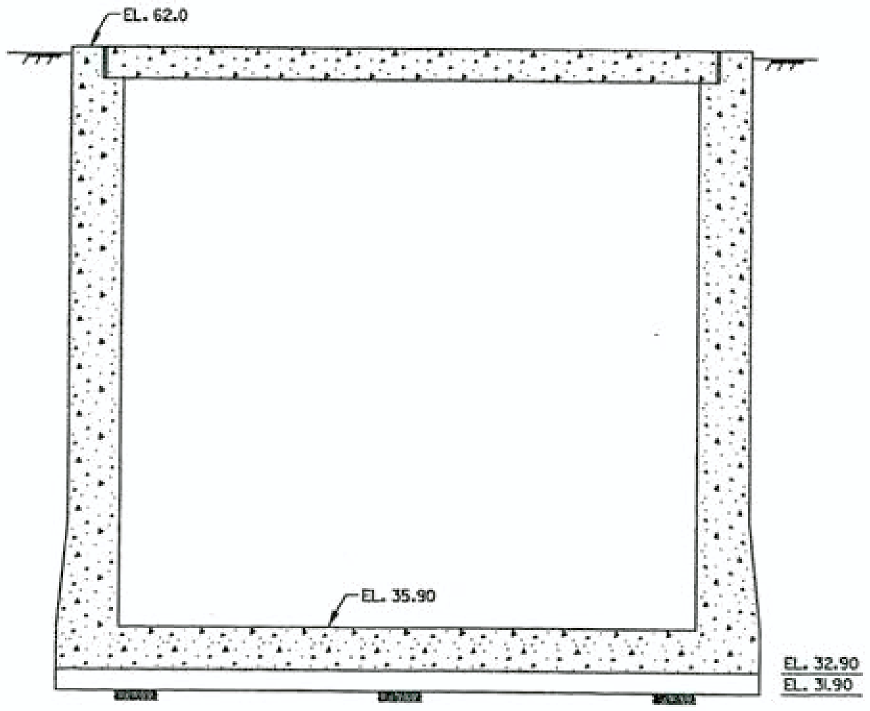


PLAN



SECTION A

NORMAL CONDITION



SECTION B

CONDITION	ΣV kips	ΣH kips	ΣM FT-kips	SLIDING FS	FOUNDATION PRESSURE TONS/FT²
NORMAL	1,314.78	148.18	23,600	5.16	U/S=0.69 D/S=0.49
DEWATERED	883.40	108.42	13,002	4.86	U/S=0.24 D/S=0.56
OPTIMUM	1,146.84	255.08	18,975	2.62	U/S=0.47 D/S=0.55

DESIGN ENG.: J.A.M.

DWN. BY: T.D.B.

CKD. BY: J.A.M.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE 61

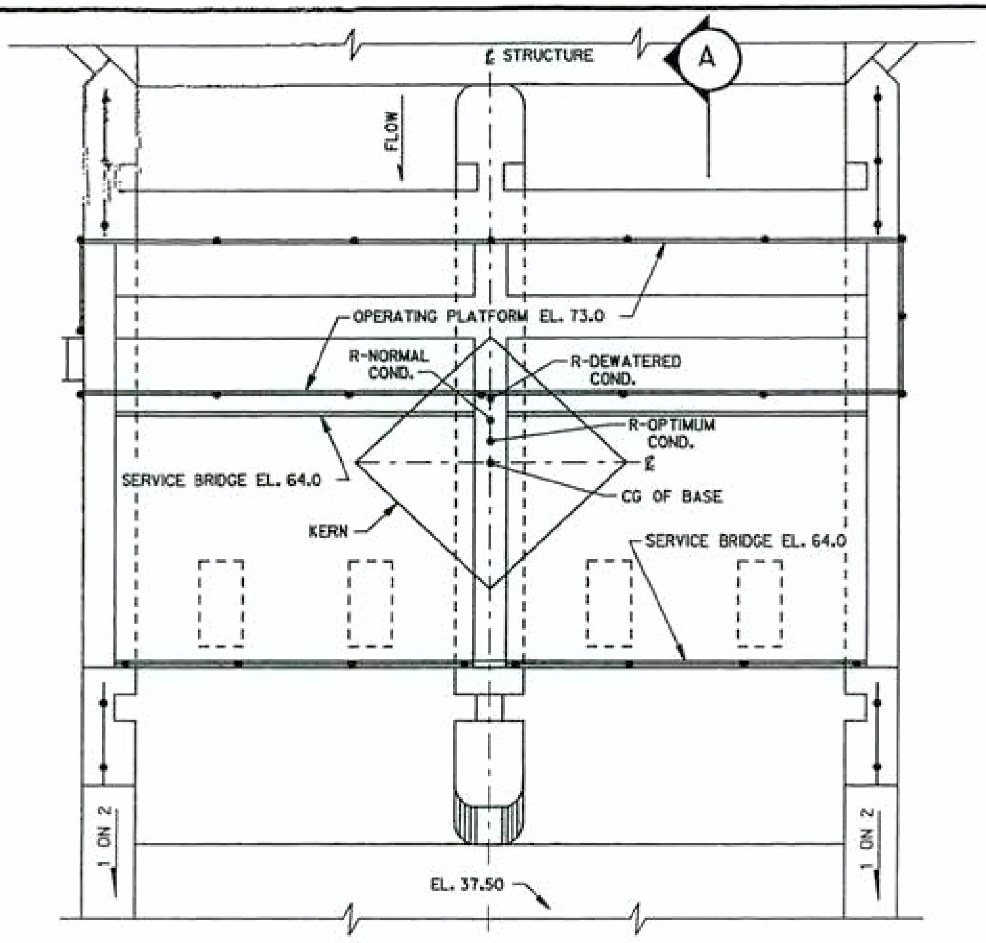
STABILITY ANALYSIS

(SCALES AS SHOWN)

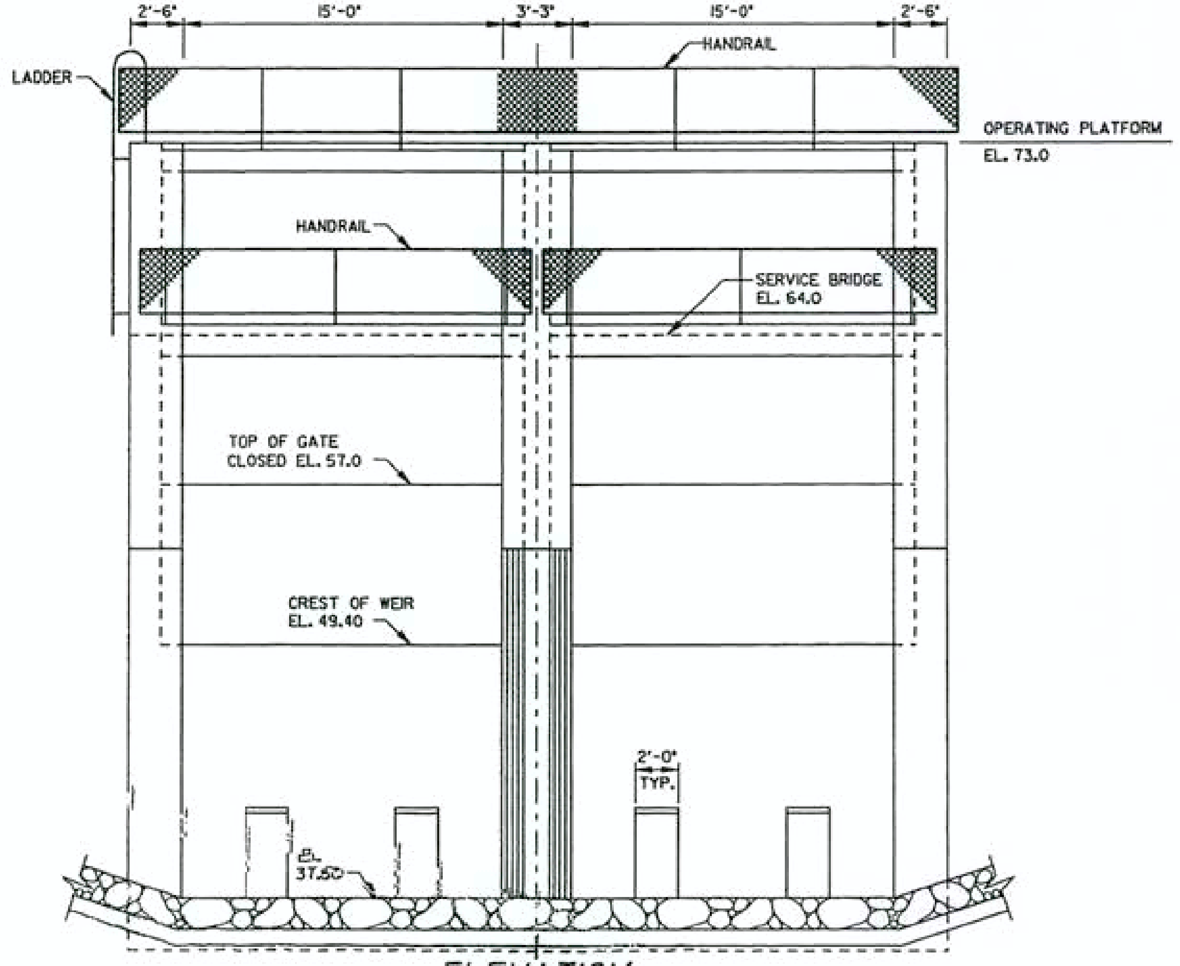
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

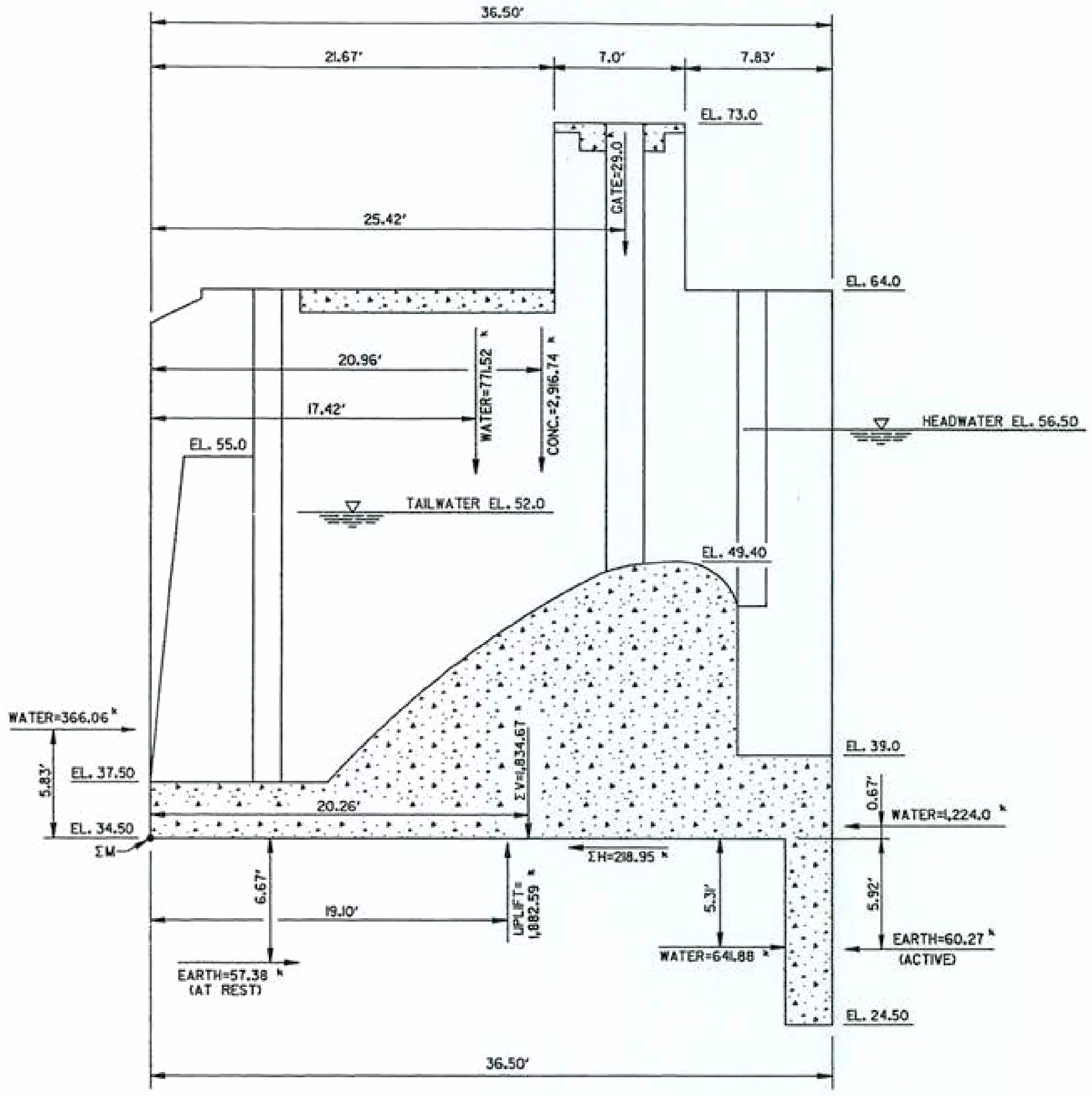
D.O. FILE NO. 400-36,826 DATE: APRIL 1995



PLAN



ELEVATION



SECTION A

NORMAL CONDITION

CONDITION	ΣV kips	ΣH kips	ΣM FT-kips	SLIDING FS	FOUNDATION PRESSURE TONS/FT²
NORMAL	1,834.67	218.95	37,163	4.92	U/S=0.87 D/S=0.44
DEWATERED	1,426.52	218.95	30,181	4.29	U/S=0.76 D/S=0.27
OPTIMUM	1,718.34	353.60	32,428	3.02	U/S=0.80 D/S=0.44

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE 63A

UPPER MONOLITH-STABILITY ANALYSIS

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

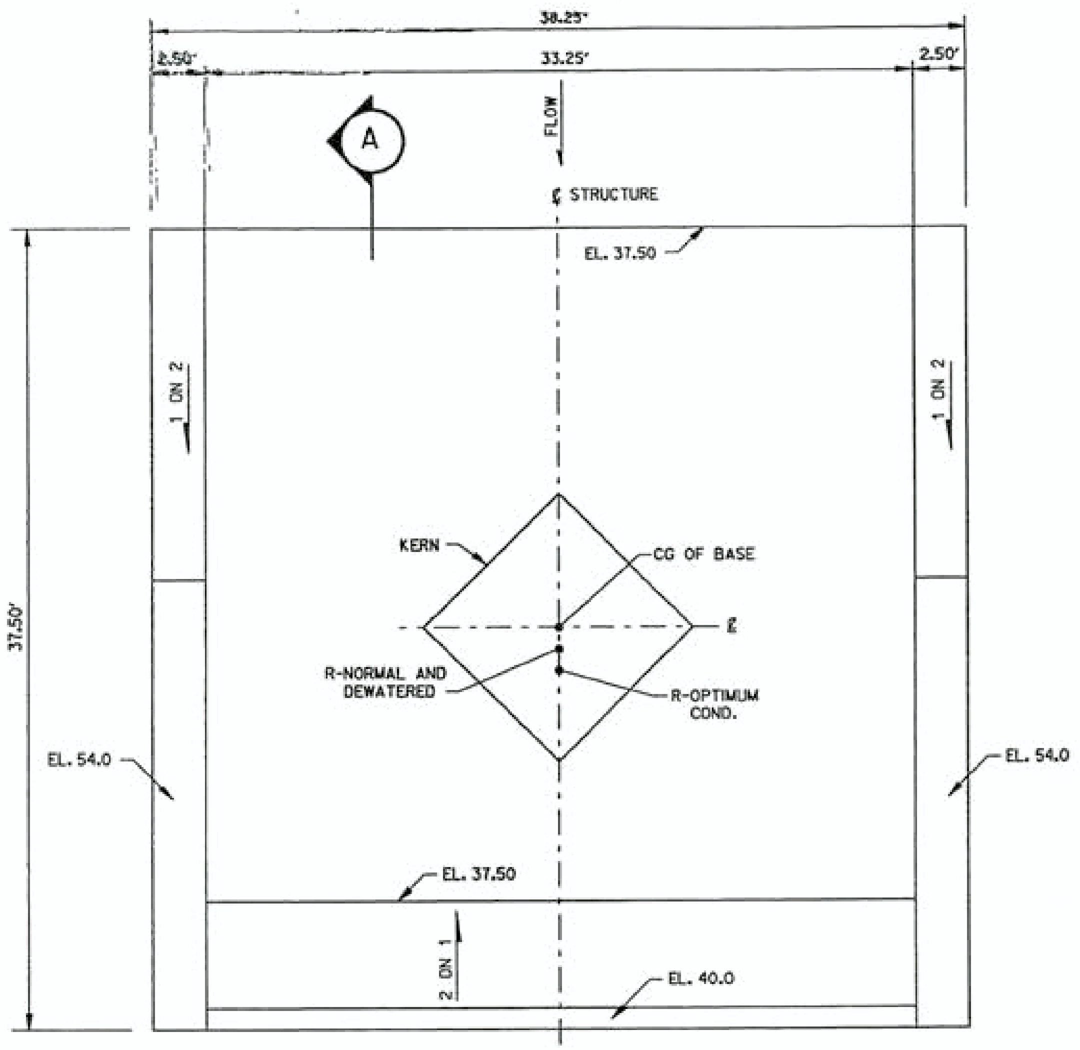
SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826 DATE: APRIL 1995

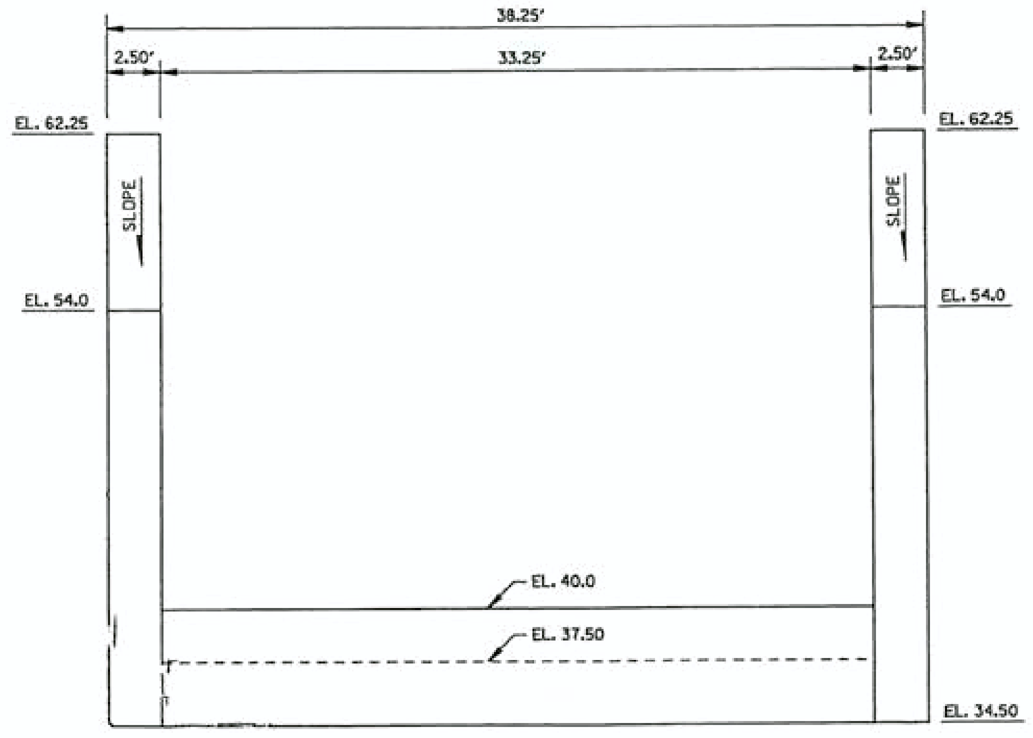
DESIGN ENG.: J.A.M.

DWN. BY: T.D.B.

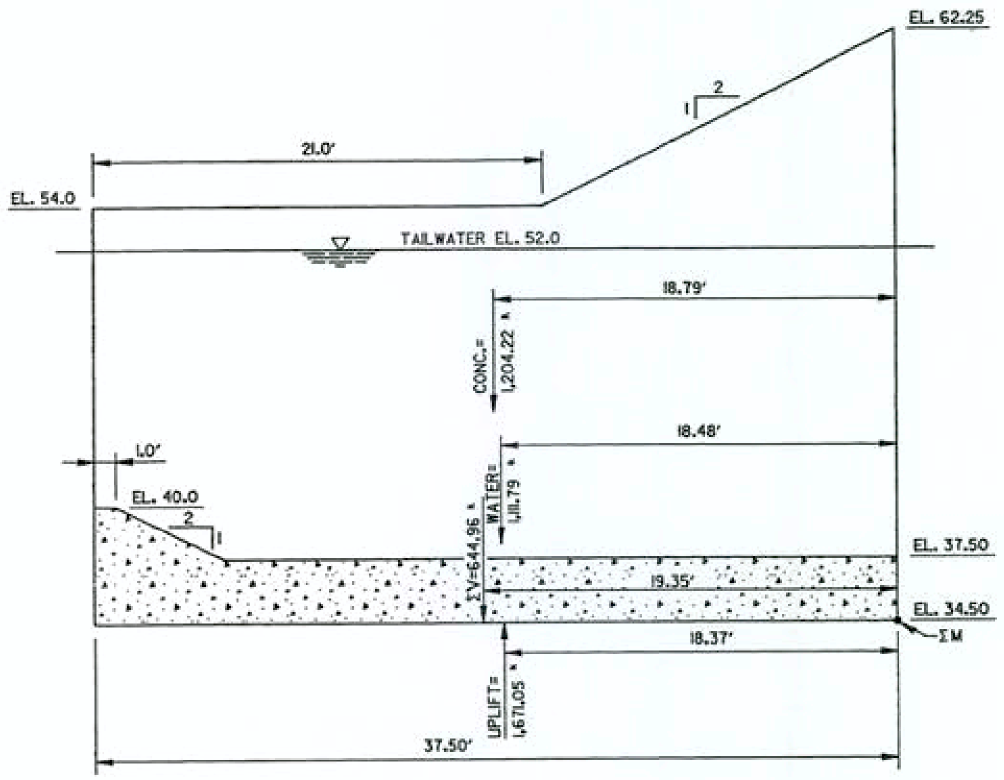
CKD. BY: J.A.M.



PLAN



ELEVATION



SECTION A

NORMAL CONDITION

CONDITION	ΣV kips	ΣH kips	ΣM FT-kips	SLIDING FS	FOUNDATION PRESSURE TONS/FT²
NORMAL	644.96	0	12,482	-	U/S=0.21 D/S=0.25
DEWATERED	644.96	0	12,482	-	U/S=0.21 D/S=0.25
OPTIMUM	606.64	0	12,259	-	U/S=0.16 D/S=0.26

DESIGN ENG.:
J.A.M.
DWN. BY:
T.D.B.
CKD. BY:
J.A.M.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION
STRUCTURE 63A
LOWER MONOLITH-STABILITY ANALYSIS
(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826
DATE: APRIL 1995

KISSIMMEE RIVER
HEADWATERS REVITALIZATION REPORT

APPENDIX D

Design and Cost Estimates

COST ESTIMATE
(Table T-1)

Kissimmee River Headwaters Rest
Project Modification Report

Designed By: Jacksonville District
Estimated By: G. Torres

Prepared By: G. Torres

Preparation Date: 01/11/96
Effective Date of Pricing: 01/11/96

Sales Tax: 6.00%

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The Project Modification Report for the Kissimmee River Headwaters Restoration Project involves the modification of the existing Lake Kissimmee regulation schedule; acquisition of approximately 16,000 acres of land bordering the affected lakes, Lake Hatchineha, Lake Kissimmee, Lake Cypress and Lake Tiger; the widening of upper basin flood control canals, C-36 and C-37; modification of the S-65 structure to reduce higher flood stage in Lake Kissimmee and to provide higher discharge capacity; and finally the degradation of local levees to expand the range of upper basin restoration.

Engineering and Design cost and Construction Management cost were provided by the project manager and are a percentage of the construction cost; 10% for E&D and 8% for S&A.

Contingencies are based on discussions with Planning Division and Design Branch. Real Estate Division determined their own contingencies.

SUMMARY REPORTS SUMMARY PAGE

No Detailed Estimate...

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - Contract **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A Construction Cost		4,957,662	810,748	5,768,410	
B Non-Construction Cost		52,011,400	20,576,500	72,587,900	
TOTAL Kissimmee River Headwaters Rest		56,969,062	21,387,248	78,356,310	

** PROJECT OWNER SUMMARY - Level 2 **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A Construction Cost					
A-02 Relocations		72,368	10,855	83,224	
A-06 Fish and Wildlife Facilities		670,990	167,748	838,738	
A-09 Channels and Canals		1,496,660	224,499	1,721,159	
A-11 Levees and Floodwalls		89,172	13,376	102,548	
A-15 Floodway Control-Diversion Struc		2,628,471	394,271	3,022,742	
TOTAL Construction Cost		4,957,662	810,748	5,768,410	
B Non-Construction Cost					
B-01 Lands and Damages		51,119,000	20,447,600	71,566,600	
B-30 Planning, Engineering and Design		495,800	49,580	545,380	
B-31 Construction Management (S&I)		396,600	79,320	475,920	
TOTAL Non-Construction Cost		52,011,400	20,576,500	72,587,900	
TOTAL Kissimmee River Headwaters Rest		56,969,062	21,387,248	78,356,310	

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A Construction Cost					
A-02 Relocations					
A-02/03 Cemetery, Utilities, & Structure		72,368	10,855	83,224	
TOTAL Relocations		72,368	10,855	83,224	
A-06 Fish and Wildlife Facilities					
A-06/03 Wildlife Facilities & Sanctuary		670,990	167,748	838,738	
TOTAL Fish and Wildlife Facilities		670,990	167,748	838,738	
A-09 Channels and Canals					
A-09/02 Canals		1,496,660	224,499	1,721,159	
TOTAL Channels and Canals		1,496,660	224,499	1,721,159	
A-11 Levees and Floodwalls					
A-11/01 Levees		89,172	13,376	102,548	
TOTAL Levees and Floodwalls		89,172	13,376	102,548	
A-15 Floodway Control-Diversion Struc					
A-15/00 Floodway Control-Diversion Struc		2,628,471	394,271	3,022,742	
TOTAL Floodway Control-Diversion Struc		2,628,471	394,271	3,022,742	
TOTAL Construction Cost		4,957,662	810,748	5,768,410	
B Non-Construction Cost					
B-01 Lands and Damages					
B-01/01 Project Planning		100,000	40,000	140,000	
B-01/02 Acquisitions		3,082,000	1,232,800	4,314,800	
B-01/03 Condemnation		2,190,000	876,000	3,066,000	
B-01/05 Appraisals		1,471,000	588,400	2,059,400	
B-01/06 PL 91-646 Assistance		459,000	183,600	642,600	
B-01/07 Temporary Permits		144,000	57,600	201,600	
B-01/08 Project Related Admin		403,000	161,200	564,200	

** PROJECT OWNER SUMMARY - Feature **

	QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
B-01/18 Real Estate Payments			43,270,000	17,308,000	60,578,000	
TOTAL Lands and Damages			51,119,000	20,447,600	71,566,600	
B-30 Planning, Engineering and Design			495,800	49,580	545,380	
B-31 Construction Management (S&I)			396,600	79,320	475,920	
TOTAL Non-Construction Cost			52,011,400	20,576,500	72,587,900	
TOTAL Kissimmee River Headwaters Rest			56,969,062	21,387,248	78,356,310	

** PROJECT OWNER SUMMARY - Element **

	QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A Construction Cost						
A-02 Relocations						
A-02/03 Cemetery, Utilities, & Structure						
A-02/03.01 Mob, Demob & Preparatory Work						
A-02/03.01.01 Mob, Demob & Preparatory Work			2,599	390	2,989	
TOTAL Mob, Demob & Preparatory Work			2,599	390	2,989	
A-02/03.18 Utilities						
A-02/03.18.01 Pole Relocation			3,502	525	4,027	
TOTAL Utilities			3,502	525	4,027	
A-02/03.47 Structures						
A-02/03.47.01 CMU Buildings w/Mechanical Equip	2.00	EA	35,083	5,262	40,345	20172.72
A-02/03.47.02 Antenna Tower Guy Wires	2.00	EA	31,185	4,678	35,863	17931.31
TOTAL Structures			66,268	9,940	76,208	
TOTAL Cemetery, Utilities, & Structure			72,368	10,855	83,224	
TOTAL Relocations			72,368	10,855	83,224	
A-06 Fish and Wildlife Facilities						
A-06/03 Wildlife Facilities & Sanctuary						
A-06/03.73 Habitat and Feeding Facilities						
A-06/03.73.01 Mercury Study			161,398	40,350	201,748	
A-06/03.73.02 Vegetation Monitoring			509,592	127,398	636,990	
TOTAL Habitat and Feeding Facilities			670,990	167,748	838,738	
TOTAL Wildlife Facilities & Sanctuary			670,990	167,748	838,738	
TOTAL Fish and Wildlife Facilities			670,990	167,748	838,738	
A-09 Channels and Canals						

** PROJECT OWNER SUMMARY - Element **

		QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A-09/02	Canals						
A-09/02.01	Mob, Demob & Preparatory Work						
A-09/02.01.01	Mob, Demob & Preparatory Work			57,562	8,634	66,196	
	TOTAL Mob, Demob & Preparatory Work			57,562	8,634	66,196	
A-09/02.31	Earthwork						
A-09/02.31.01	Excavation, Canal 36	125000.00	CY	185,038	27,756	212,794	1.70
A-09/02.31.02	Excavation, Canal 37	330000.00	CY	537,385	80,608	617,993	1.87
A-09/02.31.03	Excavation, U/S S-65	25000.00	CY	87,839	13,176	101,015	4.04
A-09/02.31.04	Excavation, D/S S-65	90000.00	CY	315,155	47,273	362,428	4.03
	TOTAL Earthwork			1,125,417	168,813	1,294,230	
A-09/02.99	Associated General Items						
A-09/02.99.01	Grassing	85.00	AC	97,693	14,654	112,347	1321.73
A-09/02.99.02	Remove Riprap	1130.00	CY	22,024	3,304	25,328	22.41
A-09/02.99.03	U/S and D/S Riprap	2965.00	CY	134,842	20,226	155,068	52.30
A-09/02.99.05	U/S and D/S Bedding	1300.00	CY	59,121	8,868	67,990	52.30
	TOTAL Associated General Items			313,681	47,052	360,733	
	TOTAL Canals			1,496,660	224,499	1,721,159	
	TOTAL Channels and Canals			1,496,660	224,499	1,721,159	
A-11	Levees and Floodwalls						
A-11/01	Levees						
A-11/01.01	Mob, Demob & Preparatory Work						
A-11/01.01.01	Mob, Demob & Preparatory Work			3,378	507	3,885	
	TOTAL Mob, Demob & Preparatory Work			3,378	507	3,885	
A-11/01.31	Earthwork						
A-11/01.31.01	Excavate Gaps @ Lake Kissimmee	12500.00	CY	13,790	2,068	15,858	1.27
A-11/01.31.02	Excavate Gaps @ Cypress Lakee	15000.00	CY	16,616	2,492	19,108	1.27
A-11/01.31.03	Excavate Gaps @ Sparks Chandler	15000.00	CY	16,616	2,492	19,108	1.27
A-11/01.31.04	Excavate Gaps @ Rolling Meadows	30000.00	CY	33,205	4,981	38,185	1.27

** PROJECT OWNER SUMMARY - Element **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A-11/01.31.06 Excavate Gaps @ Oasis Levee	2000.00 CY	2,119	318	2,437	1.22
TOTAL Earthwork		82,345	12,352	94,697	
A-11/01.99 Associated General Items					
A-11/01.99.01 Grassing	3.00 AC	3,448	517	3,965	1321.73
TOTAL Associated General Items		3,448	517	3,965	
TOTAL Levees		89,172	13,376	102,548	
TOTAL Levees and Floodwalls		89,172	13,376	102,548	
A-15 Floodway Control-Diversion Struc					
A-15/00 Floodway Control-Diversion Struc					
A-15/00.01 Mob, Demob & Preparatory Work					
A-15/00.01.01 Mob, Demob & Preparatory Work		95,478	14,322	109,799	
TOTAL Mob, Demob & Preparatory Work		95,478	14,322	109,799	
A-15/00.03 Care and Diversion of Water					
A-15/00.03.02 Steel Sheet Pile-Place & Remove		951,670	142,750	1,094,420	
A-15/00.03.05 Soil Anchors	180.00 EA	136,898	20,535	157,432	874.62
A-15/00.03.06 Tremie Concrete in Place	2624.00 CY	240,727	36,109	276,836	105.50
A-15/00.03.07 Dewatering	1.00 EA	37,484	5,623	43,106	43106.25
TOTAL Care and Diversion of Water		1,366,778	205,017	1,571,795	
A-15/00.10 Earthwork for Structures					
A-15/00.10.02 Excavation for Tremie Concrete	8000.00 CY	49,779	7,467	57,246	7.16
A-15/00.10.04 Structural Backfill	640.00 CY	4,670	700	5,370	8.39
TOTAL Earthwork for Structures		54,449	8,167	62,616	
A-15/00.11 Foundation Work					
A-15/00.11.02 Steel Sheet Pile Wingwalls	7268.00 SF	251,151	37,673	288,823	?
TOTAL Foundation Work		251,151	37,673	288,823	

** PROJECT OWNER SUMMARY - Element **

		QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A-15/00.25	Embedded Metal Work					
A-15/00.25.01	Handrail	160.00 LF	4,231	635	4,866	30.41
A-15/00.25.03	Ladder and Basket Guard	2.00 EA	8,576	1,286	9,862	4931.11
	TOTAL Embedded Metal Work		12,807	1,921	14,728	
A-15/00.41	Gates, Stop Logs-Associated Eqpt					
A-15/00.41.01	Inst. and Test Vert. Lift Gate		169,615	25,442	195,057	
A-15/00.41.02	Gate Operating Machinery	2.00 EA	99,201	14,880	114,081	57040.49
	TOTAL Gates, Stop Logs-Associated Eqpt		268,816	40,322	309,138	
A-15/00.53	Overflow Structure					
A-15/00.53.01	Concrete, in Place	1680.00 CY	362,936	54,440	417,377	248.44
A-15/00.53.04	Staff Gage Instruments	2.00 EA	3,274	491	3,766	1882.79
	TOTAL Overflow Structure		366,211	54,932	421,142	
A-15/00.99	Associated General Items					
A-15/00.99.01	Pavement	110.00 SY	2,913	437	3,350	30.45
A-15/00.99.02	Safety Barriers Floats	1.00 JOB	20,548	3,082	23,630	23630.17
A-15/00.99.03	Grassing	0.90 AC	1,034	155	1,190	1321.73
A-15/00.99.04	Misc. St, Cntrl Hse, Stllg Wells	1.00 JOB	80,721	12,108	92,829	92828.71
A-15/00.99.06	Guardrail	120.00 LF	1,256	188	1,444	12.04
A-15/00.99.07	Electrical Work		47,839	7,176	55,015	
A-15/00.99.08	Sheet Pile Retaining Wall PZ-22	1800.00 SF	58,472	8,771	67,242	37.36
	TOTAL Associated General Items		212,782	31,917	244,700	
	TOTAL Floodway Control-Diversion Struc		2,628,471	394,271	3,022,742	
	TOTAL Floodway Control-Diversion Struc		2,628,471	394,271	3,022,742	
	TOTAL Construction Cost		4,957,662	810,748	5,768,410	
B	Non-Construction Cost					
B-01	Lands and Damages					
B-01/01	Project Planning		100,000	40,000	140,000	
	TOTAL Project Planning		100,000	40,000	140,000	

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
B-01/02 Acquisitions					
B-01/02.02 By Local Sponsor		2,910,000	1,164,000	4,074,000	
B-01/02.04 Review of Local Sponsor		172,000	68,800	240,800	
TOTAL Acquisitions		3,082,000	1,232,800	4,314,800	
B-01/03 Condemnation					
B-01/03.02 By Local Sponsor		150,000	60,000	210,000	
B-01/03.03 By Govt On Behalf Local Sponsor		2,040,000	816,000	2,856,000	
TOTAL Condemnation		2,190,000	876,000	3,066,000	
B-01/05 Appraisals					
B-01/05.03 By Local Sponsor		1,369,000	547,600	1,916,600	
B-01/05.05 Review of Local Sponsor		102,000	40,800	142,800	
TOTAL Appraisals		1,471,000	588,400	2,059,400	
B-01/06 PL 91-646 Assistance					
B-01/06.02 By Local Sponsor		393,000	157,200	550,200	
B-01/06.04 Review of Local Sponsor		66,000	26,400	92,400	
TOTAL PL 91-646 Assistance		459,000	183,600	642,600	
B-01/07 Temporary Permits					
B-01/07.02 By Local Sponsor		100,000	40,000	140,000	
B-01/07.04 Review of Local Sponsor		34,000	13,600	47,600	
B-01/07.06 Damage Claims		10,000	4,000	14,000	
TOTAL Temporary Permits		144,000	57,600	201,600	
B-01/08 Project Related Admin					
B-01/08.02 Env Audit By Local Sponsor		403,000	161,200	564,200	
TOTAL Project Related Admin		403,000	161,200	564,200	
B-01/18 Real Estate Payments					

** PROJECT OWNER SUMMARY - Element **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
B-01/18.01 Land Payments		40,300,000	16,120,000	56,420,000	
TOTAL Land Payments		40,300,000	16,120,000	56,420,000	
B-01/18.02 PL 91-646 Assistance Payments					
B-01/18.02.02 By Local Sponsor		2,970,000	1,188,000	4,158,000	
TOTAL PL 91-646 Assistance Payments		2,970,000	1,188,000	4,158,000	
TOTAL Real Estate Payments		43,270,000	17,308,000	60,578,000	
TOTAL Lands and Damages		51,119,000	20,447,600	71,566,600	
B-30 Planning, Engineering and Design		495,800	49,580	545,380	
B-31 Construction Management (S&I)		396,600	79,320	475,920	
TOTAL Non-Construction Cost		52,011,400	20,576,500	72,587,900	
TOTAL Kissimmee River Headwaters Rest		56,969,062	21,387,248	78,356,310	

No errors detected...

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KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX E

EARLY ESTABLISHMENT OF HEADWATERS COMPONENT

Appendix E
Early Establishment of Headwaters Component

Table of Contents

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* Excerpt from the Proceedings of, Kissimmee River Restoration Symposium, Orlando, Florida, SFWMD, October 1988

** Excerpt from the Kissimmee River Restoration, Alternative Plan Evaluation & Preliminary Design Report, SFWMD, June 1990

Tables

List of Figures

HYDROLOGY OF THE KISSIMMEE RIVER BASIN - INFLUENCE OF MAN-MADE AND NATURAL CHANGES

*Jayantha Obeysekera and Kent Loftin**

ABSTRACT

Hydrology of the Kissimmee River basin plays a major role in current efforts for its restoration. The man-made influence in the form of basin regulation and the land use changes have significantly altered the characteristics of the flow inputs and the stages in the lower basin. A seasonal shift in the flow release from the upper basin as well as a completely altered hydrograph are key changes that the regulation has introduced to flow inputs to the lower basin. The lower basin hydrology has changed from an upland/floodplain retention with slow runoff to one characterized by upland/floodplain drainage with rapid runoff. Recently, the Kissimmee River basin has also experienced reduced rainfall which in turn have impacted the runoff availability in the entire basin. The runoff in the lower basin appears to have been influenced both by reduced rainfall as well as the changes in the land use. The changes in the hydrology both due to man-made and/or natural causes have altered the natural pre-project regime to the extent that even the feasibility its reversal is questionable. The deficiency of a simplistic approach such as restoring the physical form without any regard to current changes in functional characteristics is emphasized.

PART I

INTRODUCTION

The Kissimmee river basin located in Central Florida is the largest tributary to Lake Okeechobee and provides approximately one third of the surface water inflows to the lake. The river's original watershed area was about 3000 square miles. At present, the basin drains approximately 2400 square miles at S-65E, the last structure in the channelized Kissimmee river before it enters Lake Okeechobee. The upper Kissimmee basin defined as the drainage area above the outlet of lake Kissimmee is approximately 1600 square miles of which approximately ten percent is comprised of water bodies. The northern portion of this watershed consists of flat, marshy sandlands with high-grade development consisting of small residential communities and citrus groves concentrated on the shores of the lakes. Unimproved native pasture and citrus in highlands are common in other areas. The lower Kissimmee basin (drainage area below Lake Kissimmee) through which the Kissimmee River runs has a drainage area of about 750 square miles. This basin consists generally of grassy prairies with scattered pinewood and palmetto growths.

Hydrology of the Kissimmee river basin plays a key role in ongoing efforts for environmental restoration of the Kissimmee River. It will be shown in this paper how the regulation of the upper basin has drastically altered the hydrology of the pre-canal

---

* Senior Water Resources Engineer, and Assistant Director, respectively, Water Resources Division, South Florida Water Management District, West Palm Beach, Florida 33416.

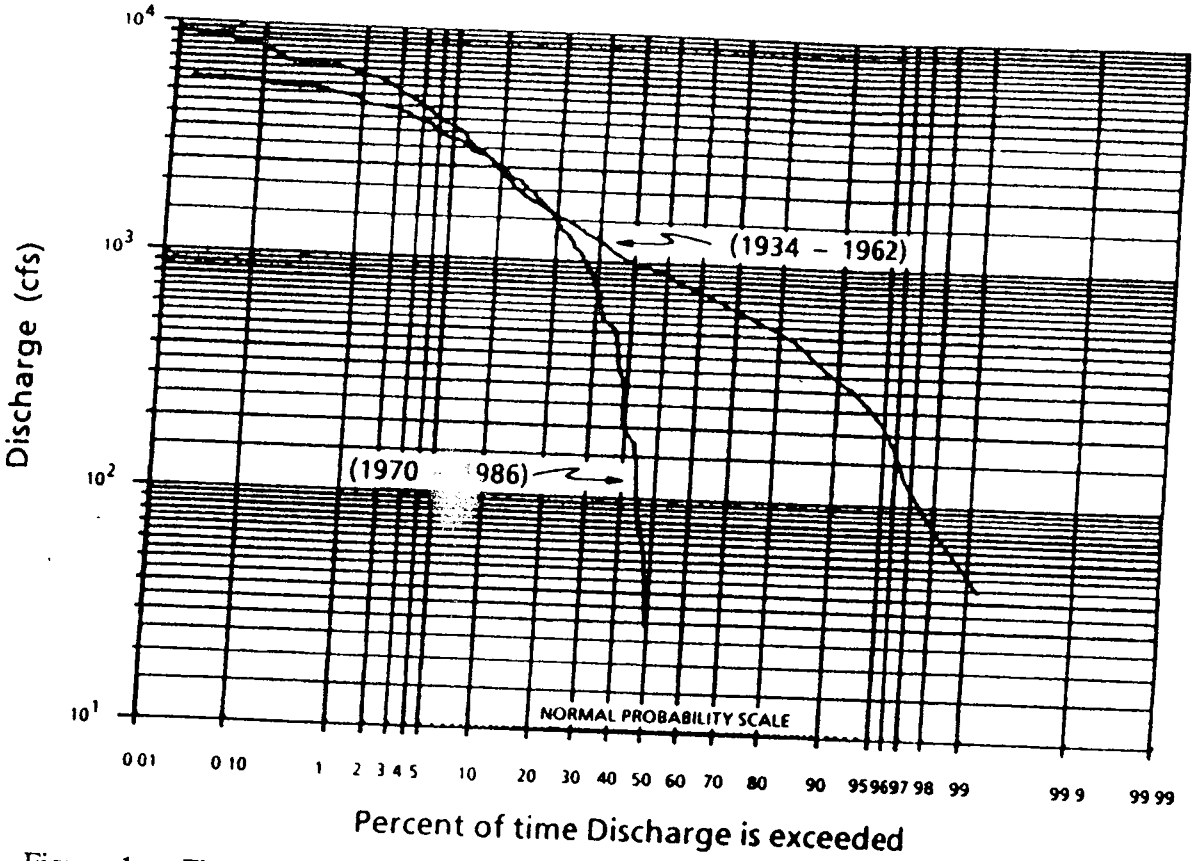

Figure 1. Flow duration curves at S-65 structure near Lake Kissimmee for pre-project(1934-1986) and post-project(1970- 1986) periods.

A close look at the pre- and post-project hydrographs reveals the frequency of near zero flow conditions. The discharges from lake Kissimmee now resembles "plug flow" (or pulse flow) with frequent periods of zero or near zero flows. This flow pattern represents a drastic change from the typical daily hydrograph with sustained flow during most of the year as seen in figure 3(a). A daily frequency of near zero flow is shown in figure 4. During months of June through January, the upper basin contribution to lower basin is frequently near zero in spite of the period covered by these months include the wet season. In comparison, prior to upper basin regulation except for few days during the entire period of record of about 20 years, there was always a substantial amount of base flow during this period. During the spring months when it is usually dry, the frequency of near zero flow from lake Kissimmee is much smaller and this can be attributed to regulatory releases.

The persistence of flows of different magnitudes is also important. The plug type flow introduced by regulation decreases the consecutive days any flow rate is sustained. The magnitude of this reduction can be estimated from the mean duration of a given flow condition or higher, computed for both pre- and post project periods. It is noted that the mean duration can be influenced by the number of consecutive periods (called "runs") used for its computation. On the average post project mean duration of flows are approximately eight to ten times smaller than those for the same flow conditions prior to regulation. This is a significant change in the pattern of flow delivery to lower basin river and the flood plain.

A consequence of the plug flow pattern under uncontrolled conditions is a potentially larger variability in the stages in the lower basin river and the flood plain. A sudden reduction of water levels in an inundated floodplain can result in a drastic increase in biochemical oxygen demand in the receding water which in turn plummet

Kissimmee River basin. The accelerated land-use practices primarily resulting from improved drainage following the completion of flood control project has significantly modified the flow characteristics of the tributaries of the lower basin. The current interest lies also in investigating the influence of natural changes that are unrelated to channelization. Unfortunately, such natural changes, say in climate, are difficult to detect until a long period of data become available. The post-canal observed data are corrupted by both man-made and natural changes and the separation of the effect of individual change is often difficult.

BASIN REGULATION

Upper basin

Regulation of flows in the upper chain of flows introduces a drastic change in the characteristics of flow inputs to C-38 at S65. Under pre-project conditions, Lake Kissimmee stages fluctuated in a range of about 10 feet at any time. In general all lake stages in the upper basin fluctuated from 2 to 10 feet (Florida Department of Administration, 1976). The flood control project in the upper basin specified the regulation of the lakes in range of about 2 to 4 feet. From an analysis of Lake Kissimmee stages, it was found that the highest post-project lake levels coincides roughly with the pre-project levels corresponding to 25 percent exceedence for the period of January through July. The reduction of high levels during the remaining period of the year is even greater with maximum post-project levels now only about a foot above mean pre-project lake levels. The water which was temporarily stored during previous high flow events is now released with a much reduced lag time. The water which maintained the recession flow prior to regulation is now stored in the lakes for maintaining increased minimum lake stages.

Figure 1 presents the flow duration curve at S65 (outflow from Lake Kissimmee) for the pre- (1942-1962) and post- (1970-1986) project periods. The mean discharges for the two periods are shown in figure 2. Figure 3 presents mean daily flows from Lake Kissimmee for pre- and post- project ten year periods. Except for a minor influence, the regulation of upper chain of lakes should not significantly alter the average annual water input to C-38 at S65. The distribution of flow within the year however, has drastically changed. Figure 1 shows that, approximately 50 percent of the time, flow input to C-38 is below 30 cfs. In comparison, prior to regulation, Lake Kissimmee delivered discharges at or above 600 cfs 70 percent of the time. In general, the discharges at or below about 1100 cfs have been influenced substantially by regulation. This is a direct result of the absence of long recession periods that existed prior to regulation. The absence of long recessions and the presence of frequent near zero flow conditions are deemed detrimental to the health of both habitat and vegetation in the lower valley.

The impact of regulation on the seasonal distribution flows is a key consideration in the overall restoration effort. Roughly, a 3-month lag in stage recession following the wet period has introduced a seasonal shift in the flow releases to lower basin. The maintenance of higher than normal stages in the months of November through January followed by a steeper recession has resulted in substantially low flows immediately following the wet period and somewhat increased flows during spring months when it is usually dry, and the river carries mostly base flow. Unless the upper basin regulation is altered to minimize the extent of this seasonal shift, the wetlands and marshes in the restored floodplain would receive less water during wet period when they should receive more for maintaining high water levels. During the dry spring period floodplain would receive more flow than what they did prior to regulation and consequently the water levels may recede at a lesser rate.

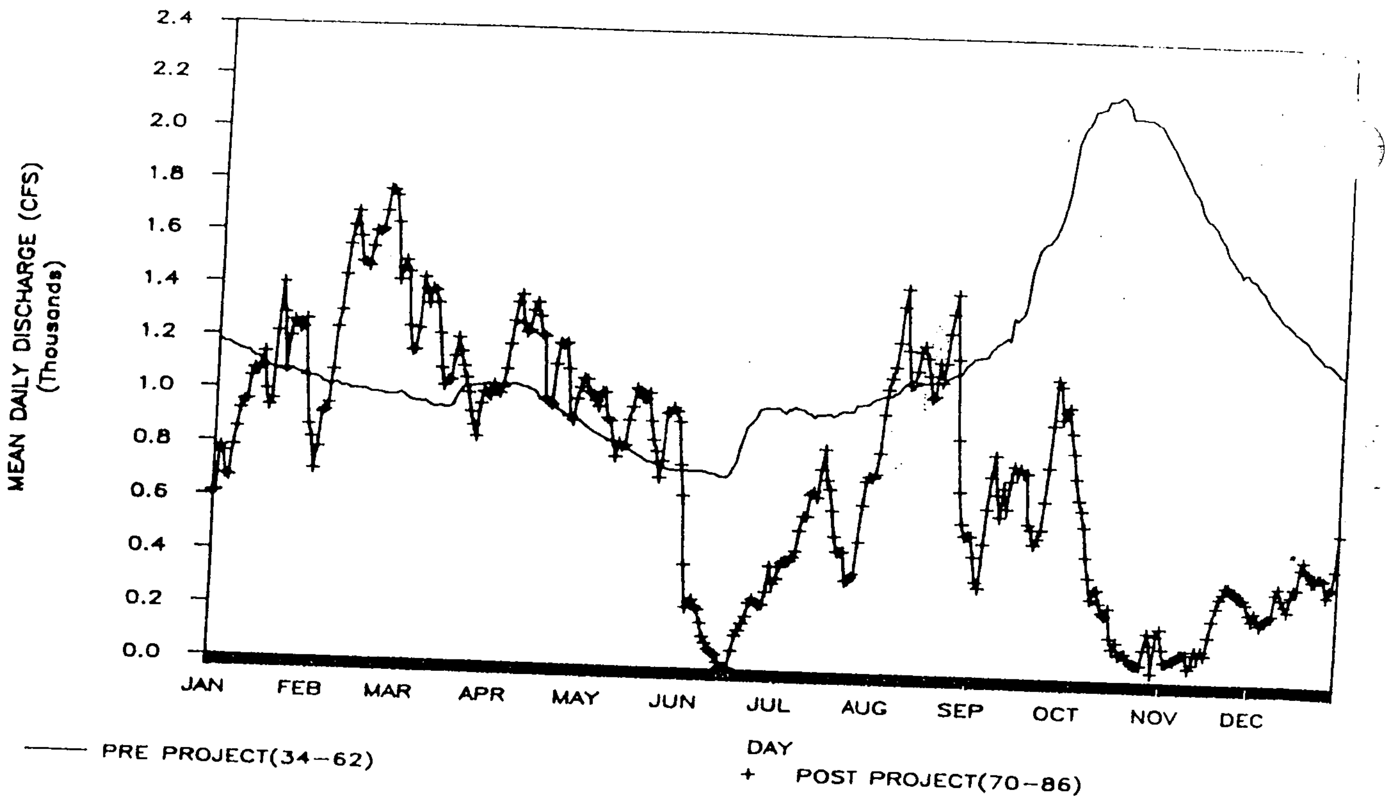

Figure 2. Mean discharge at S65 for pre-(1942-1960) and post-(1970-1986) project periods.

the dissolved oxygen levels in the river to a very low level. The final result is a potential fish kill as it has already happened twice in Pool B of the lower Kissimmee river in September of 1985, and more recently in September of 1988.

The step increase in the current regulation schedule at the beginning of the month of June is also detrimental. During the months of June and sometimes in July, the upper basin flow input is near zero. In the absence of substantial base flow in lower basin this low flow condition during summer when temperatures are high, can result in very low dissolved oxygen in the river creating choked conditions for aquatic habitat.

Lower basin

Stage regulation in the lower basin floodplain via control structures S-65A through S-65E in the C38 canal, has significantly reduced the mean and the variability of floodplain stage in comparison to the pre-project period of record. Five control structures (S-65A, S- 65B, S-65C, S-65D, and S-65E) now control water levels in five impoundments along the river. The effect of this regulation is to remove the natural slope of the Kissimmee river in such a manner that in each impoundment the water levels in the northern reach is lowered significantly, whereas water levels in the southern reach is increased, creating permanent impoundments. It is estimated that approximately 7600 acres were flooded in southern portions of all pools (Corps of Engineers, 1985). However, this form of regulation has significantly impacted the marshes in the northern portion of each pool. The historic stage fluctuation of about 10-12 feet has now been reduced to a much smaller range of about 3-4 feet at each location along the river. This again illustrates the impact of regulation on the water levels in the northern reaches of each pool.

At the Fort Kissimmee station (in Pool B above S-65B) it appears that

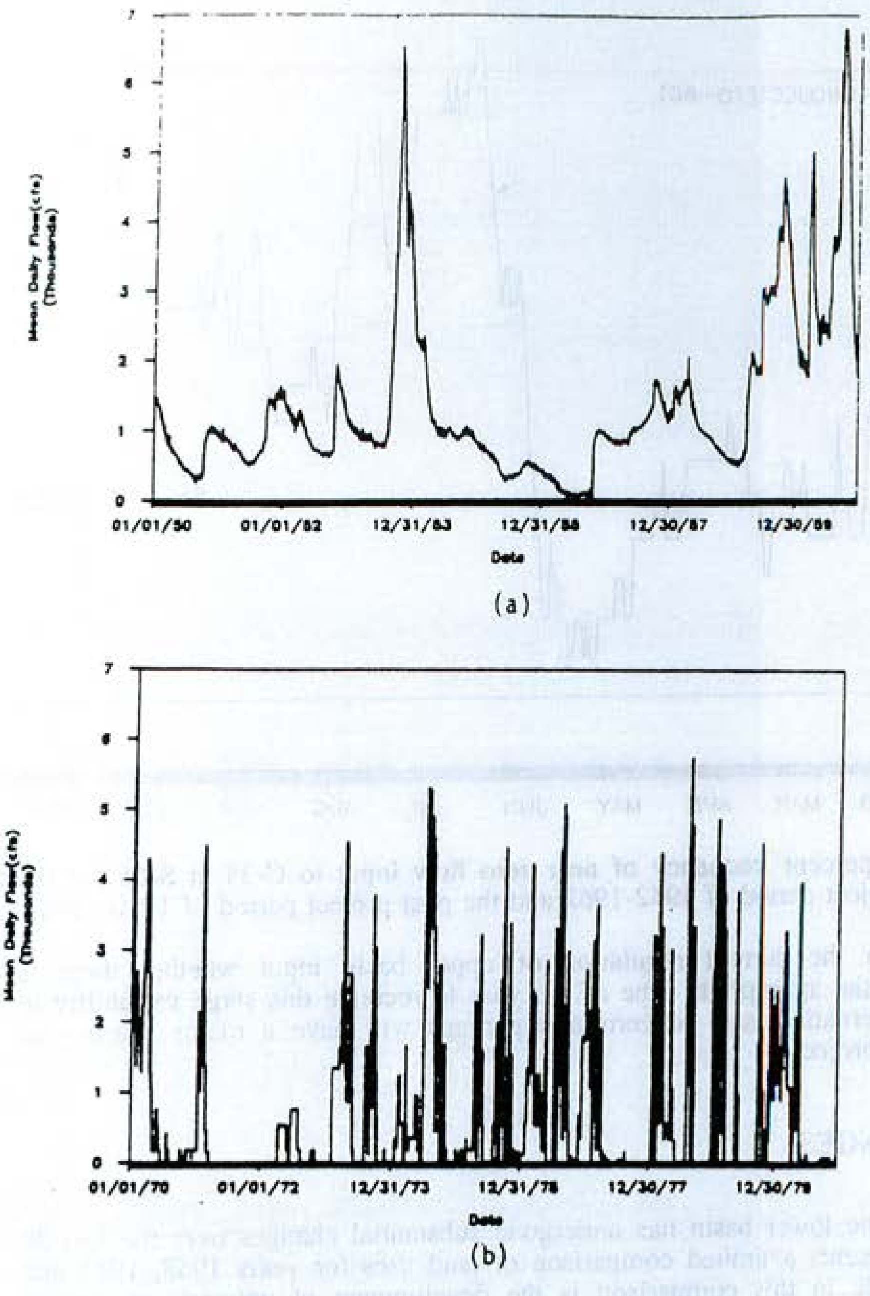

Figure 3. Mean daily flow from lake Kissimmee at S65 structure for the period (a) 1950-1960(before regulation); and (b) 1970-1980(after regulation).

approximately 70 percent of the time the floodplain was inundated. For the period 1970-1980 (prior to the alteration of the regulation of water levels in Pool B as a part of a demonstration project) at no time the water levels exceeded the average floodplain elevation of about 43 feet NGVD. In case of Basinger(Pool D), the flood plain stages exceeded the average ground elevation of about 28.5 feet about 70 percent of the time whereas for a location near Okeechobee exceedence is about 40 percent for the corresponding average floodplain elevation of 21 feet. The depth of water in the floodplain in the vicinity of Fort Kissimmee varied in a range of about 7 feet whereas the same for Basinger and Kissimmee River near Okeechobee are 7.5 feet and 7 feet

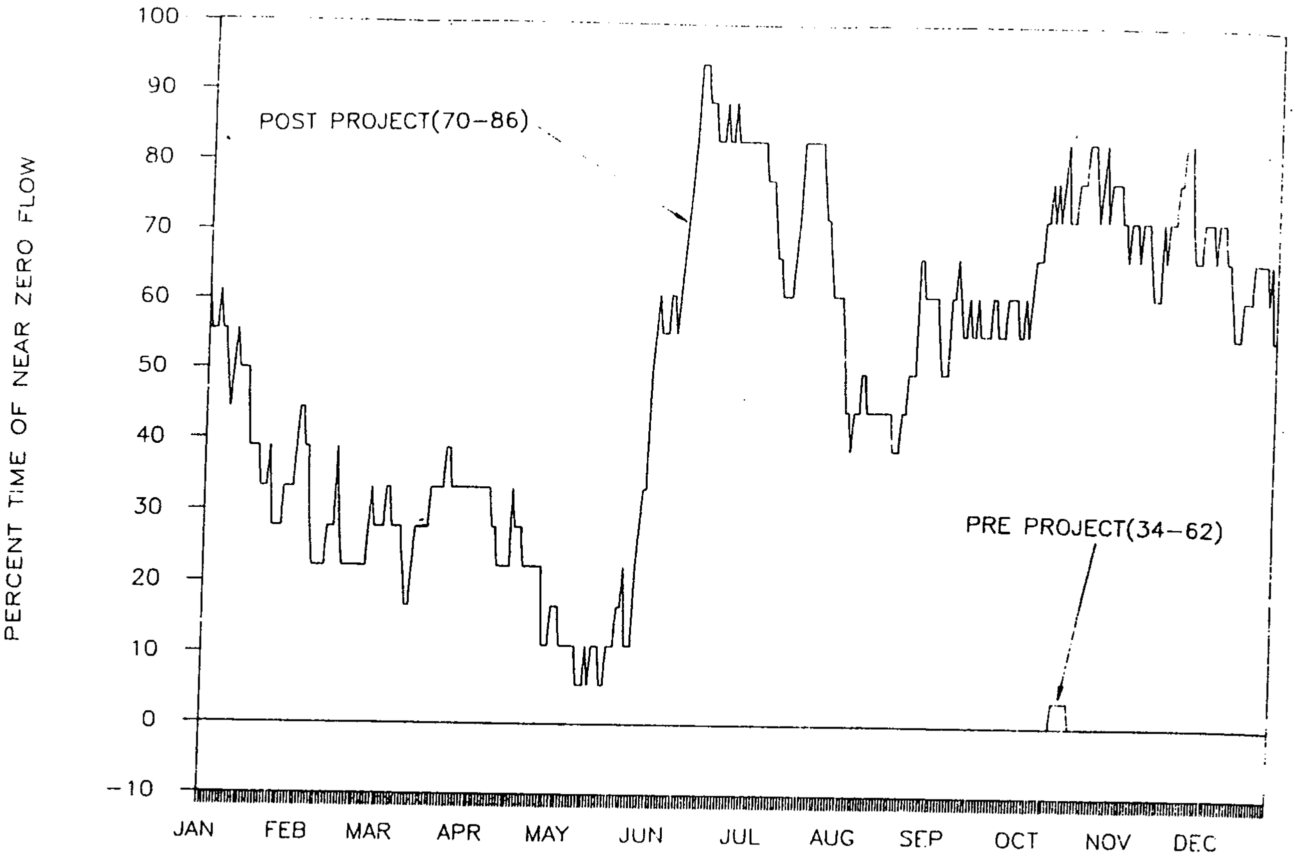

Figure 4. Daily percent frequency of near zero flow input to C-38 at S-65 for the pre-project period of 1942-1962 and the post-project period of 1970-1986.

respectively. With the current regulation of upper basin input whether there is sufficient water at the appropriate time of the year to recreate this stage variability in any restoration alternative is a concern that perhaps will have a major bearing on overall restoration project.

LAND USE CHANGES

Land use

Land use in the lower basin has undergone substantial changes over the last 30 years. Table 1 presents a limited comparison of land uses for years 1958, 1972 and 1980. Most notable in this comparison is the development of unimproved pasture lands to improved pasture at an accelerated pace during the period 1958 to 1972. This development has a significant bearing on the hydrology the lower basin primarily because of the accompanying changes in the drainage characteristics of the basin. The increased agricultural land use in the basin has resulted in the channelization of both primary and secondary tributaries and the construction of extensive tertiary ditch systems. Using the areal photographs taken in 1972-1973 and the U.S. Geological Survey quadrangle maps Gatewood and Bedient (1975) estimated that the drainage density for lower basin increased from an estimated value of 1.59 mi./ sq. mi. under natural conditions to an overall value of 4.43 mi. /sq. mi. which reflects both modified natural drainage and man-made drainage. The man-made drainage density was estimated to be as high as 23.3 mi./sq. mi.

Intensive ditching in agricultural lands alone does not provide the necessary control of the water table for agriculture practices. Control is generally accompanied by improvements to the primary and secondary drainage systems in the form of straightening, channelization, and connecting wetland areas. Previously isolated wetlands and marshy areas in the uplands and the floodplain are now connected for rapid movement of surface runoff resulting in a vastly improved drainage to the entire system. A majority of these improvements is concentrated in the lower half of the basin.

Table 1. Comparison of 1958, 1972 and 1980 land uses in the Lower Kissimmee River Basin

	Area in 100 acres (%increase from previous estimate)		
Land Use	1958†	1972†	1980††
Urban	0	13	31(138%)
Crops	3	16(433%)	54(238%)
Improved Pasture	329	2232(578%)	1871(-16%)
Unimproved Pasture	2806	1332(-53%)	1415(6%)*
Citrus	13	10(-23%)	17(70%)
Forest	32	75(134%)	358(377%)
Marsh	1337	842(-37%)	549(-35%)
Total	4520	4520	4385**

† From Huber et al(1976).

†† Estimated from South Florida Water Management District Data.

* Includes rangeland for 1980 estimate. It is assumed that previous estimates of Huber et al.(1976) also included rangeland in this category.

** Area for 1980 does not include subbasin below S-65E structure

Hydrologic impact

The reduced storage effect and the acceleration of water movement in the primary, and secondary tributaries and in the tertiary ditching systems have substantially increased the hydrologic response of the lower basin. In addition, the construction of C-38 with its increased outlet capacity has increased the efficiency of the upland drainage systems. The combined effects of upland drainage and flood control project has changed the basin hydrology from one of "upland/floodplain retention and slow runoff to one characterized by upland/floodplain drainage and rapid runoff" (Florida Department of Administration, 1976). The flow regime has experienced a major shift from predominantly baseflow runoff to one of surface (direct) runoff with increased volume discharged at a much faster rate. Huber et al(1976) estimated that from 1958 to 1972 the proportion of surface runoff for the lower basin has increased from about 14 percent to 48 percent. The increase in surface runoff is attributed to the "transfer to it of an interflow component that is derived from a soil region that no longer contributes to baseflow" (Huber and Heaney, 1976).

Closely related to reduced baseflow and increased surface runoff is the influence on flow detention times. The altered drainage practices significantly influences the detention time. Huber et al(1976) estimated, from 1958 to 1972 the lower basin surface runoff detention time has reduced from 6 days to about 4 days. Intensively drained areas has values below 2 days (Florida Department of Administration, 1976). The baseflow detention time has reduced from approximately 48 days to about 34 days during the period 1958 to 1972. Earlier, Langbein(1955) estimated that prior to 1946, the average lag of baseflow from time of recharge to mass outflow from the entire Kissimmee basin is about 3.5 months. The average lag for direct runoff was estimated to be only 10 days. For the lower basin alone Huber et. al(1976) suggested an appropriate value for baseflow travel time should be about 50 days.

.A new analysis of flow data to determine the changes in the flow recession coefficient was made using flow records at S-65E and S-65. Two periods(1942-1962 and 1970-1984) were selected to make the comparison of recession flow characteristics. The recession coefficient was computed as Qt/Qt-1 where Qt > Qt-1 is the daily flow at a given location. The values which produced a small sample are discarded. The coefficients computed for S-65 should reflect the influence of the upper basin on flow regimes for pre- and post- project periods. The coefficients for S-65E should reflect influence of both upper basin and lower basin. The recession coefficients computed for the difference S65E-S65 approximately reflects the changes in the lower basin storage recession.

A significant reduction in recession coefficient was seen for all cases as expected. As discussed earlier the upper basin regulation has changed the recession limb of the hydrograph from a slow recession to a pulse or plug flow reflecting much smaller values of recession coefficient. The improved drainage in the lower basin introduces similar effect on reducing baseflow recession coefficients for local inflow. On the average, for the flow regime in the range of 0-1000 cfs, the flow on any given day reduces to about 65 percent on the following day whereas during pre-project period this percentage is above 90 percent. The impact on the hydrograph recession characteristics is larger in the lower (baseflow) range of flow and diminishes as the magnitude of the flow increases towards values reflecting predominantly direct runoff. This reduction in lag time of inflows to the lower basin floodplain is a factor to be considered in floodplain stage fluctuation for any particular restoration alternative. The combined effects of the changes in flow characteristics due to land use changes and the upper basin regulation are steeper rising and recession limbs in the stage hydrographs in the lower basin.

RECENT CLIMATE AND ITS IMPACT

Rainfall

Since 1970, the entire south Florida region has experienced an apparent change in rainfall characteristics. Sculley(1986) analyzed the average rainfall over 12 basins within the SFWMD boundaries and found that during the period 1970-1985, most basins received below-normal annual rainfall. The Upper and Lower Kissimmee River basins were among the basins where the reduction was most evident. Moreover, the rainfall reduction appears to be concentrated in the wet season (June through September). Sculley(1986) reported that the lower Kissimmee basin received below- normal wet season amounts in eleven consecutive years beginning in 1975. Wet season deficiencies were reported for other basins as well. Shih(1983) analyzed 38 rainfall stations distributed within the SFWMD and concluded that the most probable break year for change in mean annual rainfall is 1970 and that the annual rainfall in the period following this year is about 5 inches less per year. The reduction was attributed to drier and shorter wet seasons, less heavy storms, and less rainfall associated with tropical storms. The Kissimmee River basin has not experienced a major tropical storm since 1969. There is evidence of reduced rainfall also in the dry season. Shih(1988) analyzed five rainfall stations in south Florida and concluded that the chance of rainfall occurring during the second half of the dry season (February, March, and April) showed a significant decrease since 1960. The month of April showed the most significant decrease.

Any natural change in climate reflecting reduced rainfall, will have a serious impact on water management in south Florida. It should also be a major concern for Kissimmee restoration efforts for potential reduction that it may have on water availability for maintaining water levels in restored floodplain and the areas in uplands.

Moreover, if the range of extremes are lesser now than before perhaps the fluctuation that the floodplain water levels experienced in the past may not return in the future. Any attempt to fully restore the hydrology that existed prior to channelization (assuming this is the restoration approach selected) will be unsuccessful if it is proven that the nature itself has changed or is changing significantly.

Rainfall-Runoff Relationship

Any potential change in rainfall characteristics will also induce a similar change in the rainfall-runoff relationship of a particular basin. Unfortunately, the data available for upper and lower Kissimmee basins reflect not only the change of rainfall amounts received but also potential changes in runoff generation due to man-made changes. It is difficult to isolate the changes due to natural causes from those due to man-made changes. However, an attempt will be made to investigate impact of both. Table 2 presents a comparison of relevant statistics for two periods reflecting pre- and post-project conditions.

A careful review of the statistics computed in Table 2 led to the following conclusions. The pre-project runoff contribution by the upper basin agrees well with the proportion of the area drained by the upper basin. However, this is not the case for post-project period. The post- project average of percent runoff from upper basin is only about 58 percent whereas the percent area in the upper basin for post-project condition is 70 percent. However, a careful look at individual years revealed that in 9 out of 16 years, percent runoff from upper basin is over 80 percent. Under average rainfall conditions, percent runoff contribution from the upper basin is expected to approach the percent area drained by the upper basin.

The mean annual rainfall input to both upper and lower basins have decreased by about 10 percent from the pre- project period to the post-project period. The decrease in rainfall has caused the amount of runoff contributed by the upper basin to decrease as much as 40 percent. The rainfall decrease however, has caused only about 18 percent decrease in runoff in the lower basin. The upper basin evapotranspiration estimates (computed as rainfall-runoff) do not indicate a significant change whereas the lower basin evapotranspiration estimates in fact show a decrease from pre-project period to post-project period. A possible explanation for such a decrease is that the post-project drainage improvements have decreased the evaporation opportunity of the natural impoundments, and surface soil layers which were previously exposed for evapotranspiration for long periods following storm events. Whether this seemingly reduction has any influence on the local climate is a separate issue that has not been proven conclusively.

Hypotheses on Climatic Changes

Recently, many hypotheses have been advanced regarding possible influences of land use changes on climate in south Florida. Art Marshall (reported by Boyle and Meachem, 1982) has suggested that the recent drought(1981) is not a "meterological aberration but a predictable consequence of the land development and the drainage of wetlands in the Everglades and the Kissimmee River basin that have disrupted the normal rain cycle." His theory suggested that the recent development has reduced the amount of sheet-flow water and consequently the reduced evapotranspiration is insufficient to initiate what is called the "rain machine."

Pielke et al.(1988) presented following other arguments for potential effect of land use changes on local precipitation patterns.

Table 2. Rainfall-runoff statistics for upper and lower Kissimmee River basins for pre- and post-project periods. For all entries under rainfall the periods 1915-1961 and 1970-1986 were used for pre- and post project conditions respectively. For all others except as noted the analysis periods were 1934-1961 for pre-project condition and 1970- 1986 for the post project condition.

Rainfall-Runoff Statistics		
Statistic	Pre-project	Post-project
Rainfall(inches)		
Upper basin mean	49.80	44.99*
Lower basin mean	51.47	45.82*
Runoff(cfs)		
Upper basin mean	1241	722*
Total basin mean	2200	1151*
(period used)	(1929-1961)	(1970-1986)
Percent runoff from upper basin		
Mean	0.558	0.583**
(95% confidence interval)	(0.529,0.586)	(0.475,0.690)
Median	0.566	0.627
Minimum	0.400	0.100
Maximum	0.700	0.836
Runoff coefficient		
Upper basin mean	0.199	0.134*
(95% confidence interval)	(0.164,0.234)	(0.097,0.170)
Lower basin mean		
using area ratio	0.192	0.184**
(95% confidence interval)	(0.161,0.222)	(0.123,0.244)
using Istok. canal data	0.184	
(95% confidence interval)	(0.148,0.221)	
Evapotranspiration		
(estimated as Rainfall-Runoff)		
Upper basin mean	40.18	38.90*
(95% confidence interval)	(37.58,42.79)	(36.52,41.28)
Lower basin mean	41.10	36.85*
(95% confidence interval)	(38.56,43.64)	(34.87,38.83)

* Difference statistically significant at 5 percent level

** Difference is not statistically significant at 5 percent level

(a). Blanchard(1983) found that the water conservation areas (as well as Lake Okeechobee and the coastal configuration) played a major role in the generation, maintenance and decay of thunderstorms.

(b). In the southwest region, the large evapotranspiration and evaporation from the wet peat surface provides an enriched lower atmosphere which is conducive to earlier thunderstorm activity.

Further, Peilke et al(1988) hinted that the land use changes can have a major impact on summer convective rainfall over south Florida. The elimination of standing water and wet peat soils can have a "deleterious effect precipitation, as well as result in higher surface temperatures."

Occurrence of droughts are not a recent phenomenon in south Florida. Langbein(1955) reported occurrence of droughts at Miami in 1944-45, 1906,07, 1927-28, 1897-98, and 1913-14 (listed in approximate order of magnitude). At Kissimmee, the five droughts occurred in 1897-98, 1942-43, 1906-07, 1931-32, and 1938-39. Hypotheses on the influence of land use changes on climate appear intuitively appealing but more evidence is needed for their proof. However, these theories if proven to be valid can have a major bearing on restoration of wetlands and marshes not only in Kissimmee but also in other areas of south Florida as well.

Other potential causes of climatic changes must be considered in future planning. For instance one such cause is the "green house effect." Using a Pielke(1988) concluded that based on the General Circulation Model (GCM) results of Schlesing and Mitchell(1987), the loss of precipitation due to a global doubling of CO2 can be as much as 7 inches per year. The results of any GCM however must be considered in the light of their poor resolution in representing a local area.

CONCLUSIONS

Following is a list of findings based on the results of the previous sections:

1. The upper basin regulation has significantly altered the characteristics of flow inputs to the lower basin from the upper basin. The restoration of the Kissimmee river may not claim full success unless upper basin regulation is modified to mimic as closely as possible, the flow characteristics required for environmental enhancement objectives.

2. The land use changes in the lower basin have further influenced its hydrology. The lower basin hydrology has changed form upland/floodplain retention with slow runoff to one characterized by upland/floodplain drainage with rapid runoff. Consequently, the physical re-creation of floodplain/upland marsh system alone will not re-create the hydrology of pre-project Kissimmee River and a careful design is needed to establish to variability of water levels necessary for environmental restoration.

3. Since 1970 the Kissimmee River basins have received about 10 percent less rainfall than the mean annual rainfall for the prior period beginning 1915. As a consequence a reduction in water availability as indicated by the runoff estimates is evident. However, the lower basin runoff appears to be less impacted by the reduced rainfall and this appears to be the result of lesser evapotranspiration that has occurred during the post-project period.

4. There is not enough data to determine whether the recent decrease rainfall is a random behavior or else if south Florida is experiencing a change in climate due to land use changes. The water availability with or without a climatic change which may be natural or man-made must play a key role in the restoration of possibly thousands of acres of wetlands in the floodplain and uplands.

The above evidence clearly demonstrates the deficiencies of a restoration approach which advocates re-creation of the river physically (say by backfilling) expecting restoration of environmental values to follow automatically. Since the system itself has changed and evolved over the years an approach which seeks the desirable features of environmental restoration under the current changed conditions may be the only feasible one unless a total basin solution is sought.

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PART II

4.2 HEADWATERS REVITALIZATION

The Upper Kissimmee Chain of Lakes has been regulated since 1970. Regulation has altered surface water flow patterns within and out of the basin. For restoration of the Kissimmee River to be successful, some alteration of the current Upper Lakes regulation scheme must be implemented. Of particular importance to river restoration is the magnitude and distribution of flow from S-65.

Figure 4-2 and 4-3 compare flows at the present location of S-65 for a pre-project (1934 to 1962) and post-project period (1970 to 1987). Figure 4-2 shows a comparison of flow duration curves; Figure 4-3 shows a comparison of the monthly distribution of flows. Pre-project flows at S-65 serve as a quantification of "natural" flow patterns. The main goal of re-regulation of the Upper Basin Chain of Lakes is to restore a more natural pattern of S-65 discharges (i.e., like that of the pre-project period).

It is not possible to restore flow patterns completely because some changes in the basin, such as secondary drainage and regulation for flood control, are considered not reversable. Additionally, there is substantial impact to flow resulting from decreased basin rainfall over the past twenty years. This reduction is attributable mostly to a lack of tropical storm rainfall in the basin during this period. Within these bounds, flows will be restored to more natural conditions to the maximum extent possible.

Any regulation plan for the Upper Chain of Lakes is subject to several constraints:

- The current level of flood protection in the Upper Kissimmee Basin should be maintained.
- Some acceptable level of surface water availability in the Upper Kissimmee Basin should be maintained.
- Some level of navigability should be maintained.
- The biological resources of the Upper Kissimmee Chain of Lakes should not be impacted.

Methods of Regulation Schedule Analysis

A preliminary schedule modification was evaluated for Lakes Kissimmee, Hatchineha, and Cypress. Other lakes may be involved in a final regulation plan. Several schedules were developed and evaluated using a modified version of Fan's (1986) Upper Kissimmee Chain of Lakes (UKISS) Model.

The model has three modes of operation:

Calibration mode: In calibration mode, the model performs a simulation for the available record of rainfall data, including all local runoff values rather than historic runoff values.

Simulation mode: In simulation mode, historic runoff values are used whenever possible. If historic values are missing, values are estimated with methods utilized in calibration mode.

Forecast mode: In forecast mode, a small set of forecasted rainfall values are used as input, and the model simulates for a six month period. This mode was not used for this evaluation.

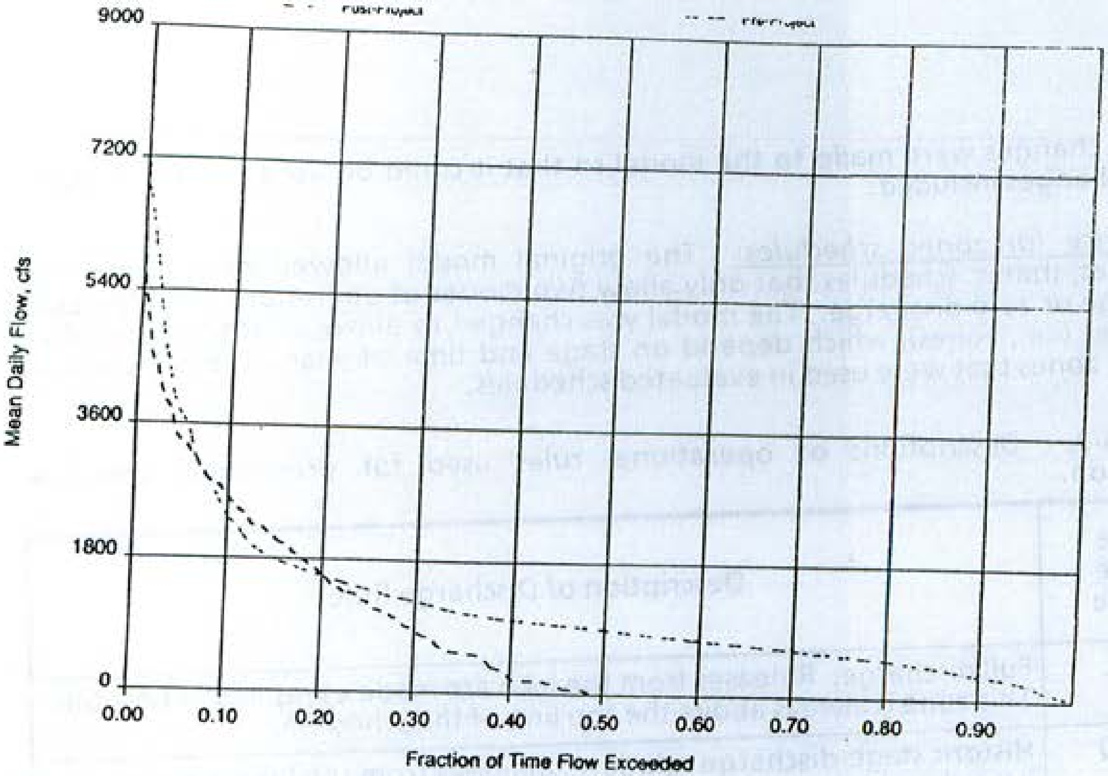
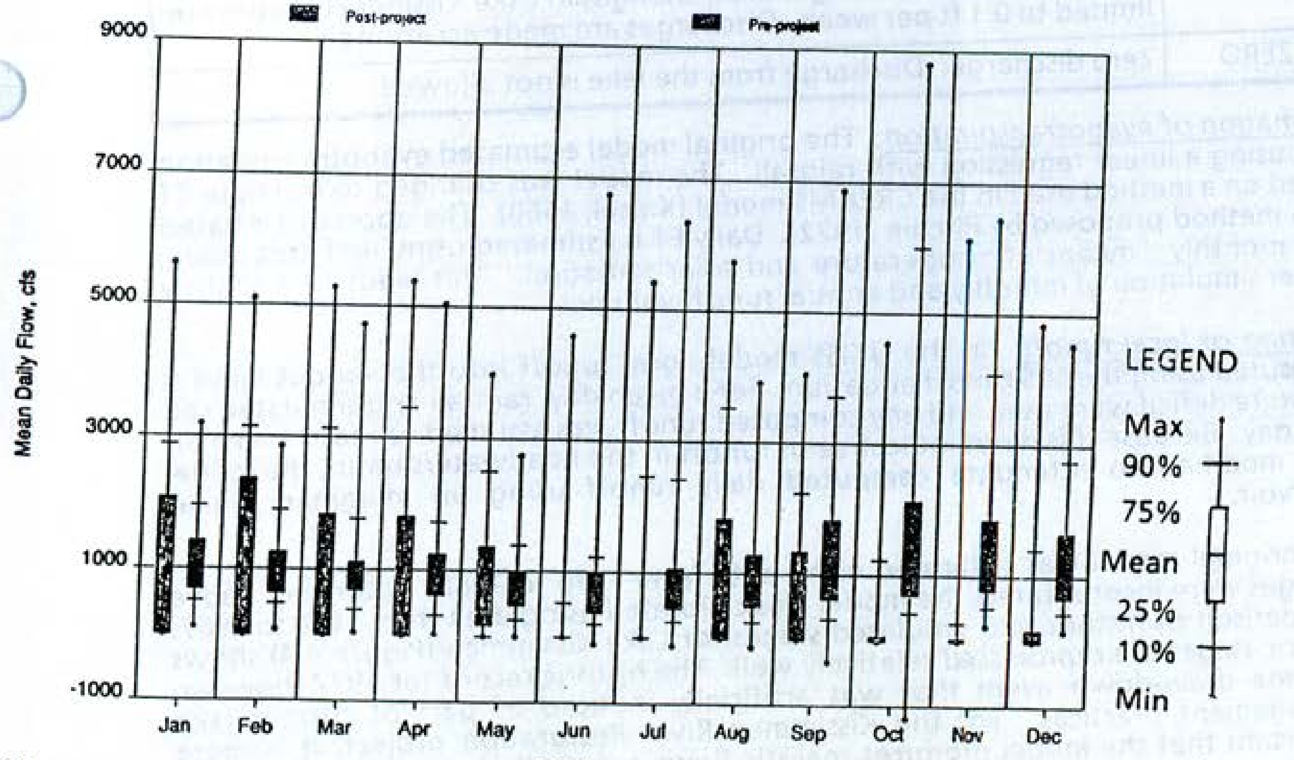


FIGURE 4-2 Pre-project (1934-1962) and post-project (1970-1987) flow duration curves for the outlet of Lake Kissimmee.



JRE 4-3 Comparison of pre project (1934 - 1962) and post-project (1970 - 1987) daily flow frequencies, by month, for the outlet of Lake Kissimmee.

Several changes were made to the model so that it could be used for this analysis. Major changes included:

Allowance for zoned schedules: The original model allowed only single line schedules, that is, schedules that only allow two modes of operation: full allowable discharge or zero discharge. The model was changed to allow an arbitrary number of modes (i.e., zones), which depend on stage and time of year. Table 4-2 shows types of zones that were used in evaluated schedules.

Table 4-2. Descriptions of operational rules used for preliminary schedule evaluation.

Zone Code Name	Description of Discharge Rule
FULL	Full discharge: Releases from the lake are made as rapidly as possible. This zone is always above the top line of the schedule.
STGQ	Historic stage-discharge relation: Releases from the lake are made according to the historic stage-discharge relationship at S-65.
M250	Minimum 250 cfs: Discharges are maintained at a minimum of 250 cfs.
MRCH	The March Rule: During March, changes in Lake Kissimmee stages are limited to 0.1 ft per week. Discharges are made accordingly.
ZERO	Zero discharge: Discharge from the lake is not allowed.

Estimation of evapotranspiration: The original model estimated evapotranspiration (ET) using a linear regression with rainfall. The model was changed to estimate ET based on a method used in the CREAMS model (Knisel, 1980). The approach is based on a method proposed by Ritchie (1972). Daily ET is estimated using leaf area index, and monthly means of temperature and solar radiation. This leads to a slightly better simulation of monthly and annual runoff volumes.

Routing of local runoff: In the UKISS model, local runoff into the various lakes is computed using the SCS runoff equation. For a given day, rainfall and simulated soil moisture deficit were used and any computed runoff was assumed to reach a lake on that day. Because this is not indicative of runoff in the headwaters basin, the model was modified to attenuate computed daily runoff using an imaginary linear reservoir.

The original model was calibrated using data from 1970 to 1980. After the above changes were incorporated, the model was calibrated using data from 1970 to 1987. Comparison of historic and simulated stages for Lake Kissimmee (Figure 4-4) shows historic stages are reproduced relatively well. The historic record for 1977 shows an extreme draw-down event that was artificially induced as part of current lake management practices. For the Kissimmee River Restoration project, it is more important that the model produces realistic flows, especially from S-65. Figure 4-5 shows a comparison of historic and simulated annual volumes from S-65. Figure 4-6 compares historic and simulated flow duration curves at S-65. Figure 4-7 shows observed and simulated flows by month. The UKISS model tends to produce flows

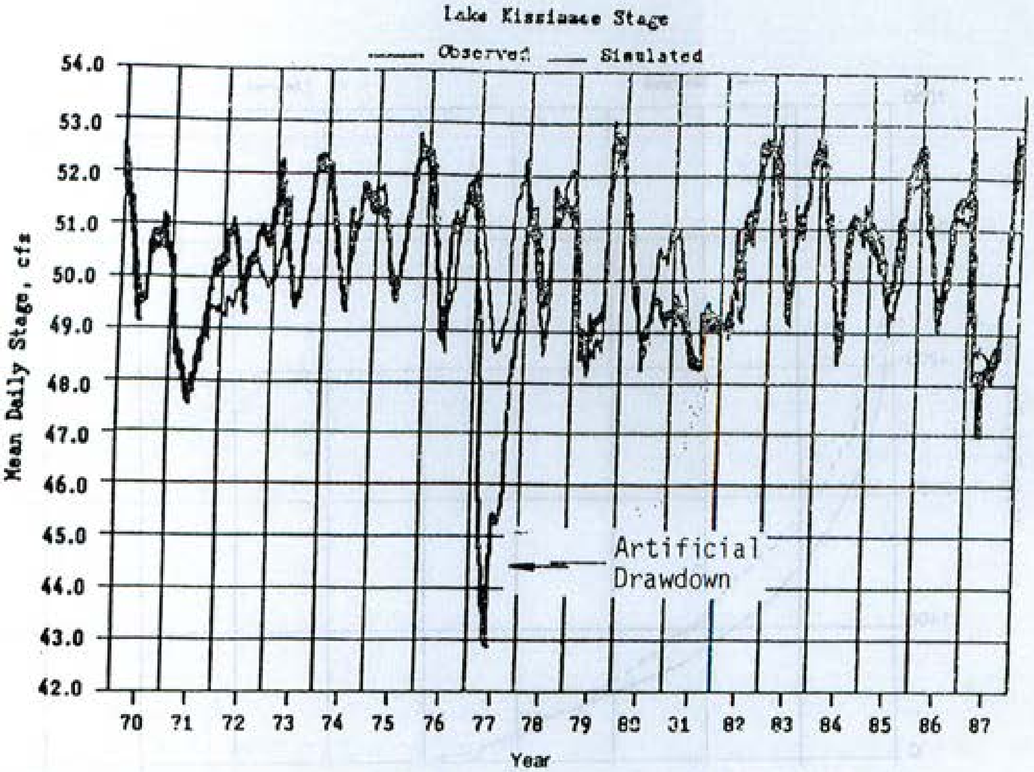


FIGURE 4-4 Comparison of observed stages in Lake Kissimmee, and stages simulated by the Upper Kissimmee Chain of Lakes Model.

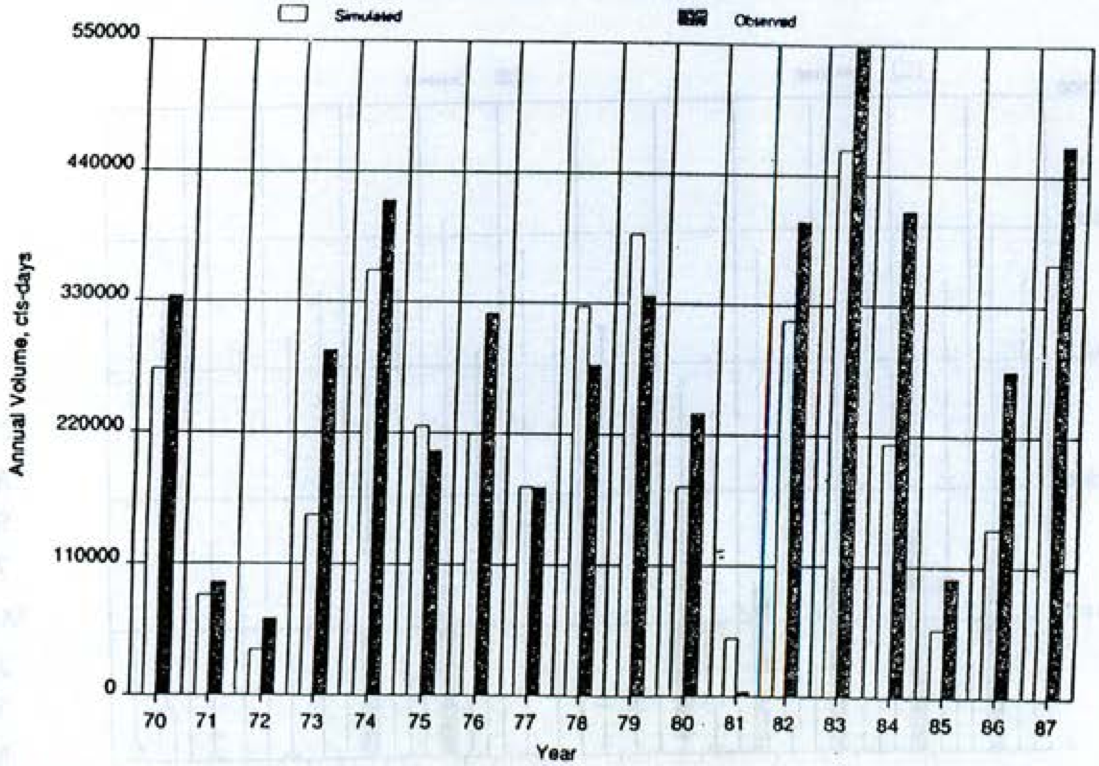


FIGURE 4-5 Calibration results: comparison of observed annual runoff volumes at the outlet of Lake Kissimmee and volumes simulated by the Upper Kissimmee Chain of Lakes Model.

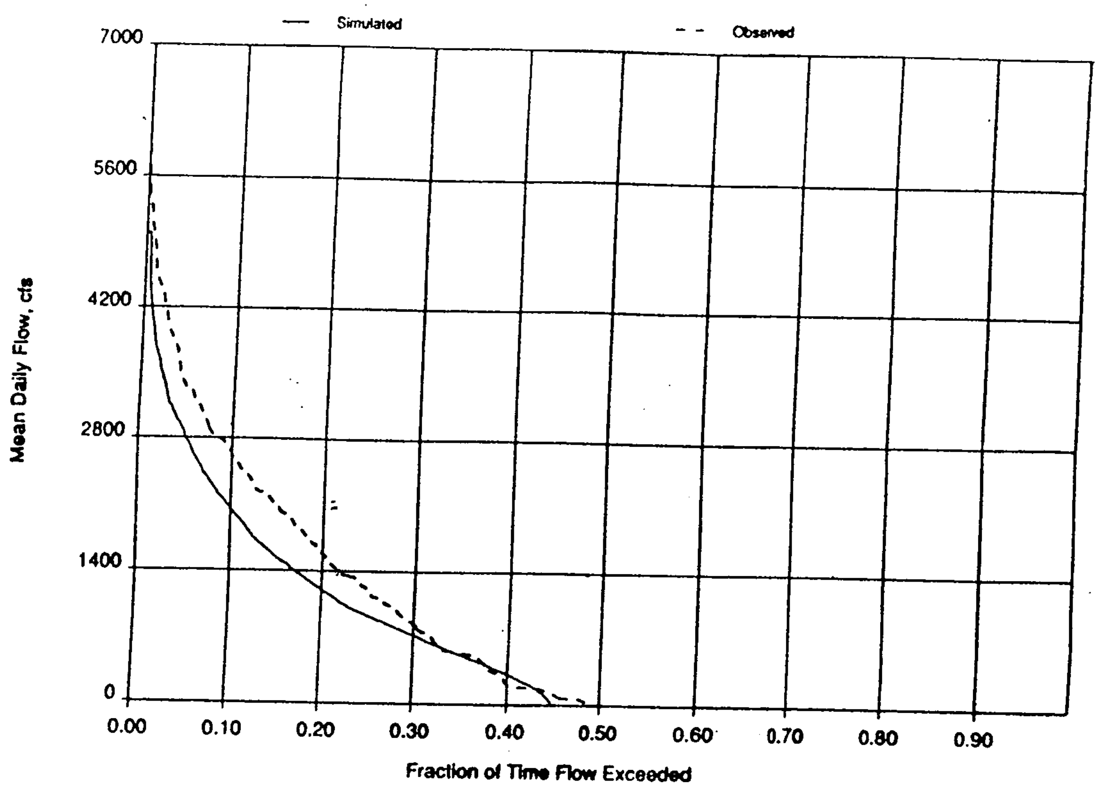


FIGURE 4-6 Observed and simulated flow duration curves at the outlet of Lake Kissimmee.

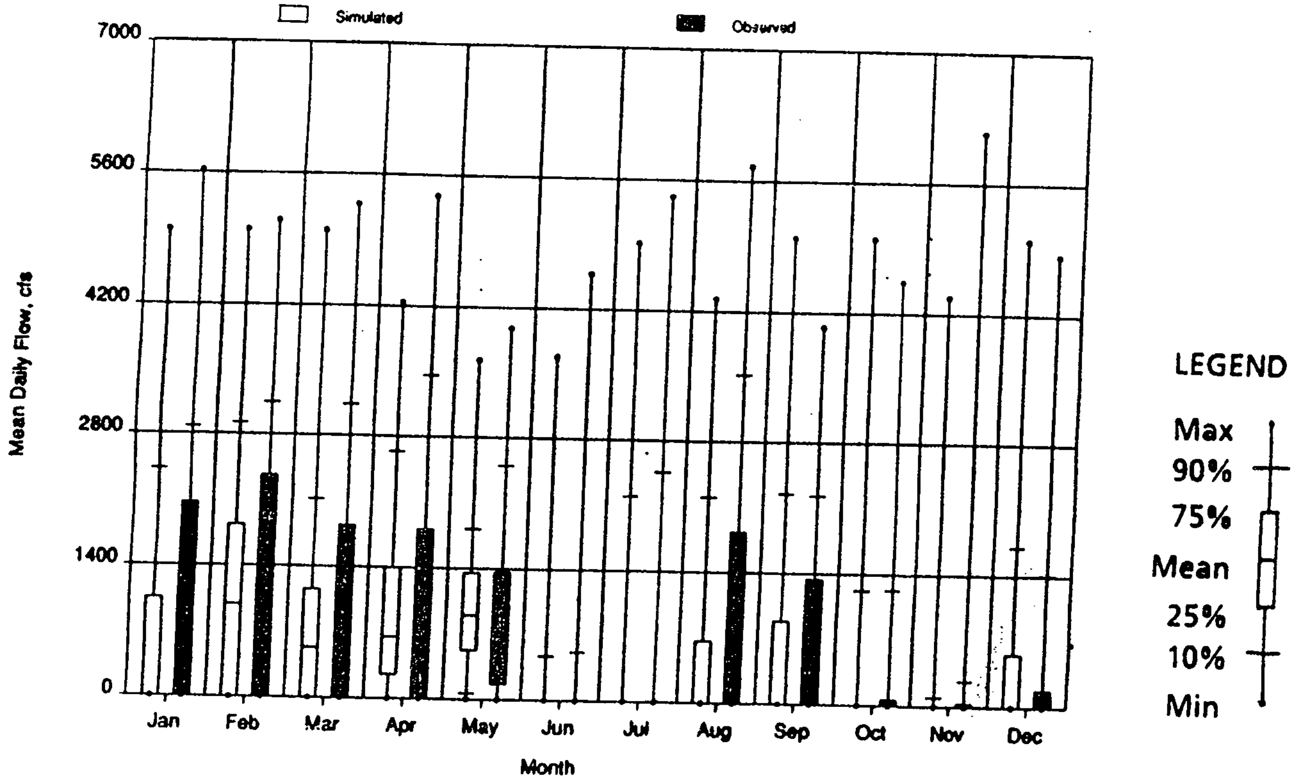


FIGURE 4-7 Box and whisker plots of observed and simulated daily flows, by month, at the outlet of Lake Kissimmee.

which are less variable than occurred historically, but is a useful tool for comparison of schedule alternatives.

Several schedules were developed and examined using post-project (1970 through 1987) conditions. A single schedule was selected for presentation in this report. Additional schedules, with appropriate structural modifications, should be evaluated in the detailed design phase of this restoration component.

Schedule Evaluation

Of the schedules examined, the one shown in Figure 4-8 produced the most desirable effects. Comparison of simulated, post-project, and pre-project flow duration curves (Figure 4-9) shows that this schedule maintains low flows, and decreases the time when zero flow occurs at S-65. The simulated flow duration curves clearly show the impact of reduced rainfall during the past twenty years. If rainfall patterns return to the wetter pre-project conditions, there would be substantial increases in flow performance (i.e., flow characteristics would be more similar to pre-project data). When the performance of this schedule is examined over the entire simulation period (Figures 4-10 and 4-11), it is clear that the preliminary schedule not only maintains a minimum flow for a longer portion of the period, but also tends to smooth the historically sharp discharge peaks. Figure 4-12 compares simulated daily flows that were produced using the schedule in Figure 4-8, to pre-project and post-project flow distributions. Values for simulated and post-project flows are presented in Table 4-3 and Table 4-4, respectively. The preliminary

Table 4-3 Distribution of simulated (1970-1987) post-project daily flows, by month, at the outlet of Lake Kissimmee.

Month	Percent Time Mean Daily Flow (cfs) is Exceeded During Month						
	0%	10%	25%	50%	75%	90%	100%
January	2041	1196	968	250	250	0	0
February	1815	1204	808	250	250	0	0
March	2500	299	256	236	0	0	0
April	4000	1947	999	250	250	0	0
May	2500	1302	1021	473	250	0	0
June	1790	1058	804	599	250	0	0
July	2500	1556	746	462	261	236	0
August	2500	1870	1220	495	250	175	0
September	2500	1731	1265	904	386	250	0
October	7739	1790	1152	722	250	250	235
November	1766	1089	250	250	250	250	250
December	1755	1052	250	250	250	250	0

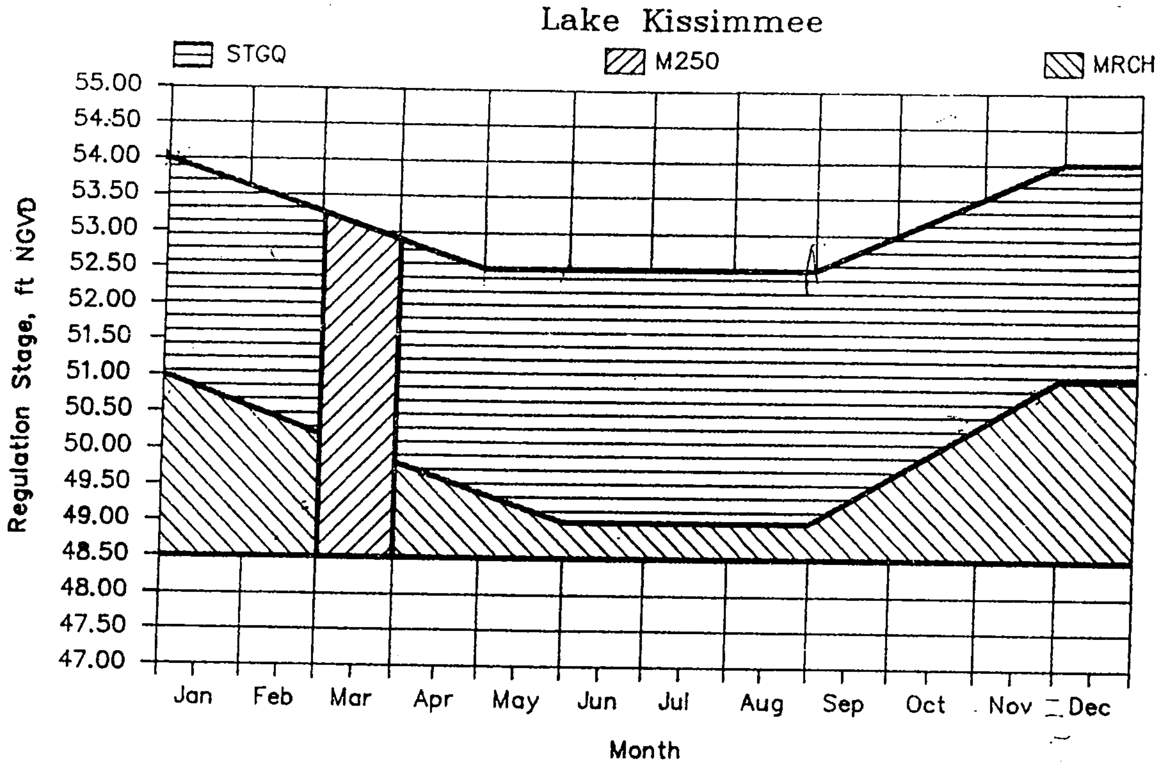


FIGURE 4-8 Proposed preliminary schedule for Lakes Kissimmee, Hatchineha and Cypress.

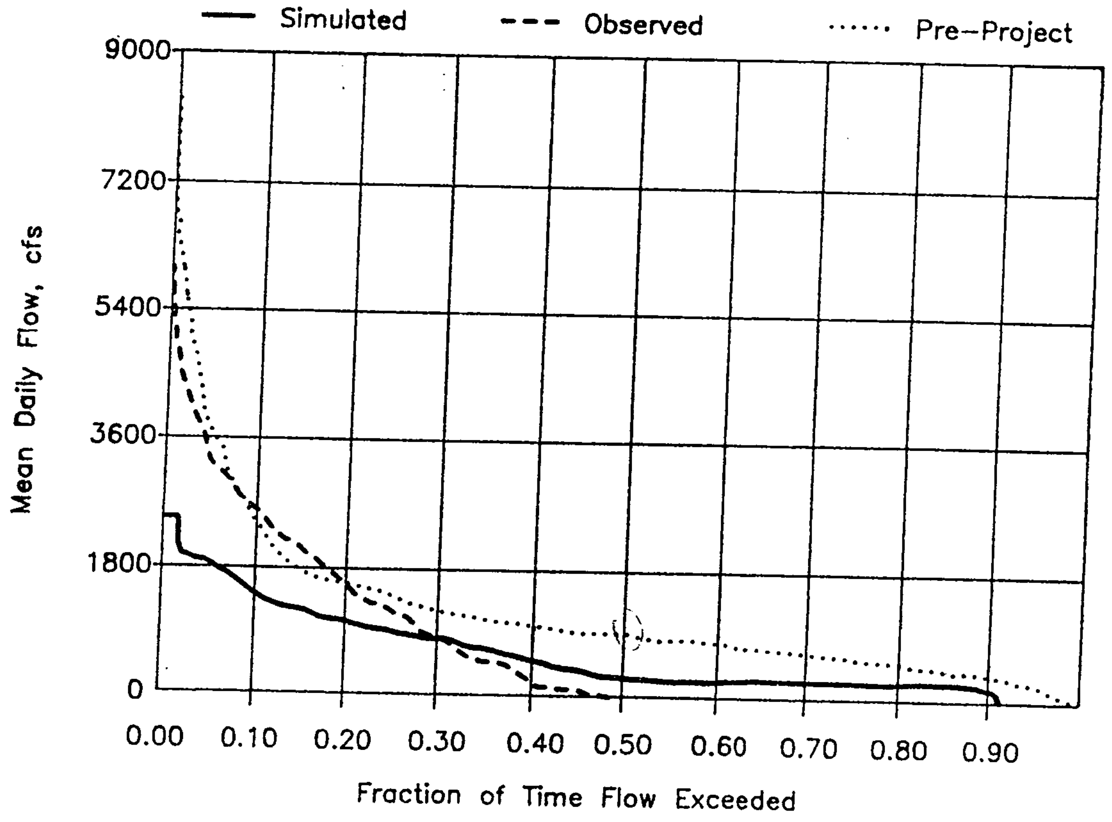


FIGURE 4-9 Comparison of pre-project observed and post-project observed and simulated daily flow duration curves at the outlet of Lake Kissimmee. Simulated values are based on the schedule shown in Figure 4-8.

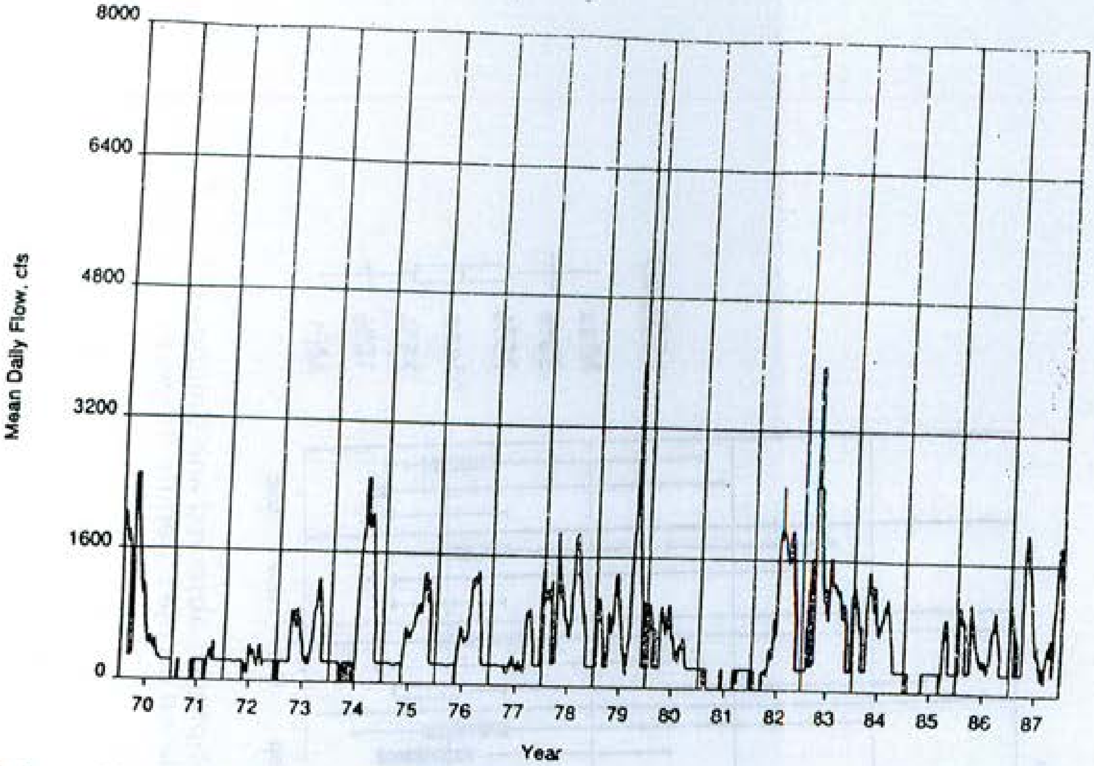


FIGURE 4-10 Simulated flows from the outlet of Lake Kissimmee for the post-project period (1970-1987). Simulated values are based on the schedule shown in Figure 4-8.

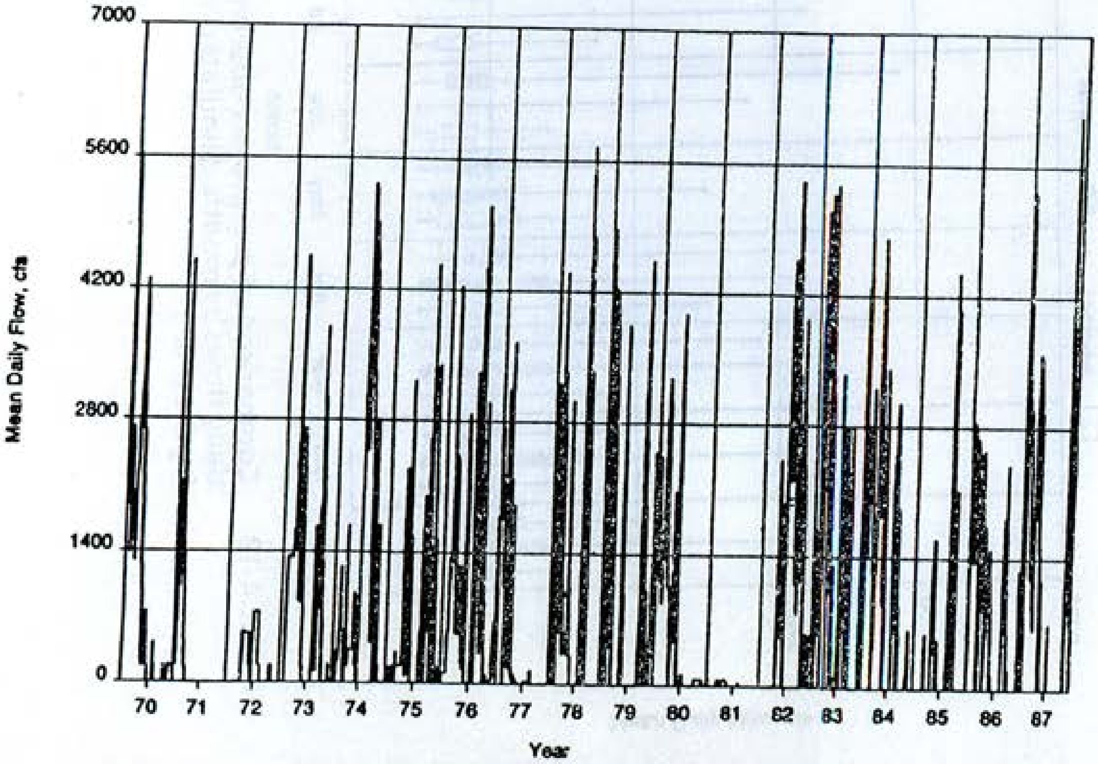


FIGURE 4-11 Observed flows from the outlet of Lake Kissimmee for the post-project period (1970-1987).

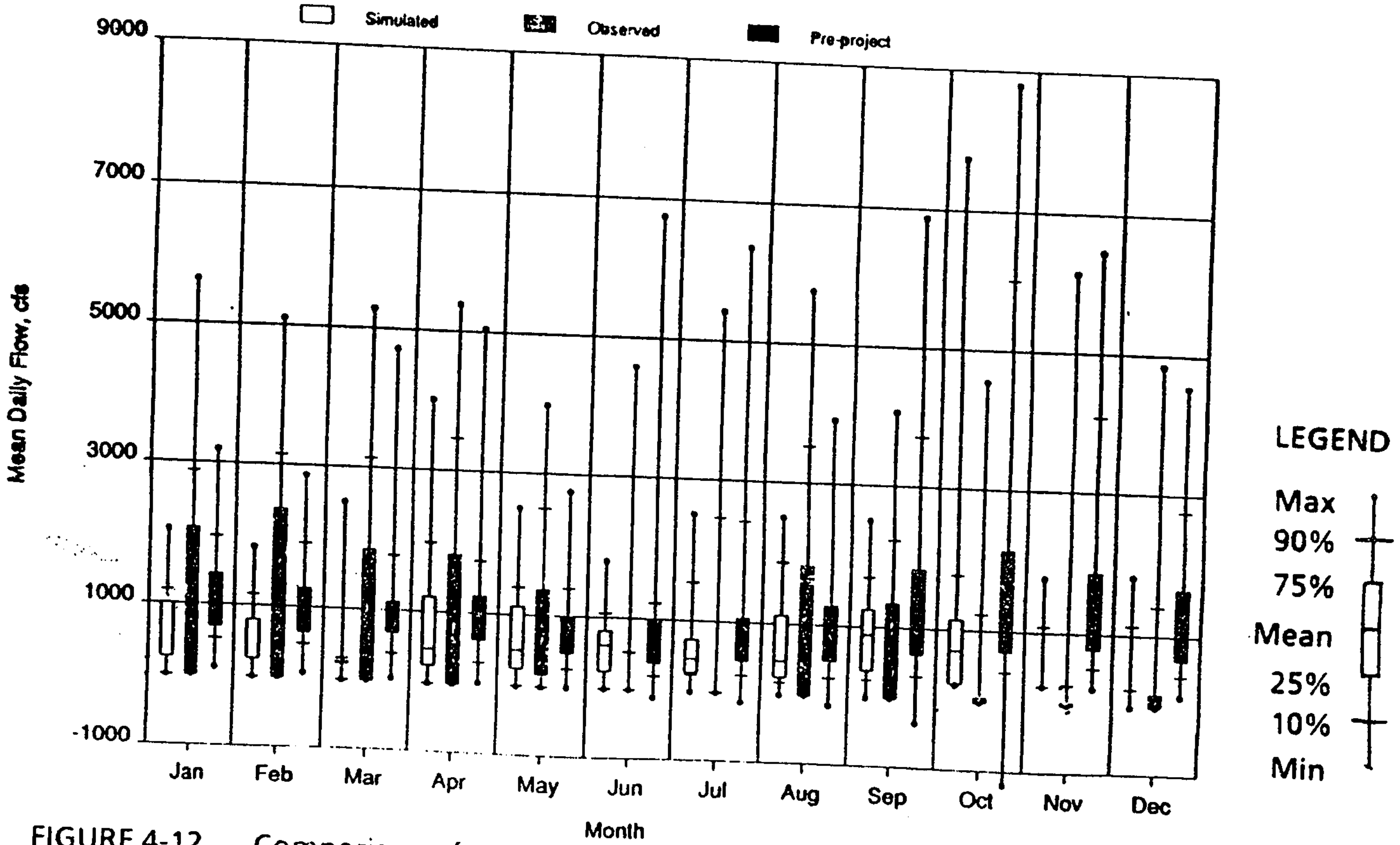


FIGURE 4-12 Comparison of pre-project observed and post-project observed and simulated daily flows by month. Simulated values are based on the schedule shown in Figure 4-8.

Table 4-4. Distribution of observed (1970-1987) post-project daily flows, by month, at the outlet of Lake Kissimmee.

Month	Percent Time Mean Daily Flow (cfs) is Exceeded During Month						
	0%	10%	25%	50%	75%	90%	100%
January	5630	2860	1970	113	1	0	0
February	5100	3121	2250	1350	3	1	0
March	5280	3051	1795	739	2	0	0
April	5380	3450	1837	546	4	0	0
May	3980	2580	1362	538	167	1	0
June	4580	521	3	0	0	0	0
July	5420	2461	5	1	0	0	0
August	5760	3523	1822	167	0	0	0
September	4050	2230	1340	2	0	0	0
October	4540	1231	69	1	0	0	0
November	6140	274	37	1	0	0	0
December	3970	1410	183	2	0	0	0

schedule reversed the change in seasonal flow patterns caused by regulation of the Upper Kissimmee Chain of Lakes (Figure 4-12, Tables 4-3 and 4-4). However, during some months, particularly March, November, and December, simulated flows do not show as much variability as desired. Lack of variability in March flows is due to imposition of the "March Rule". This constraint was recommended by the GFC to facilitate fish spawning.

The schedule shown in Figure 4-8 should be considered a pattern for future schedules to be incorporated in the Kissimmee Restoration project. It is not a final recommended schedule. It produces some of the desired changes in S-65 flows, but there is still some latitude with which some "fine tuning" can be investigated. For example, schedule adjustments involving tradeoffs between high- and low-flow regimes can be made. The "March Rule"also could be re-evaluated with consideration given to accomplishing goals of this rule while reestablishing hydrologic variability in the ecosystem.

This schedule is the basis for evaluation of alternative plans considered in this report. The preliminary schedule shows the potential improvement in the hydrologic performance possible in future restoration scenarios.

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX F

LAKE KISSIMMEE REGULATION SCHEDULE EVALUATION PROCESS

Appendix F
Lake Kissimmee Regulation Schedule Evaluation Process

Table of Contents

Tables

Description of Figures

Figure A1 - Existing flood control regulation schedule for Lake Kissimmee. It is my understanding that this will be shown in a previous section. Change the A1 reference in the text to whatever the figure number should be.

Figure A2a - Bar graphs showing monthly discharge exceedence data for the pre-regulation period of record (1934-60).

Figure A2b - Bar graphs showing monthly discharge exceedence data for the post-regulation period of record (1970-88).

Figure A3 - Bar graphs showing mean monthly Lake Kissimmee stages during the pre- and post-regulation periods of record.

Figure A4 - Alternative regulation schedule RS1.

Figure B1-B6 - Alternative regulation schedules RS1-A, 1-B, 2, 3, 4, 5, 6, 7, 8, 9, 9-A, 9-B, 9-C, 9-D, 10, 10-A, 10-B, 10-C, 11, and 11-A.

Appendix F
Lake Kissimmee Regulation Schedule Evaluation Process

SECTION A

One of the key findings of the planning studies that have been conducted for the Kissimmee River Restoration Project is that dechannelization alone, that is backfilling of C-38, is not sufficient to accomplish ecological restoration of the river/floodplain ecosystem. Due to the flood control schedules and operation rules that are used to regulate stages in Lakes Kissimmee, Cypress, and Hatchineha (Figure A1), discharge regimes from the Upper Basin have been greatly altered compared to historical conditions. Prior to regulation, the river received continuous inflows from the Upper Basin, with lowest discharge typically occurring during the winter-spring dry season and steadily increasing to the November peak (Figure A2a). Since regulation began, the natural seasonality of high and low flow periods has been reversed and there are extended periods during each year when there is no discharge from the upper lakes to the Lower Basin. Low or no discharge is common during the period June through November, while highest annual flows often occur during the dry season months (particularly February-May), as stages in the upper lakes are lowered to provide storage for flood control (Figure A2b). the changes to historical flow regimes have impact the potential for restoring fish and wildlife habitat in the river and its flanking floodplain.

Flood control regulation also has impacted environmental resources in the Upper Basin. Because the range of water level fluctuations and maximum annual lake stages have been reduced (Figure A3), the outer fringe of littoral wetlands surrounding the lakes has been drained and associated fish and wildlife values have diminished.

The 1991 feasibility study demonstrated that discharges required to accomplish ecological restoration of the Lower Basin could be provided by modifying the flood control regulation schedule and operation rules for the lower group of headwater lakes (i.e., Kissimmee, Hatchineha, and Cypress). The proposed modifications (Figure A4) provided required inflow regimes for the Lower Basin restoration, including relatively continuous discharges, with rates that varied with lake stages. These modifications to the operation rules, along with proposed provisions to raise the upper level of the regulation schedule to 52.5 during May-September and between 52.5-54 ft during the remaining months of the year, also have the potential for increasing the range and temporal dynamics of water level fluctuations in the lakes. An associated expansion of littoral wetlands and increased quality and productivity of littoral habitat surrounding the lakes was suggested, but not rigorously evaluated.

SECTION B

Use of regulation schedule and operation rule modifications, such as those proposed in the 1991 feasibility study for achieving the integrated environmental objectives for the Upper and Lower Kissimmee Basins, is based upon the established premise that the basin's environmental restoration objectives will be met by reestablishing key hydrologic characteristics. Hydrologic restoration criteria for the Lower Basin requires reestablishment of continuous inflows from the Upper Basin, particularly during July-October, natural seasonality of high and low inflow regimes and a wide-range of stochastic discharge variability. The primary measure for achieving environmental improvements in the Upper Basin is to increase the extent and frequency of high lake stages. The basic strategy is to modify the regulation schedule and operation rules to allow lake stages to fluctuate more naturally with rainfall and associated inflows from the Upper Basin watershed, and to reestablish outflow regimes that reflect historic (pre-regulation) stage-discharge relationships for the headwater lakes. More natural, rainfall-driven fluctuations would lead to higher lake stages which would provide increased water storage and thereby accommodate maintenance of continuous inflows from the Upper to Lower Basins.

However, the potential for modifying the Upper Basin regulation schedule and operation rules is limited by flood control and navigation constraints, which establish an upper and lower envelop for lake stages and discharge manipulations. The flood control envelop limits maximum lake stages to 54 ft, and to 52.5 ft from June 1-September 1. Navigation constraints restrict minimum lake stages to 48.5 ft. Within this envelop, alternative operation rules can be devised for manipulating discharge regimes to the lower basin.

Key components of the regulation schedule and operation rule modifications in the 1991 feasibility study were used as a template for developing alternative Upper Basin water management schemes for meeting the restoration criteria and environmental objectives of the river and headwater lakes. Through an iterative process, 21 alternative schemes (Table B1 and Figures B1-B6) were developed and evaluated by Corps and SFWMD staff, with input from the FGFWFC and USFWS.

Table B1
Regulation Schedule Alternatives
Lake Kissimmee Regulation Schedule Evaluation

Regulation schedule alternatives. See Figures A4 and B1-6 for more details on operation rules for each alternative.

ALTERNATIVE	OPERATION RULES
RS1	Three discharge zones bounded by an upper flood control regulation zone when lake stages exceed 52.5-54 ft and a lower no discharge zone when lake stages are < 48.5 ft. Within this envelop no discharges are made during March; during other months discharges either vary according to the historic (pre-regulation) stage-discharge relationship or are maintained at 250 cfs, depending upon lake stages.
RS1-A	Same as RS1 with slight modifications to historic stage-discharge rating curve.
RS1-B	Same as RS1 without March no discharge zone.
RS2	Same discharge zones as RS1-B except upper flood control regulation zone is bounded by existing regulation schedule elevations.
RS3	Same as RS1-B with slightly higher flood control envelop during May.
RS4	Same as RS4 except 250 cfs zone changed to 400 cfs zone.
RS5	Two discharge zones bounded by the same flood control and lower no discharge zones as RS4. Within this envelop discharges are maintained at 250 cfs when lake stages are < 41.68 ft or vary as lake stages overtop a weir with a fixed crest of 41.68 ft.
RS6	Two discharge zones bounded by the same flood control and lower no discharge zones as RS4. Within this envelop discharges are maintained at 150 cfs when lake stages are < 49 ft or vary according to a this alternative's stage-discharge rating curve.
RS7	Same as RS6 with the addition of a 400 cfs discharge zone when lake stages fall within designated ranges during November-May.
RS8	Same as RS6 with a different stage-discharge rating curve.
RS9	Same as RS6 with the addition of a 400 cfs discharge zone that occurs at different lake stages than the RS7 400 cfs discharge zone
RS9-A	Same as RS9 with a modification to the 400 cfs discharge zone

Regulation schedule alternatives. See Figures A4 and B1-6 for more details on operation rules for each alternative.

ALTERNATIVE	OPERATION RULES
RS9-B	Same as RS9 with a modification to the 400 cfs discharge zone different from that of RS9-A
RS9-C	Same as RS9 with a modification to the 400 cfs discharge zone different from that of RS9-A and RS9-B
RS9-D	Same as RS9-C with elimination of 400 cfs discharge zone during November-December
RS10	Same as RS9-A with historical stage-discharge rating curve.
RS10-A	Same as RS9-B with historical stage-discharge rating curve.
RS10-B	Same as RS9-C with historical stage-discharge rating curve.
RS10-C	Same as RS9-D with historical stage-discharge rating curve.
RS11	Same as RS9-C and RS10-B with RS8 stage-discharge rating curve during January-June and historical stage-discharge rating curve during July-December.
RS11-A	Same as RS11 with elimination of 400 cfs discharge zone during November-December.

SECTION C

The hydrologic performances of the alternative schemes were modeled over an 18-year, post-channelization (1970-87) simulation period, using a modified version of a continuous simulation model (Fan, 1986) for the upper chain of lakes (UKISS). Period of record of rainfall, average monthly temperature, and average solar radiation data provided required inputs for the model to generate daily lake stages and flow for the simulation period. The model has been calibrated for stage, but appeared to underestimate discharge during the simulation period by approximately 20 percent. During the 18-year period used for model simulations, the Upper Basin received approximately 10 percent less rainfall, and as a result, contributed 40 percent less average annual runoff to the Lower Basin than during the pre-regulation period of record (Obeysekera and Loftin, 1990).

The long term hydrologic effects of the alternative regulation schedules on Lakes Kissimmee, Hatchineha and Cypress were analyzed using UKISS, a computer model developed by the SFWMD. The model was first developed in 1981 to address the problems created by the prolonged Kissimmee Basin drought of 1980-81.

Later, the model was used to evaluate new schedules proposed in 1982 for the Middle and Upper Kissimmee Lakes. It has subsequently been modified extensively and used to evaluate impacts associated with the Kissimmee River Demonstration Project and extreme drawdowns. It was again used to by SFWMD to evaluate the alternative plans presented in their 1990, Alternative Plan Evaluation & Preliminary Design Report on Kissimmee River Restoration. A detailed description of the UKISS model is contained in SFWMD Technical Publication 86-5 entitled, A ROUTING MODEL FOR THE UPPER KISSIMMEE CHAIN OF LAKES, dated September, 1986. In summary, UKISS is a continuous simulation model designed to simulate the daily operation of the nine lakes in the Middle and Upper Kissimmee Basins. The model estimates the average daily stage of nine Kissimmee lakes, including Lakes Kissimmee, Hatchineha, and Cypress. It also estimates the average daily discharge from Lake Kissimmee. Input to the model are regulation schedules for each year of simulation, daily rainfall, and average monthly temperature and solar radiation. It uses linear reservoir routing techniques and the SCS methods for estimating overland flow travel times and soil moisture storage. The model simulates the complex hydrologics of structures gate operations by simplified equations. The period of record for which records are available is from 1970 to 1988. In order to verify the accuracy of the model the period of record, 1970 to 1988, was simulated for Lake Kissimmee using historical schedules; the results were compared with the historical stage and discharge data (Figures C1 and C2).

In previous studies of the restoration of the Kissimmee River most of the effort was directed to the lower River. It was generally assumed that the new regulation schedule for Lake Kissimmee would be a zoned schedule where the regulated outflow in that zone would closely resembled the outflow prior to the project, (pre 1970). It was also assumed with this outflow that Lake Kissimmee would be higher at the end of the wet season and this additional storage would extend the hydroperiod of the lower river. Perhaps because the rainfall has been less since the project was completed in 1970, Ukiss routings showed that with historical outlet capacity Lake Kissimmee would not have sufficient water to adequately extend the hydroperiod of the Kissimmee River. The historical rating curve used in the model was then modified to limit flow to 400 cfs at a lake stage of 50.0 feet and no outflow below 48.5 feet. Later, two other outlet ratings (RC-A and RC-B) were developed by Lou Toth of the SFWMD. These new outlet capacities were modeled for each general schedule plan to produce two new alternatives. The RC-A and RC-B rating curves are displayed along with historical capacity (Figure C3). The historical outlet capacity for Lake Kissimmee is derived from a rating curve developed by the U.S. Geological Survey based on records from 1934 to 1955 for a gage that was located 3 miles south of Structure 65 at State Road 60. The original rating curve is presented on plate 57 of the basic report, Part II Supplement 5 General Design Memorandum Kissimmee River Basin 1956. To correct for the stage difference over that 3 miles, 0.3 feet was added to the stage at S-65.

In order to evaluate the effect of the alternative regulation schedules on the Kissimmee River below Lake Kissimmee, it was necessary to devise a relationship between the discharges from Lake Kissimmee and the percent of floodplain inundated along the Kissimmee River. In the SFWMD 1990 Restoration Study, a relationship was developed by linear regression between historical stages at the Fort Kissimmee gage and the discharges from Lake Kissimmee. In Table 2-1 of the 1990 study, a relationship is given between the river stages at Fort Kissimmee and the percentage of local floodplain inundation for a representative 0.66 square mile floodplain adjacent to Fort Kissimmee. These relationships were used to evaluate the effects of the alternative regulation schedules on the Kissimmee River floodplain and are shown in Table C1. The table shows 100 percent of the representative floodplain inundated at elevation 45 feet. Stages of 45 feet were equalled or exceeded approximately 30 percent of the time during the period of record. Although flood stages greater than 45 feet inundated areas beyond the representative floodplain during the period of record, these areas were not inundated frequently enough to increase the area representing the "natural floodplain" boundary.

Table C1
A Comparison of Lake Discharges to River Elevations

Lake Kissimmee Discharge (cfs)	Fort Kissimmee Stage (feet msl)	% of Flood- Plain Inundated
0	38.0	0
190	39.9	0
250	40.5	7.5
350	41.0	15.85
400	41.6	30.00
500	42.2	45.85
600	43.0	48.73
700	43.5	88.70
800	44.0	93.65
900	44.3	96.50
1000	44.5	97.80
1200	45.0	100.0
1500	45.5	100.0
2000	46.0	100.0
3000	46.8	100.0
4000	47.1	100.0
5000	47.8	100.0
6000	48.2	100.0

Environmental analyses of the alternatives focussed on comparisons of their simulated hydrologic performance with the established restoration criteria. Upper Basin environmental analyses were based upon comparisons of observed and simulated stage duration curves for the post-channelization period. Although maximum hydrologic restoration would be achieved by reestablishing lake stage frequencies similar to the pre-regulation period, the flood control and navigation constraints limit the range of fluctuation to 48.5-54 ft. During the 1934-60 period of record, Lake Kissimmee stages exceeded 54 ft approximately 7 percent of the time and were less than 48.5 ft approximately 19 percent of the time. Because frequencies of lake stages between 49.6 ft and 50.8 ft were similar for the observed post-regulation period and historical period (Figure C4), and the primary environmental objective for the Upper Basin is to reestablish littoral wetlands that were drained by lowered lake stages, Upper Basin analyses focussed on the degree to which the alternatives increased frequencies of lake stages between 50.8 ft and 54.0 ft.

Lower Basin environmental analyses were based upon the simulated discharge regimes of the alternatives. Simulated Lake Kissimmee outflows for each alternative were compared to discharge characteristics of the RS1 schedule, because the 1991 feasibility study demonstrated that the hydrologic performance of this schedule met the criteria for restoration of the Lower Basin ecosystem and was used as a basis for the restoration project's authorization. New alternatives were considered acceptable if their simulated discharge characteristics equalled or exceeded the hydrologic performance of the RS1 schedule. Comparisons were based upon monthly discharge exceedence data (i.e., discharges that were exceeded during various percentages of the simulation period). The continuous flow criteria was evaluated by determining monthly discharges that were exceeded during 90 percent of the simulation period. The degree to which the alternatives reestablished discharge variability and natural seasonal distributions of high and low flow periods was evaluated by monthly discharges that were exceeded during 10, 25, 50, and 75 percent of the simulation period. These percentages were chosen to represent magnitudes of discharges that could be expected during low (discharge exceeded during 75% of simulation period), average (discharge exceeded during 50% of simulation period), high (discharge exceeded during 25% of simulation period), and peak (discharges exceeded during 10% of simulation period) flow periods.

SECTION D

Initial screening of the hydrologic performance of each alternative indicated that nine schedules failed to meet the minimum requirements of the upper or lower basin restoration criteria. Five alternatives, the RS1, RS1-A, RS1-B, RS3, and RS4 schedules, were eliminated because simulations indicated these alternatives would result in Upper Basin water levels that would be consistently lower than stages produced by the existing regulation schedule (Figure D1-4). The RS2, RS5, RS6 and RS8 alternatives were eliminated because their discharge characteristics during average flow periods (Figure D5) were inadequate for Lower Basin restoration. Simulations indicate that 50 percent of the time the RS2 and RS5 schedules would produce inflows of only 250 cfs. The RS6 and RS8 alternatives produced higher discharges, but were less than 600 cfs during most months, including much of the wet season. Based upon Lower Basin stage and Upper Basin discharge relationships (Figure D6), inflows produced by these schedules would consistently inundate only 50 percent or less of the river's floodplain.

All other alternatives produced discharge regimes that met the Lower Basin restoration criteria and improved upon the hydrologic performance of the RS1 schedule. Compared to the RS1 schedule, these remaining alternatives had lower frequencies of no flow periods, increased the magnitude of low flows during wet season months, and average flows during dry season months, and redistributed average and high flow volumes in a more natural seasonal pattern.

When the simulated effects of these 12 schedules on lake stages were compared to observed lake stage frequencies between 1970-88, the remaining alternatives grouped into three categories. Alternatives RS10, RS10-A, RS10-B, and RS10-C resulted in frequencies of lake stages > 51.5 feet that were similar to that produced by the current regulation schedule, but significantly lower frequencies of stages between 49.5-51.5 feet (Figure D7-10). Alternatives RS7, RS11, and RS11-A resulted in slightly higher frequencies of stages > 51.0 feet and lower frequencies of stages between 50-51 feet than the current schedule (Figure D11-13). Alternatives RS9, RS9-A, RS9-B, RS9-C, and RS9-D produced the greatest increase in frequencies of lake stages >51 feet, and had frequencies of stages between 49-51 feet similar to observed frequencies of these stages during the 1970-88 simulation period (Figures D14-18).

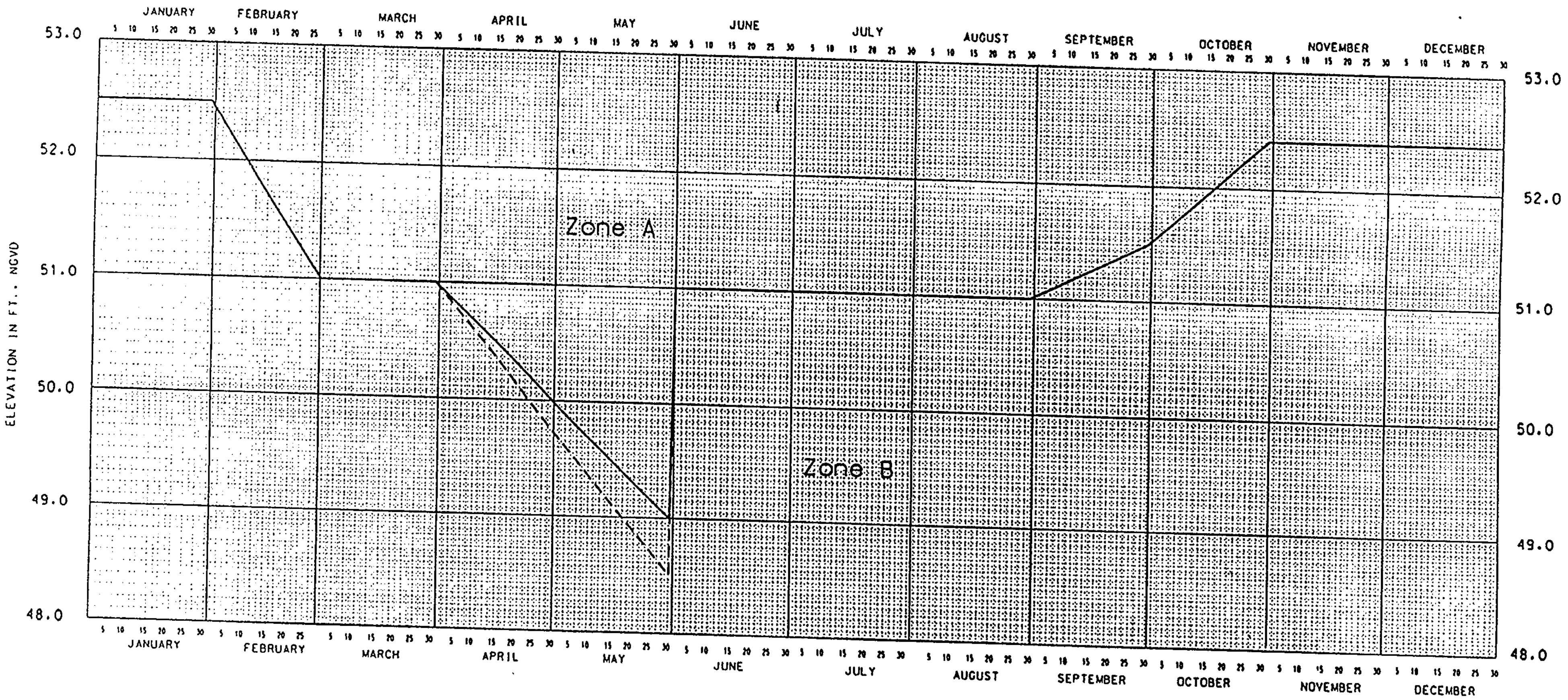
Based upon the simulated effects of the alternatives on lake stage frequencies, alternatives RS9, RS9-A, RS9-B, RS9-C, and RS9-D had the greatest potential for leading to expanded littoral wetlands and associated environmental improvements to the Upper Basin. Although all five of these alternatives also would provide inflow regimes that meet the Lower Basin restoration criteria, the simulations suggest that alternatives RS9-C and RS9-D would provide a more natural seasonal distribution of high and low flow periods (Figure D19). While the hydrologic performance of these two alternatives would be similar for both the Upper and Lower basins, RS9-D has less operation constraints. Because this alternative does not have a zone that limits discharges to 400 cfs when lake stages are between 50-52 feet during November-December, it would produce more natural inflows to Lower Basin during these months than alternative RS9-C.

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX F

Lake Kissimmee Regulation Schedule Evaluation Process

FIGURES



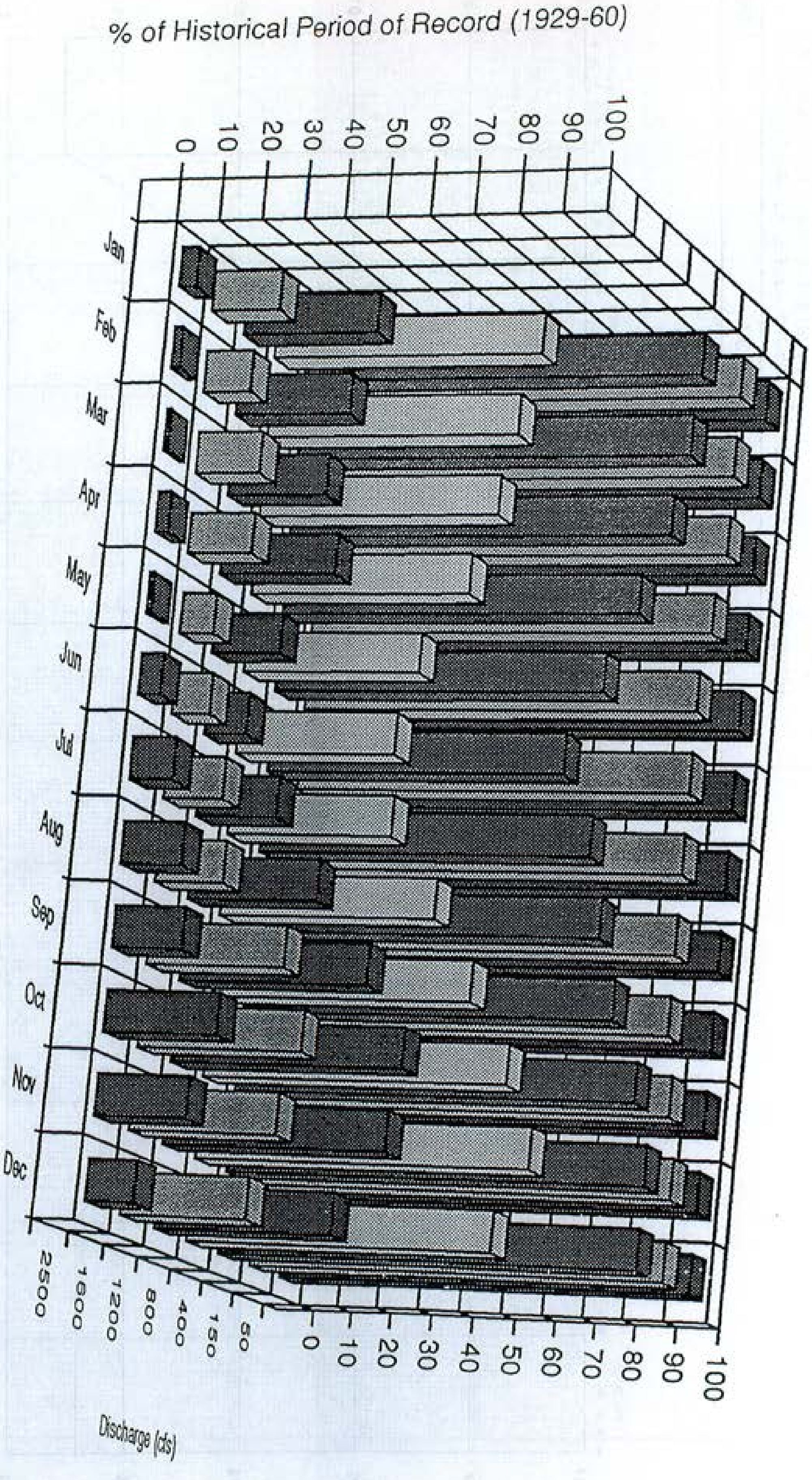
ZONE	RELEASES
A	3,000 CFS UP TO DESIGN CAPACITY(11000) WITHOUT EXCEEDING DESIGN CONDITIONS DOWNSTREAM. WHEN THE LAKE IS WITHIN 0.5 FEET OF SCHEDULED STAGE FORECASTS WILL BE MADE AND RELEASES STARTED TO RETURN THE LAKE TO SCHEDULE WITHIN 15 DAYS
B	TO MAINTATIN MINIMUM FLOWS

NOTE: (............................) USE THIS SCHEDULE ONE YEAR IN THREE

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN
LAKES KISSIMMEE, HATCHINEHA,
AND CYPRESS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981


% of Historical Period of Record (1929-60)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2500
1600
1200
800
400
150
50
Discharge (cfs)

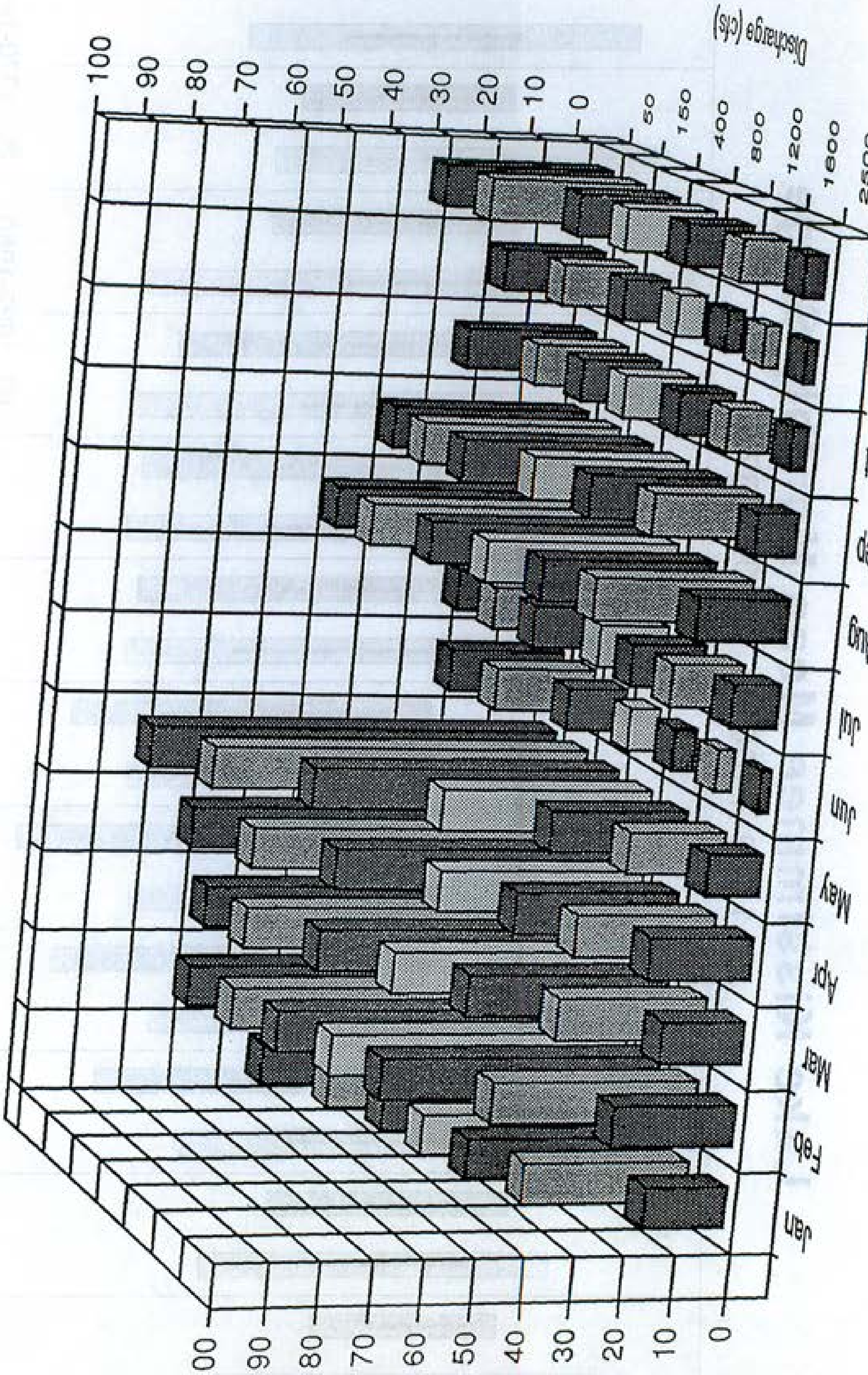
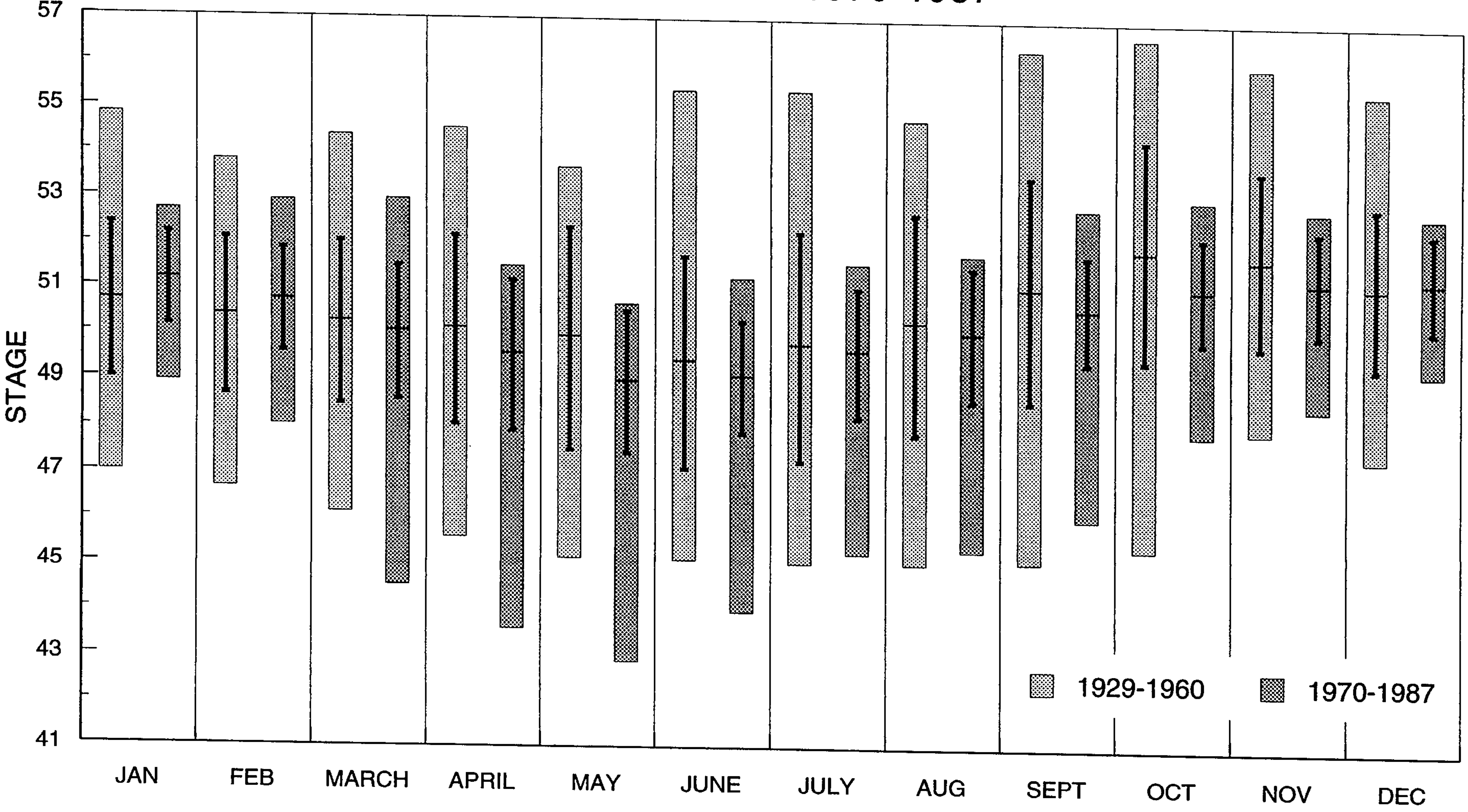

Discharge (cfs)
50
150
400
800
1200
1600
2500
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0
10
20
30
40
50
60
70
80
90
100
% of Post-Regulation Period of Record (1970-88)

FIGURE A2b

Lake Kissimmee Mean Monthly Stage

1929-1960 vs 1970-1987



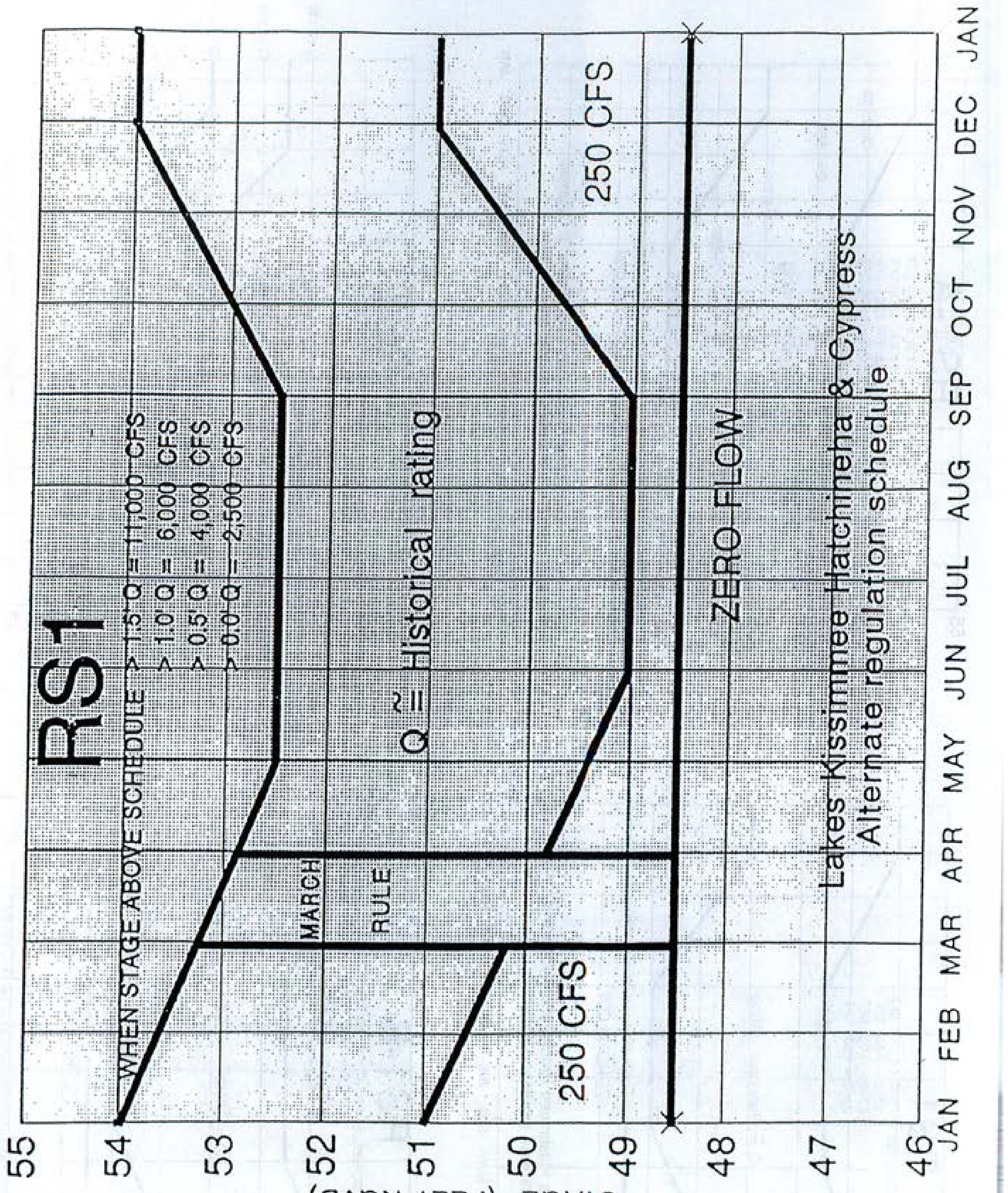

RS1
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q ≈ Historical rating
MARCH
RULE
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN

FIGURE A4

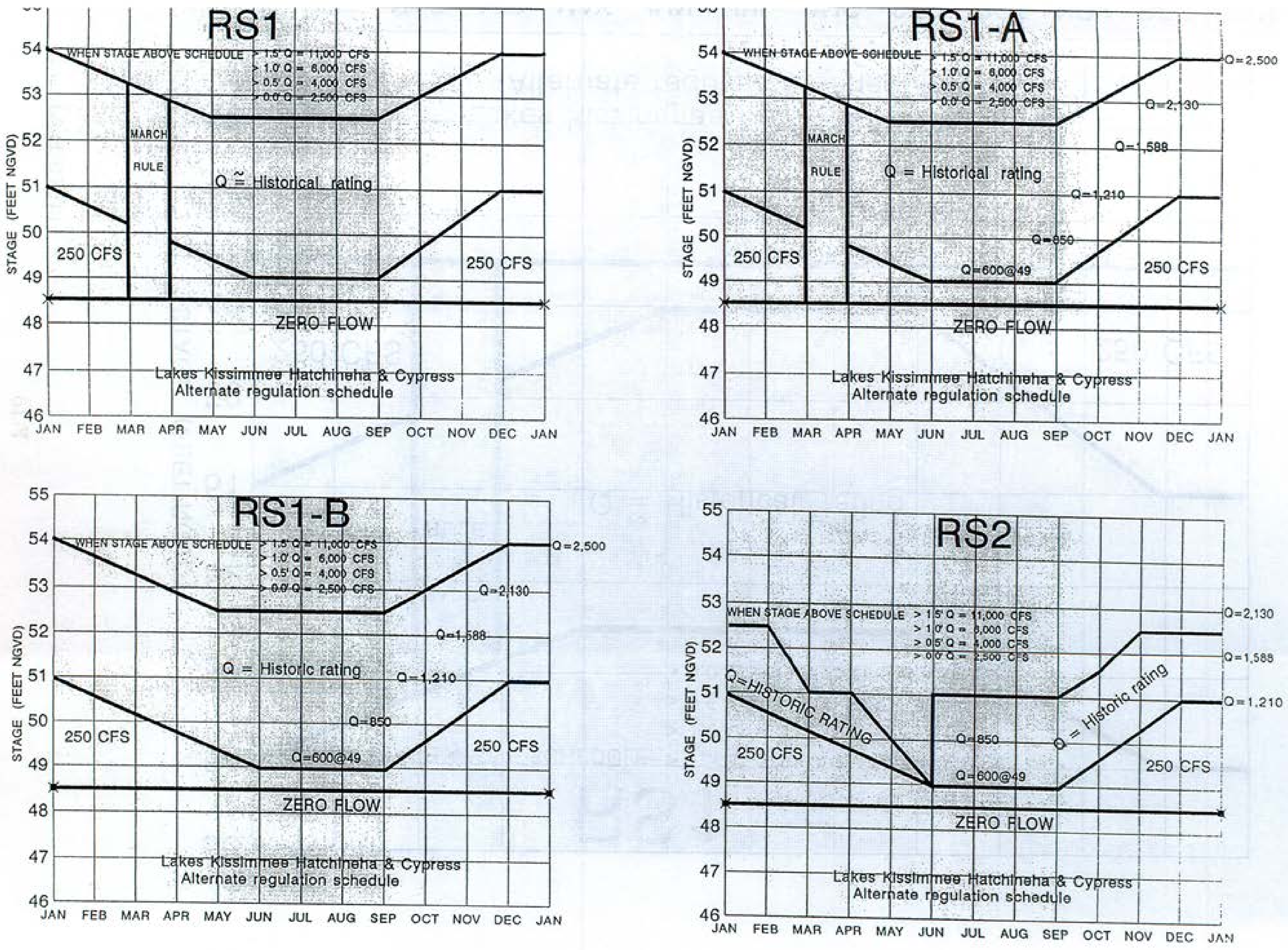

RS1
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
MARCH
RULE
Q ≅ Historical rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
54
53
52
51
50
49
48
47
46
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
RS1-A
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
MARCH
RULE
Q = Historical rating
Q=2,500
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
RS1-B
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q = Historic rating
Q=2,500
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
55
RS2
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=HISTORIC RATING
Q = Historic rating
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule

FIGURE B1

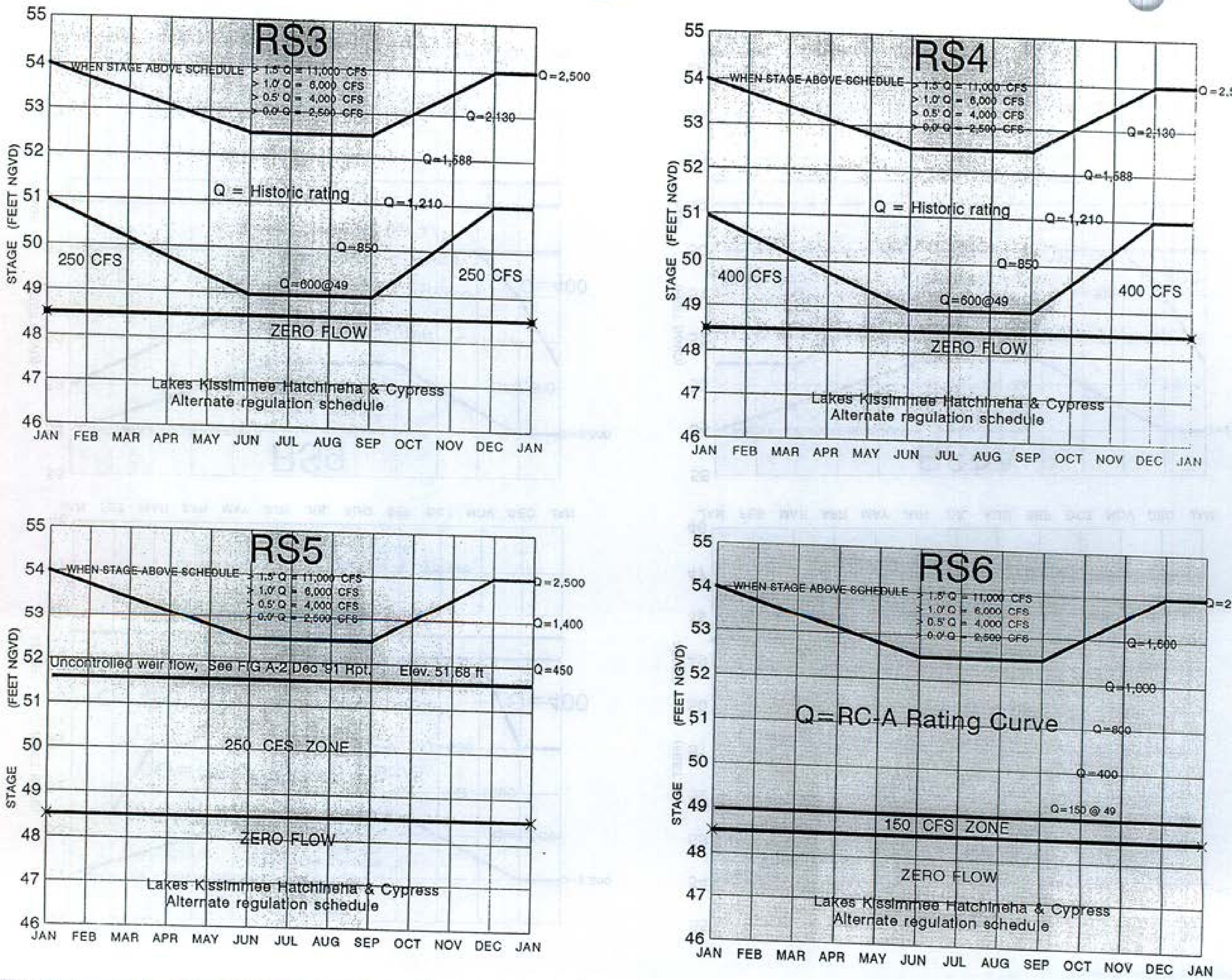

RS3
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
Q = Historic rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN
RS4
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
Q = Historic rating
400 CFS
400 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN
RS5
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,400
Q=450
Uncontrolled weir flow, See FIG A-2 Dec '91 Rpt. Elev. 51.68 ft
250 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN
RS6
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,500
Q=1,000
Q=800
Q=400
Q=150 @ 49
Q=RC-A Rating Curve
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE B2

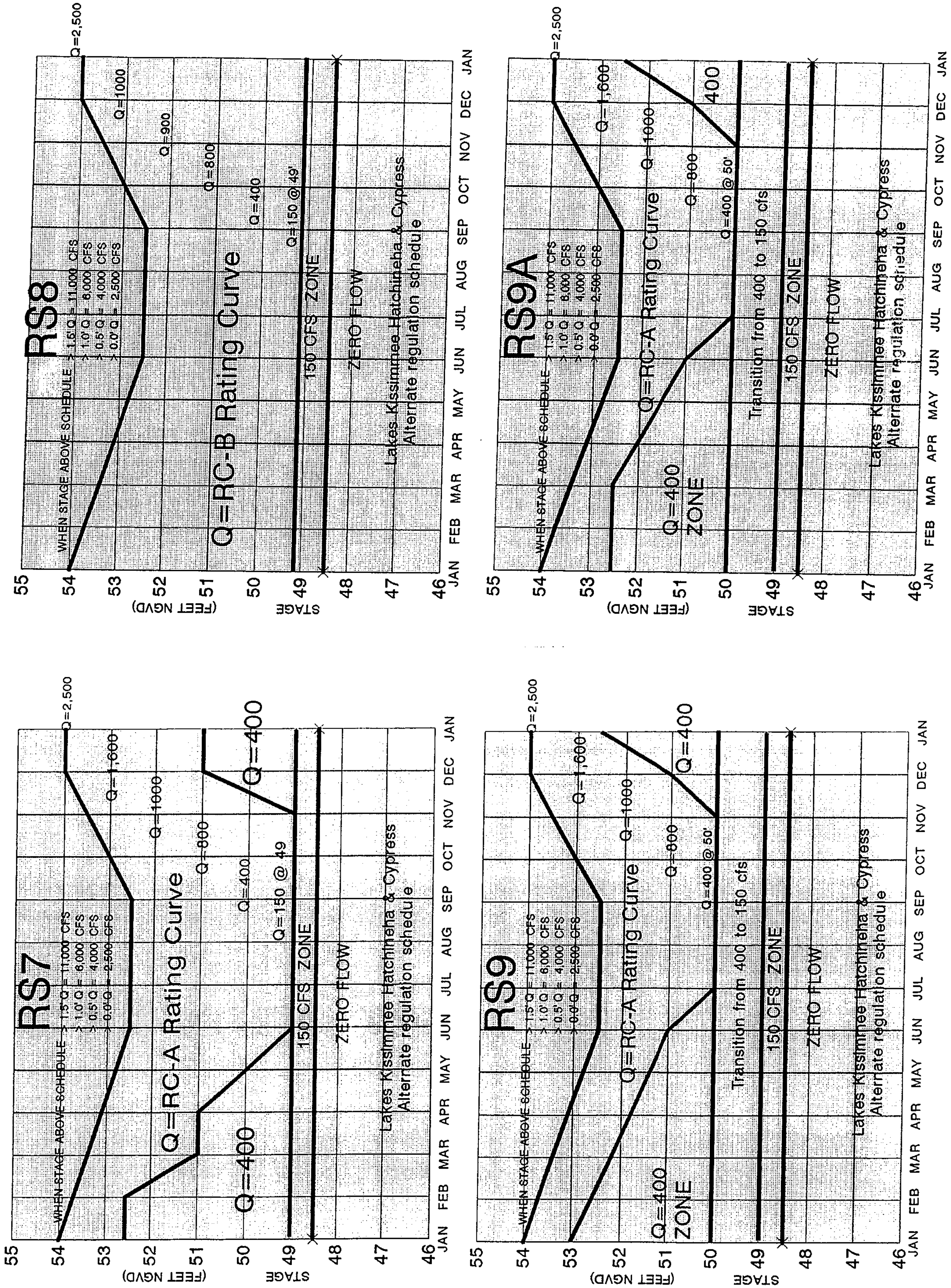

RS7
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 8,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400
Q=150 @ 49
Q=RC-A Rating Curve
Q=400
Q=400
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
RS8
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 8,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1000
Q=900
Q=800
Q=400
Q=150 @ 49'
Q=RC-B Rating Curve
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
RS9
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 8,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400 @ 50'
Q=RC-A Rating Curve
Q=400
Q=400
ZONE
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
RS9A
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 8,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400 @ 50'
400
Q=RC-A Rating Curve
Q=400
ZONE
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule

FIGURE B3

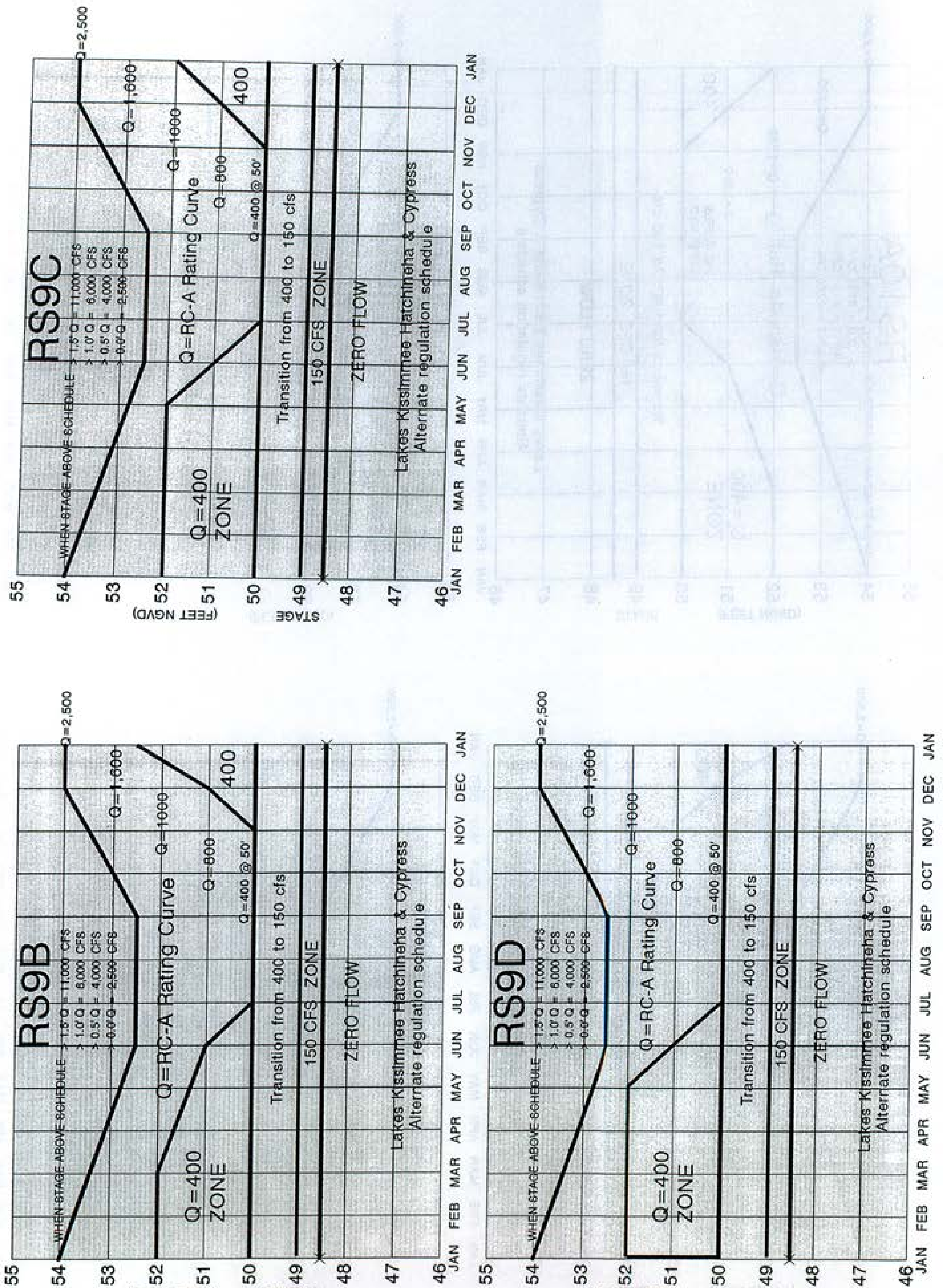
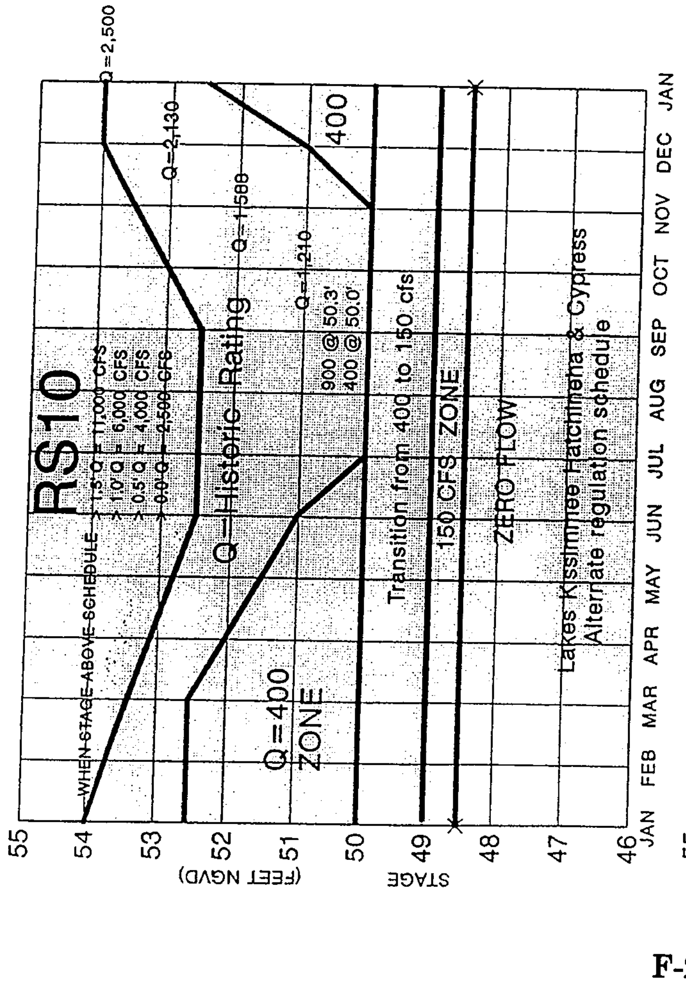
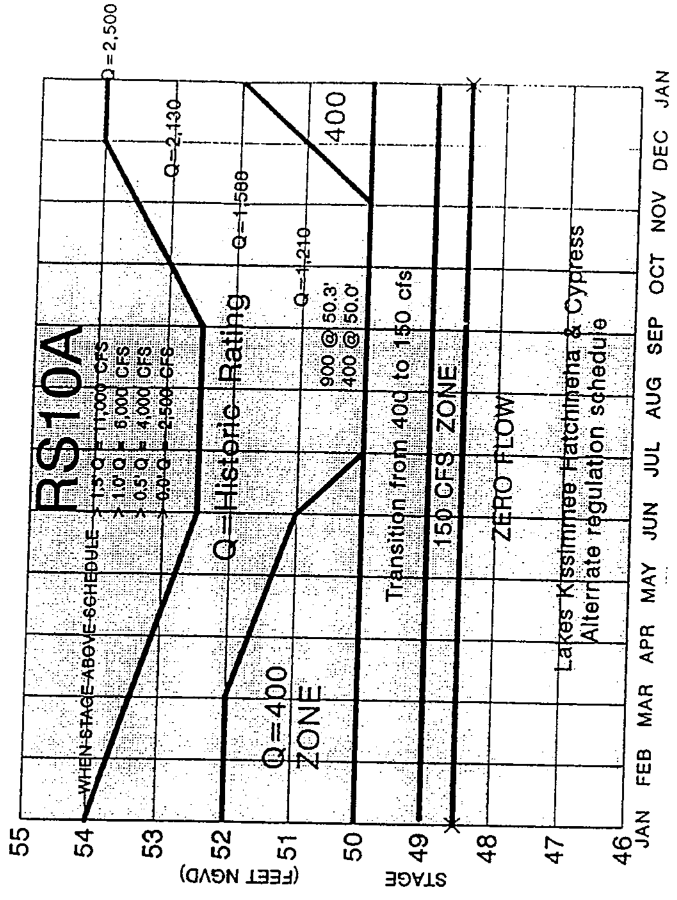
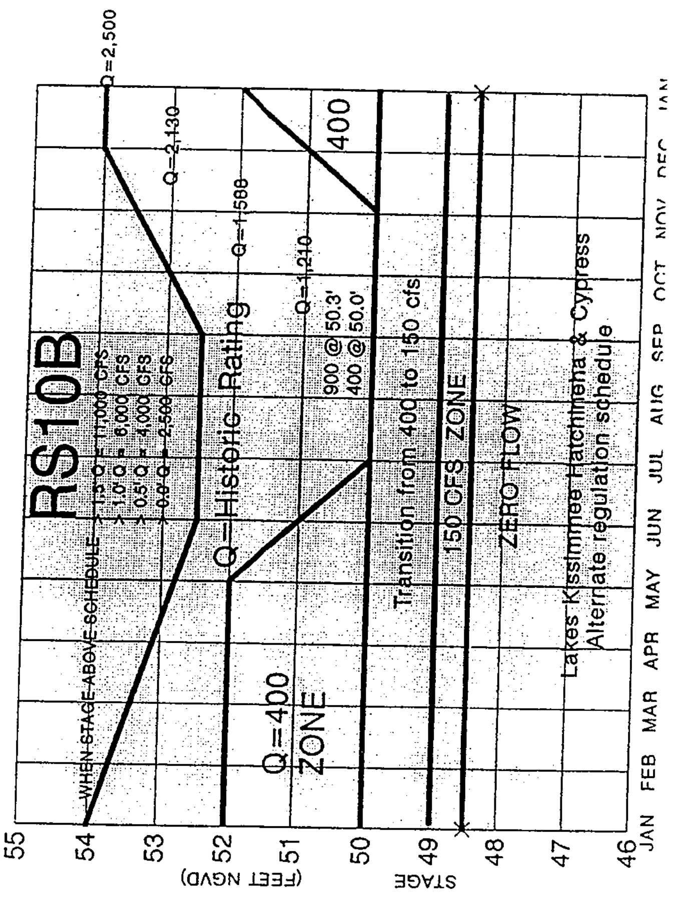

RS9B
RS9C
RS9D
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400 @ 50'
Q=RC-A Rating Curve
Q=400
ZONE
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule

FIGURE B4


RS10
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,580
Q=1,210
Q=Historic Rating
Q=400 ZONE
400
900 @ 50.3'
400 @ 50.0'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress Alternate regulation schedule


RS10A
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,580
Q=1,210
Q=Historic Rating
Q=400 ZONE
400
900 @ 50.3'
400 @ 50.0'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress Alternate regulation schedule


RS10B
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,580
Q=1,210
Q=Historic Rating
Q=400 ZONE
400
900 @ 50.3'
400 @ 50.0'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress Alternate regulation schedule

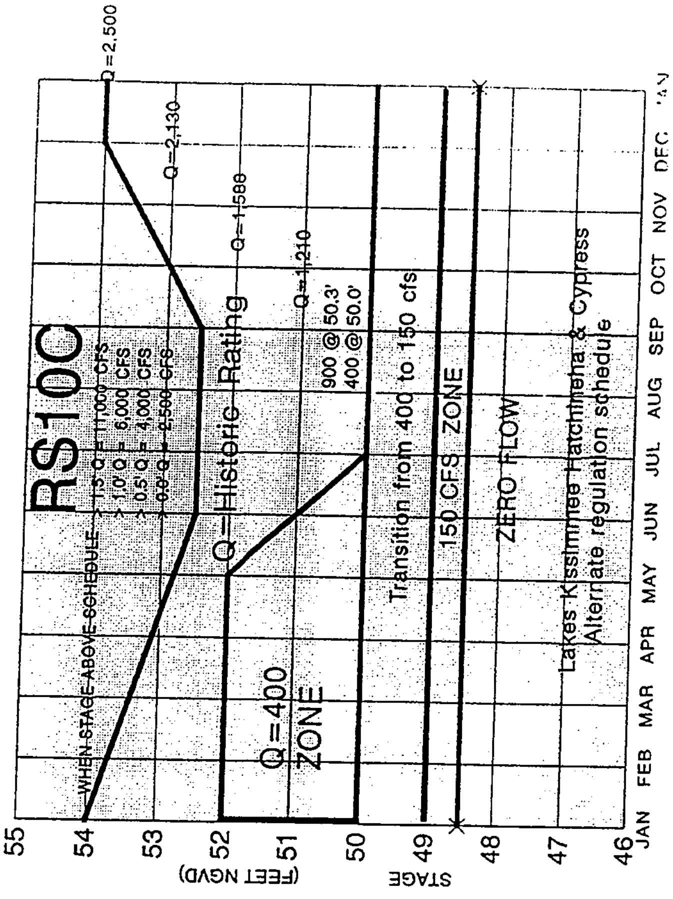
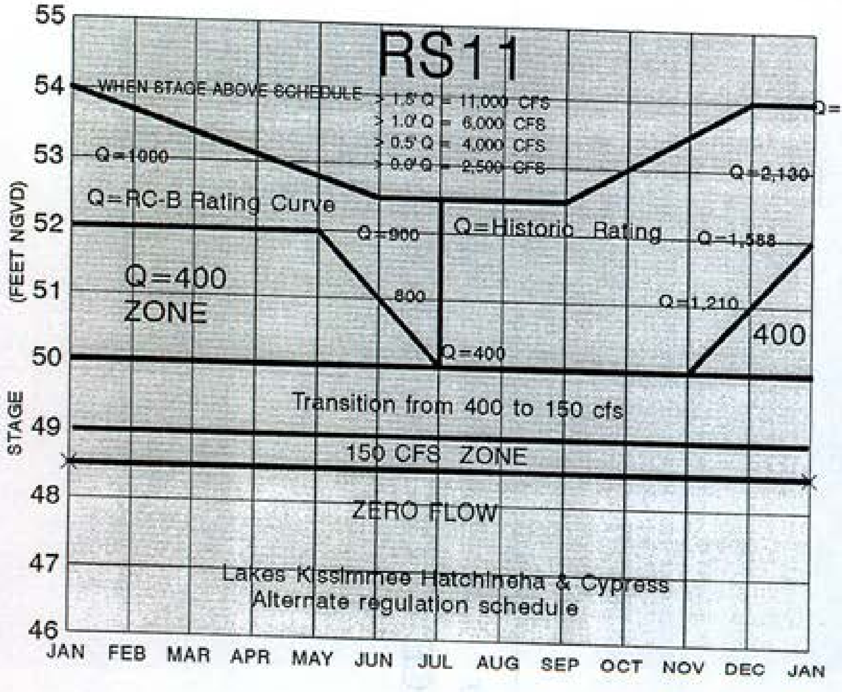

RS10C
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,580
Q=1,210
Q=Historic Rating
Q=400 ZONE
900 @ 50.3'
400 @ 50.0'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress Alternate regulation schedule

FIGURE B5


RS11
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1000
Q=2,130
Q=RC-B Rating Curve
Q=900
Q=Historic Rating
Q=1,588
Q=400
ZONE
800
Q=1,210
400
Q=400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

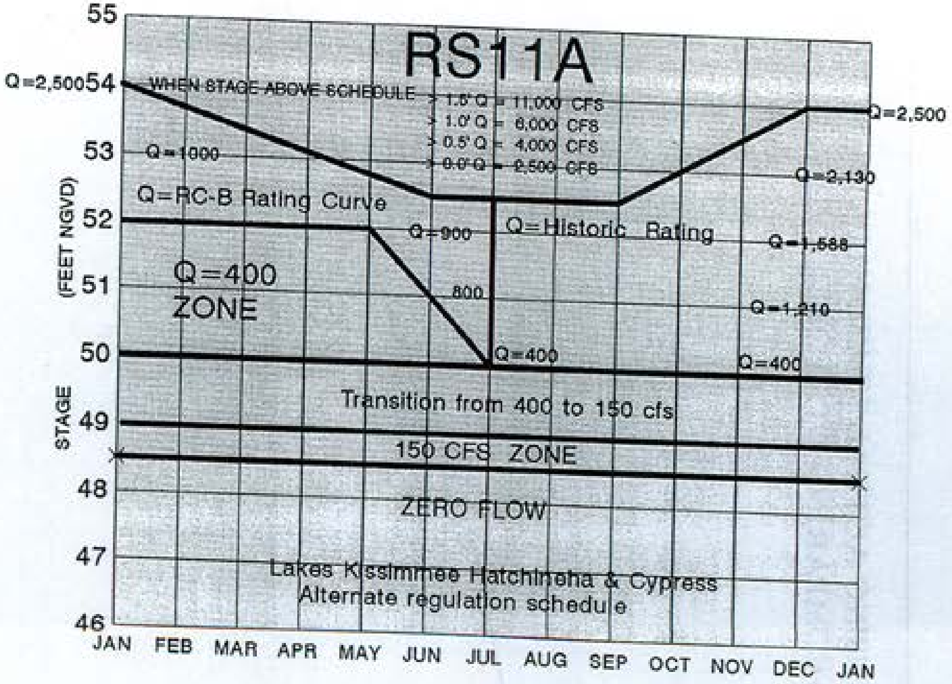
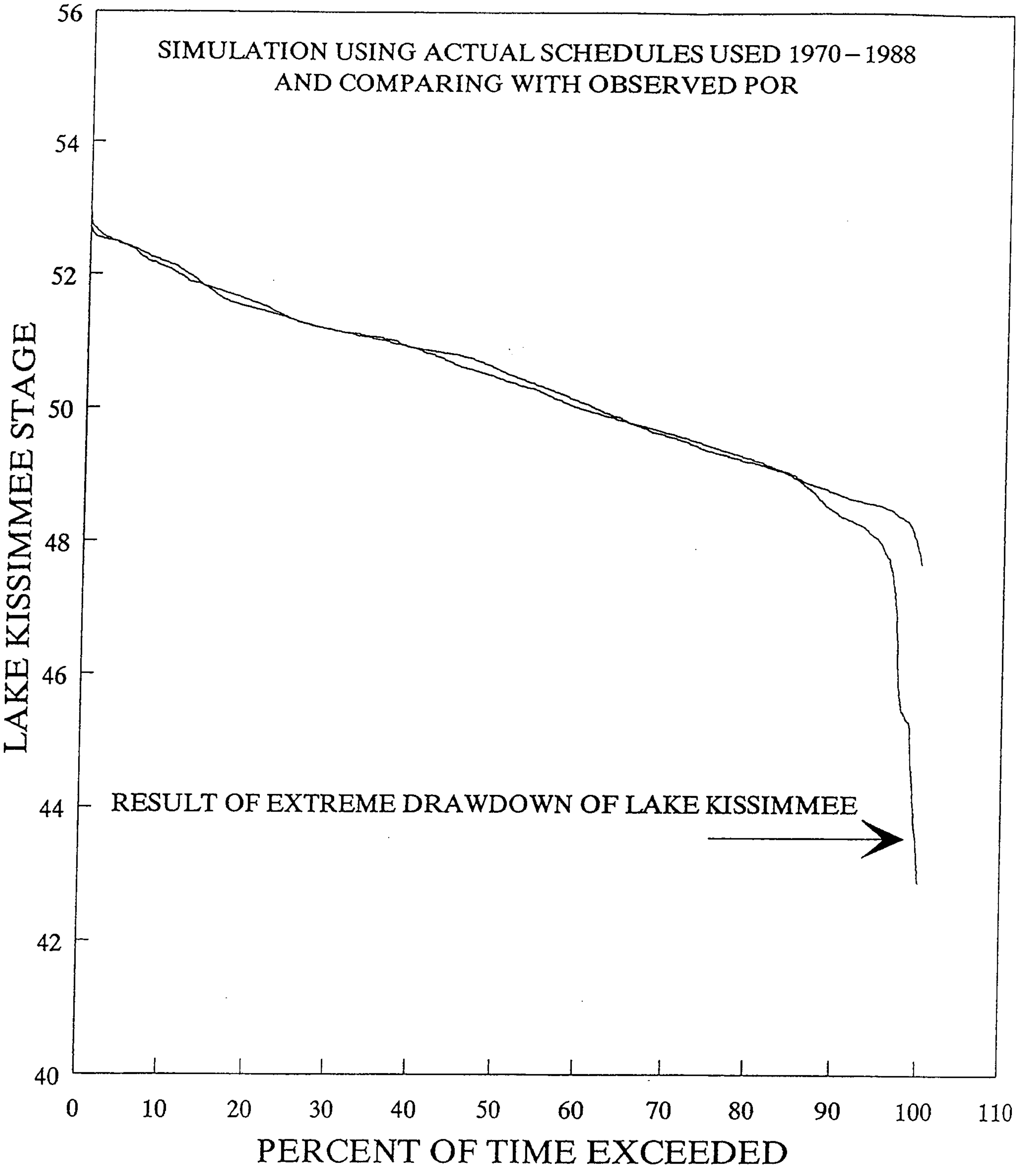

RS11A
Q=2,500
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1000
Q=2,130
Q=RC-B Rating Curve
Q=900
Q=Historic Rating
Q=1,588
Q=400
ZONE
800
Q=1,210
Q=400
Q=400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE B6


SIMULATION USING ACTUAL SCHEDULES USED 1970 – 1988
AND COMPARING WITH OBSERVED POR
LAKE KISSIMMEE STAGE
56
54
52
50
48
46
44
42
40
RESULT OF EXTREME DRAWDOWN OF LAKE KISSIMMEE
0
10
20
30
40
50
60
70
80
90
100
110
PERCENT OF TIME EXCEEDED

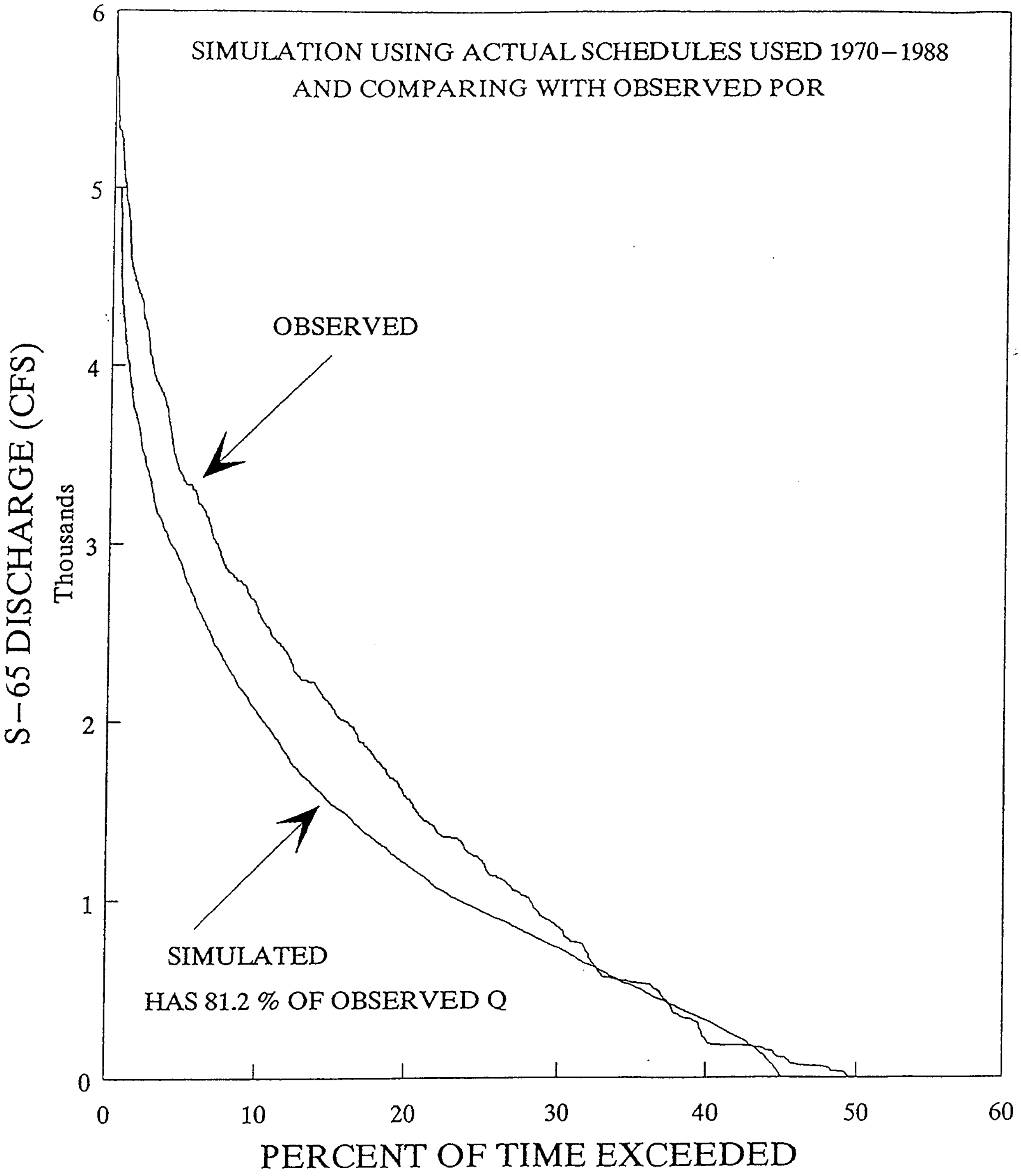
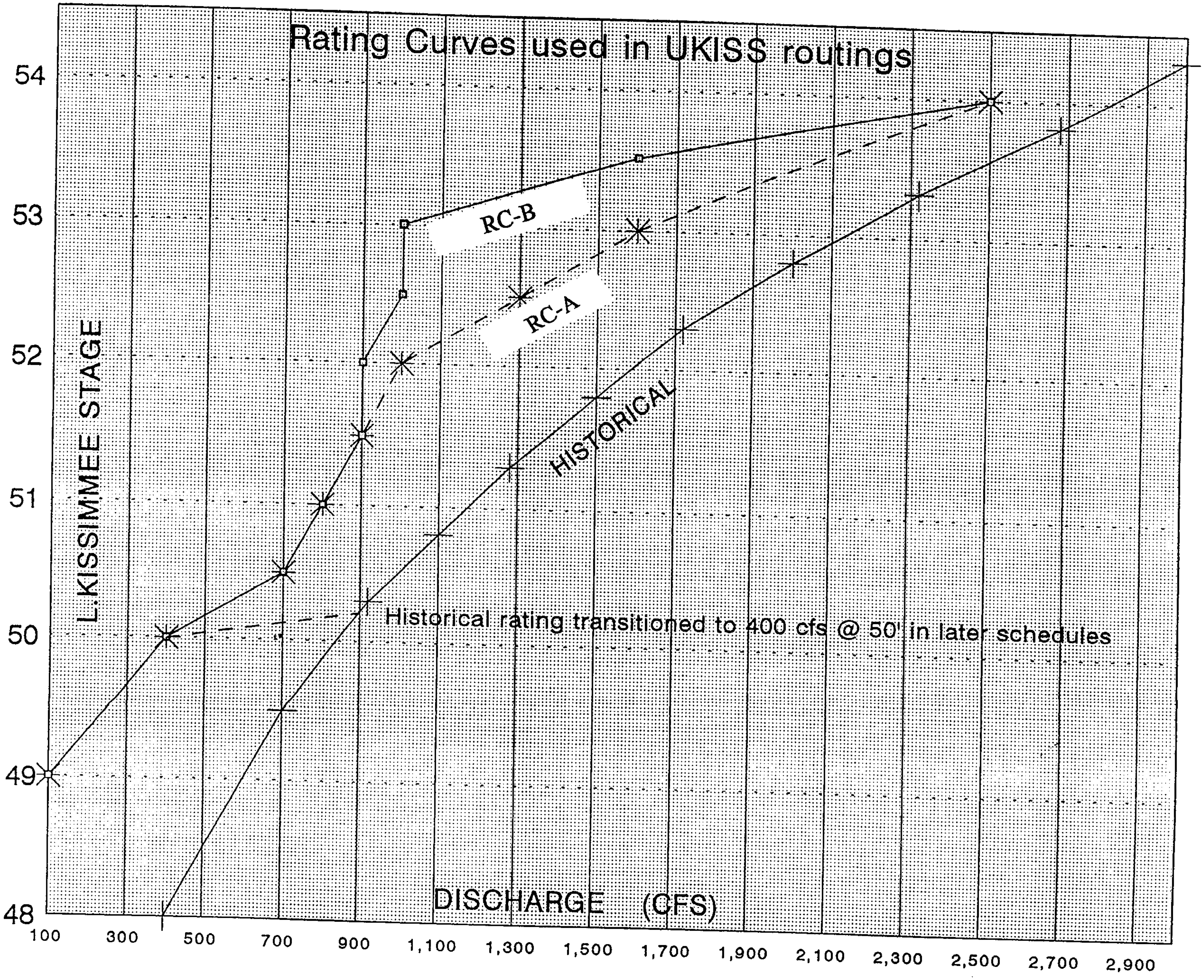
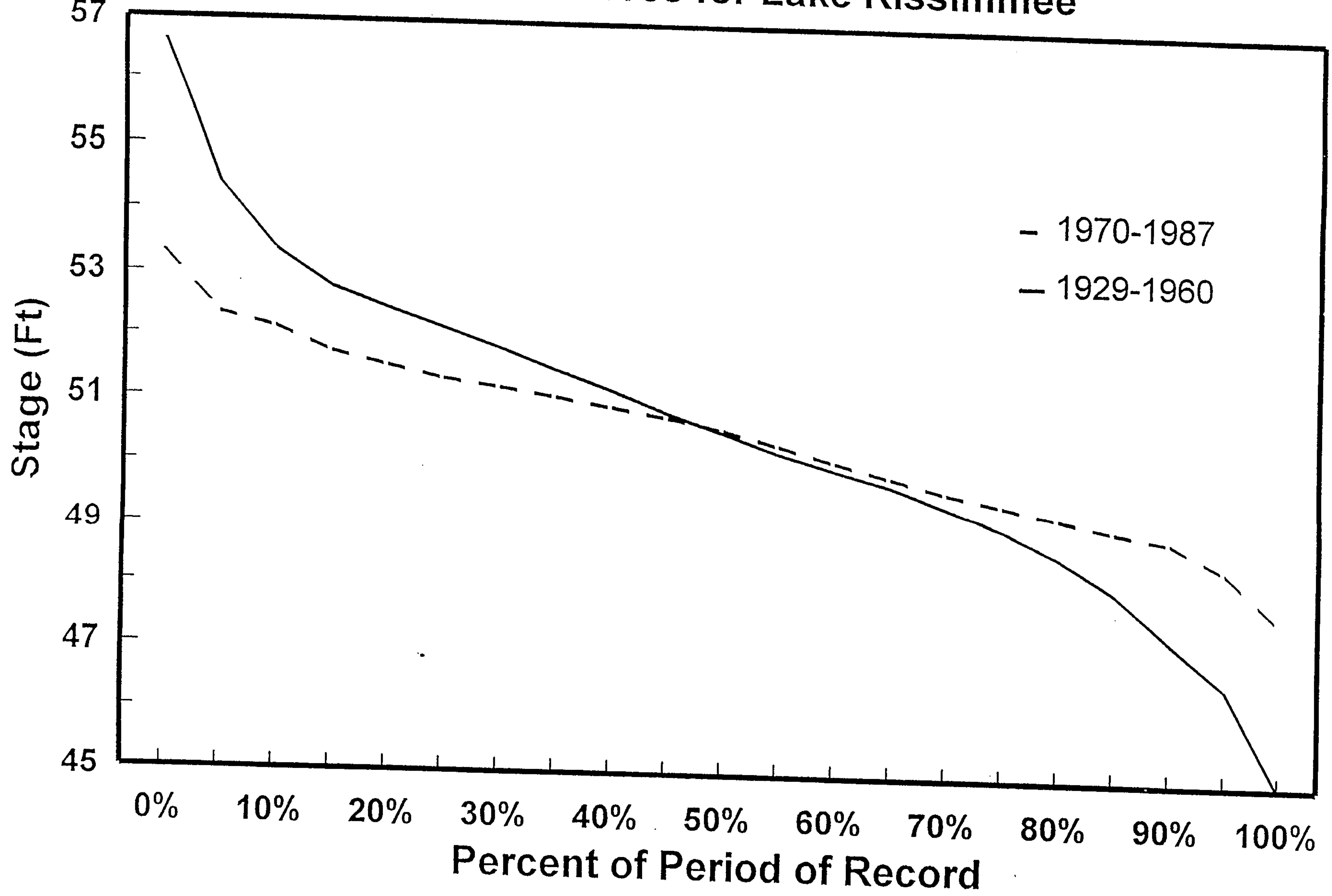

SIMULATION USING ACTUAL SCHEDULES USED 1970–1988
AND COMPARING WITH OBSERVED POR
OBSERVED
SIMULATED
HAS 81.2 % OF OBSERVED Q
S–65 DISCHARGE (CFS)
Thousands
0
1
2
3
4
5
6
0
10
20
30
40
50
60
PERCENT OF TIME EXCEEDED

FIGURE C2


Rating Curves used in UKISS routings
L.KISSIMMEE STAGE
54
53
52
51
50
49
48
DISCHARGE (CFS)
100
300
500
700
900
1,100
1,300
1,500
1,700
1,900
2,100
2,300
2,500
2,700
2,900
RC-B
RC-A
HISTORICAL
Historical rating transitioned to 400 cfs @ 50' in later schedules

Comparison of Pre and Post-channelization Stage

Duration Curves for Lake Kissimmee



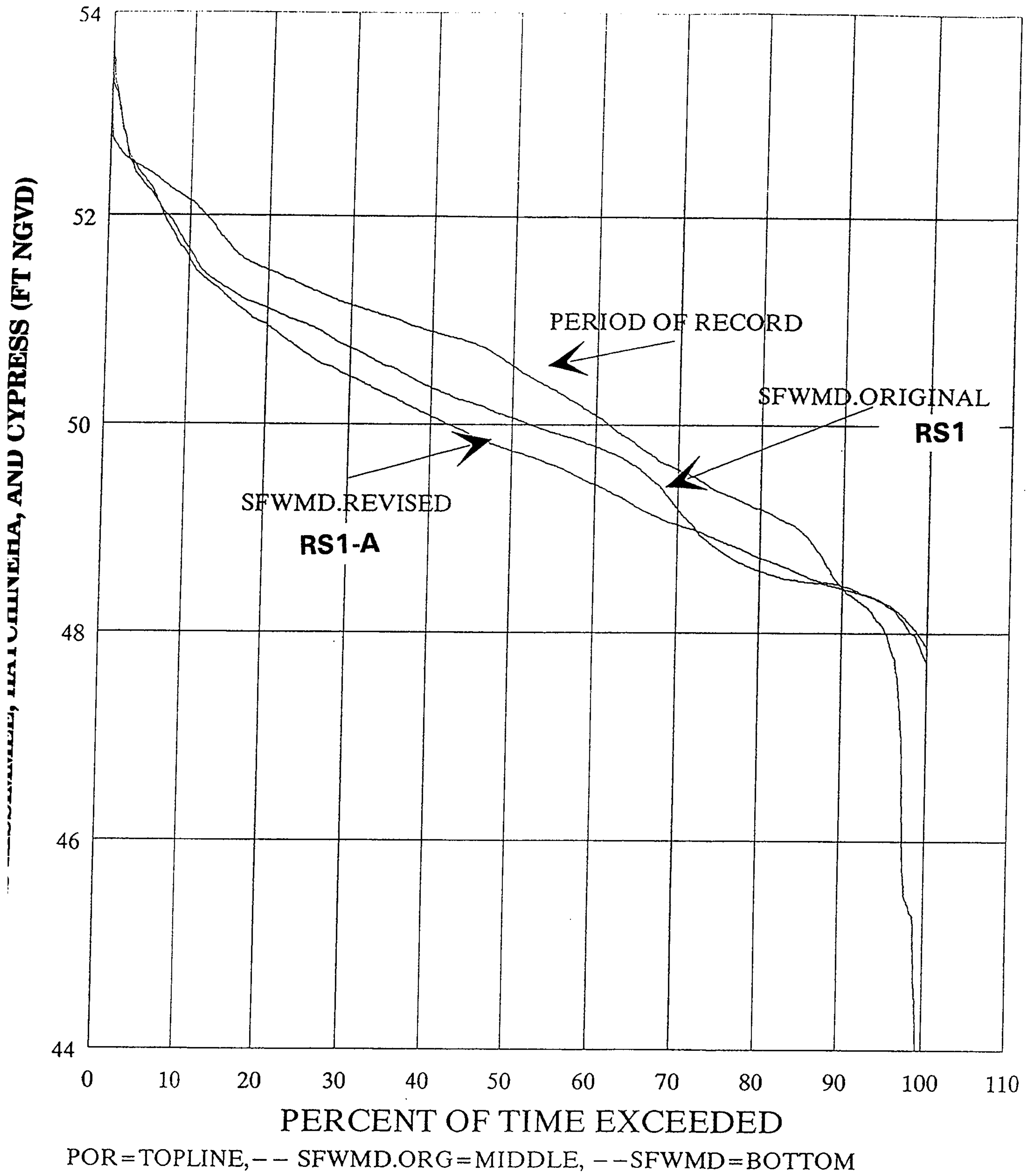
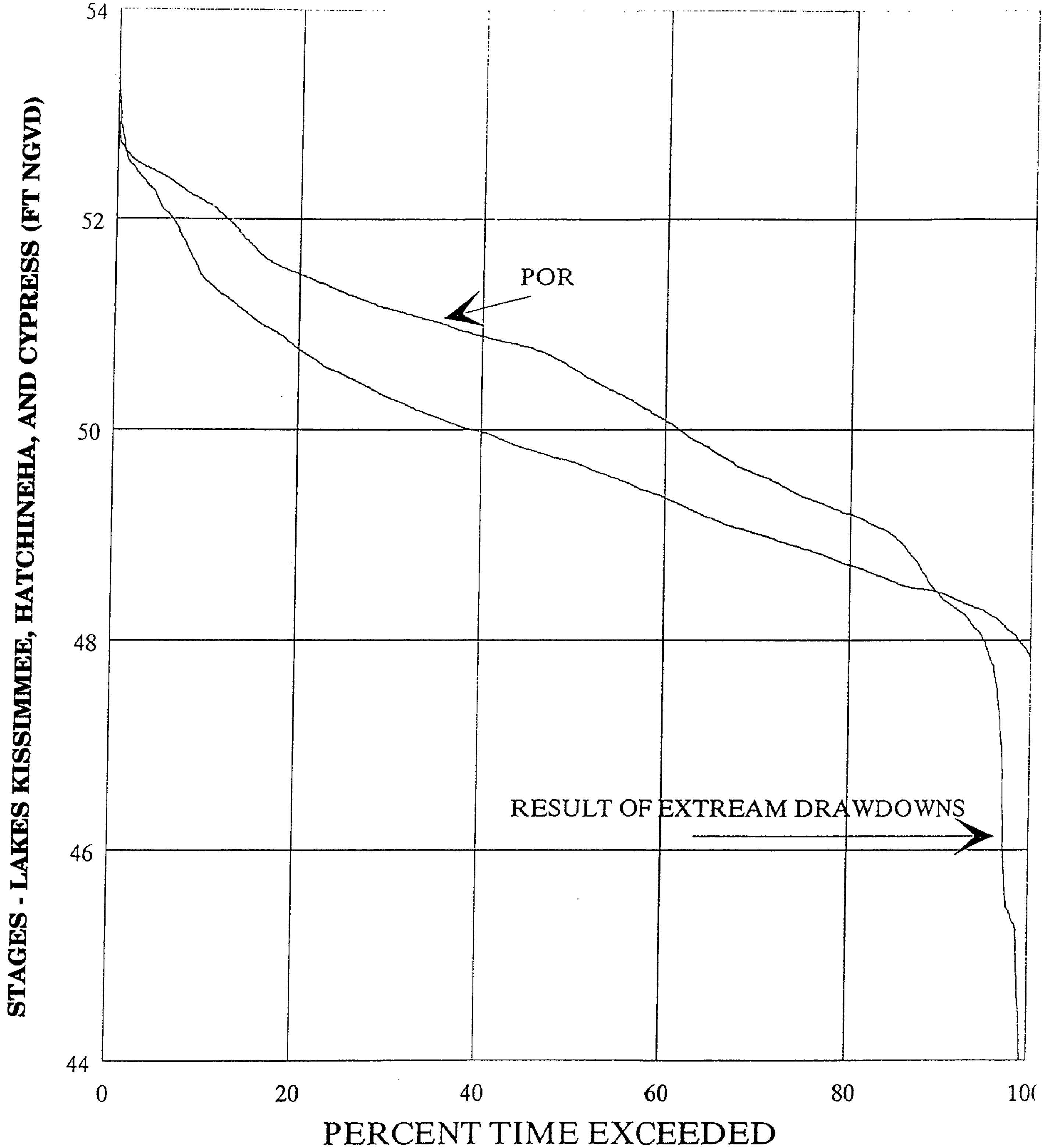
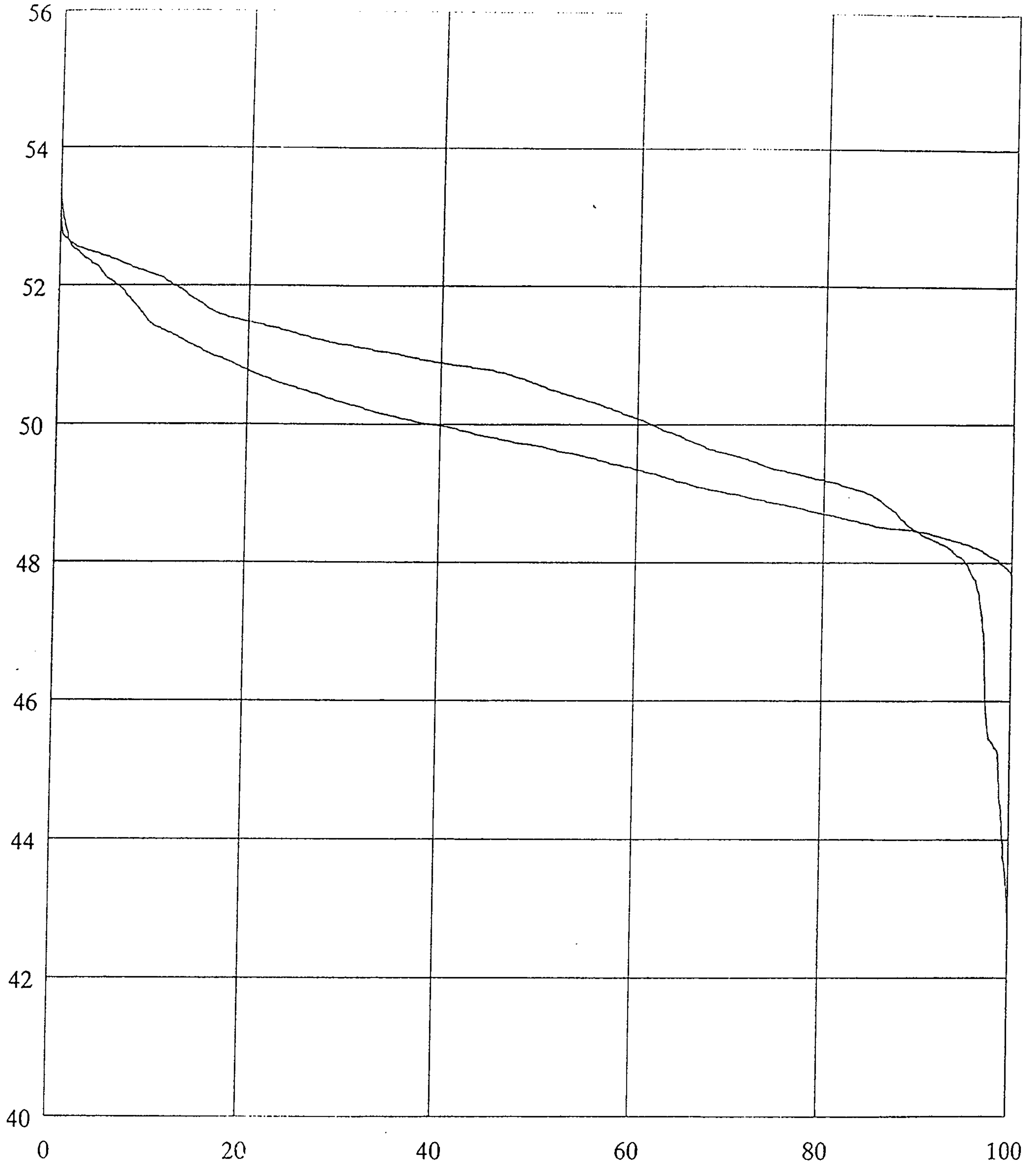

HATCHINEHA, AND CYPRESS (FT NGVD)
54
52
50
48
46
44
0
10
20
30
40
50
60
70
80
90
100
110
PERIOD OF RECORD
SFWMD.ORIGINAL
RS1
SFWMD.REVISED
RS1-A
PERCENT OF TIME EXCEEDED
POR=TOPLINE,-- SFWMD.ORG=MIDDLE, --SFWMD=BOTTOM

FIGURE D1



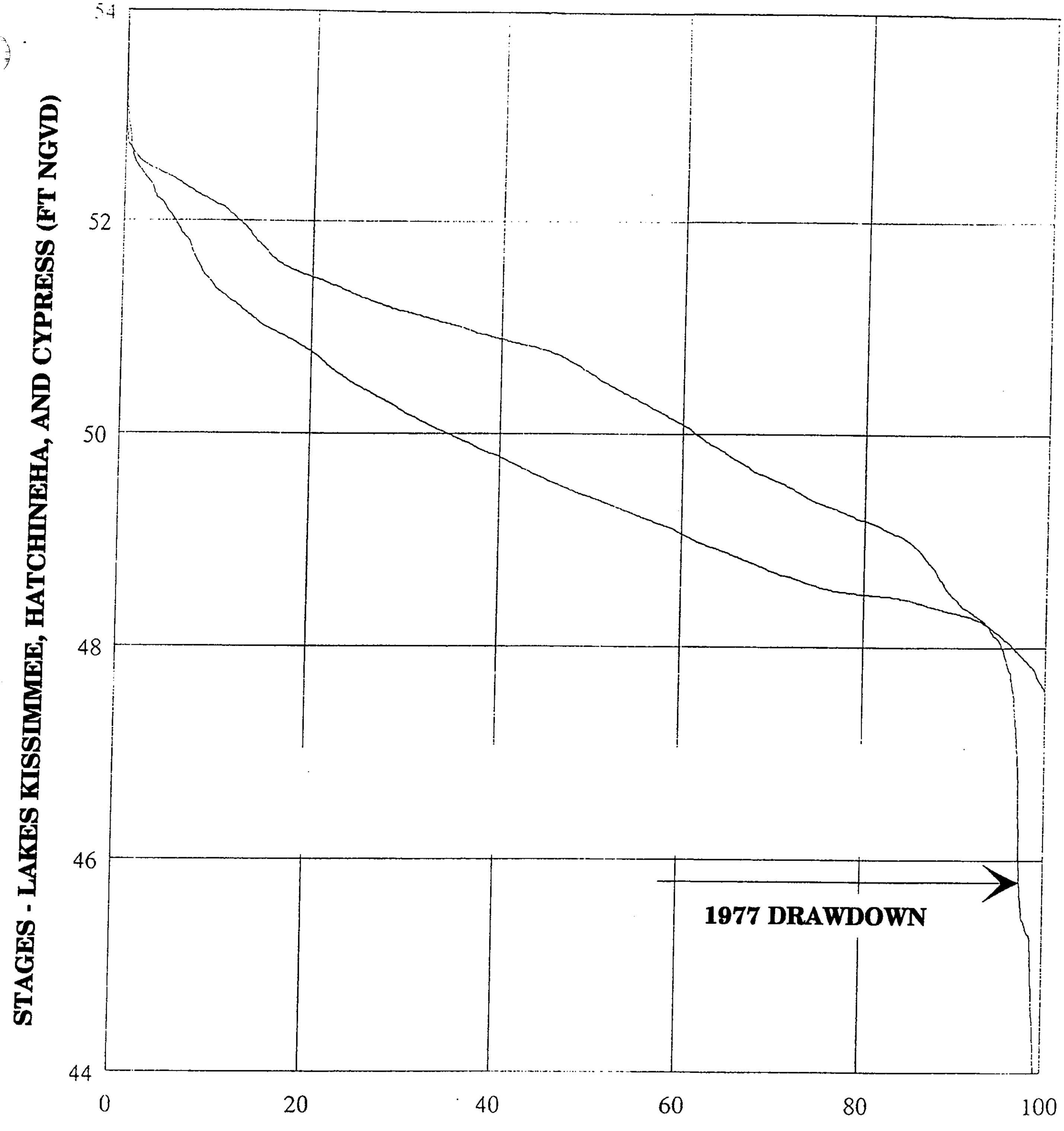
Schedule **RS1-B**

FIGURE D2



Schedule **RS3**

FIGURE D3



Schedule **RS4**

FIGURE D4

Discharge Exceeded 50% of the Time

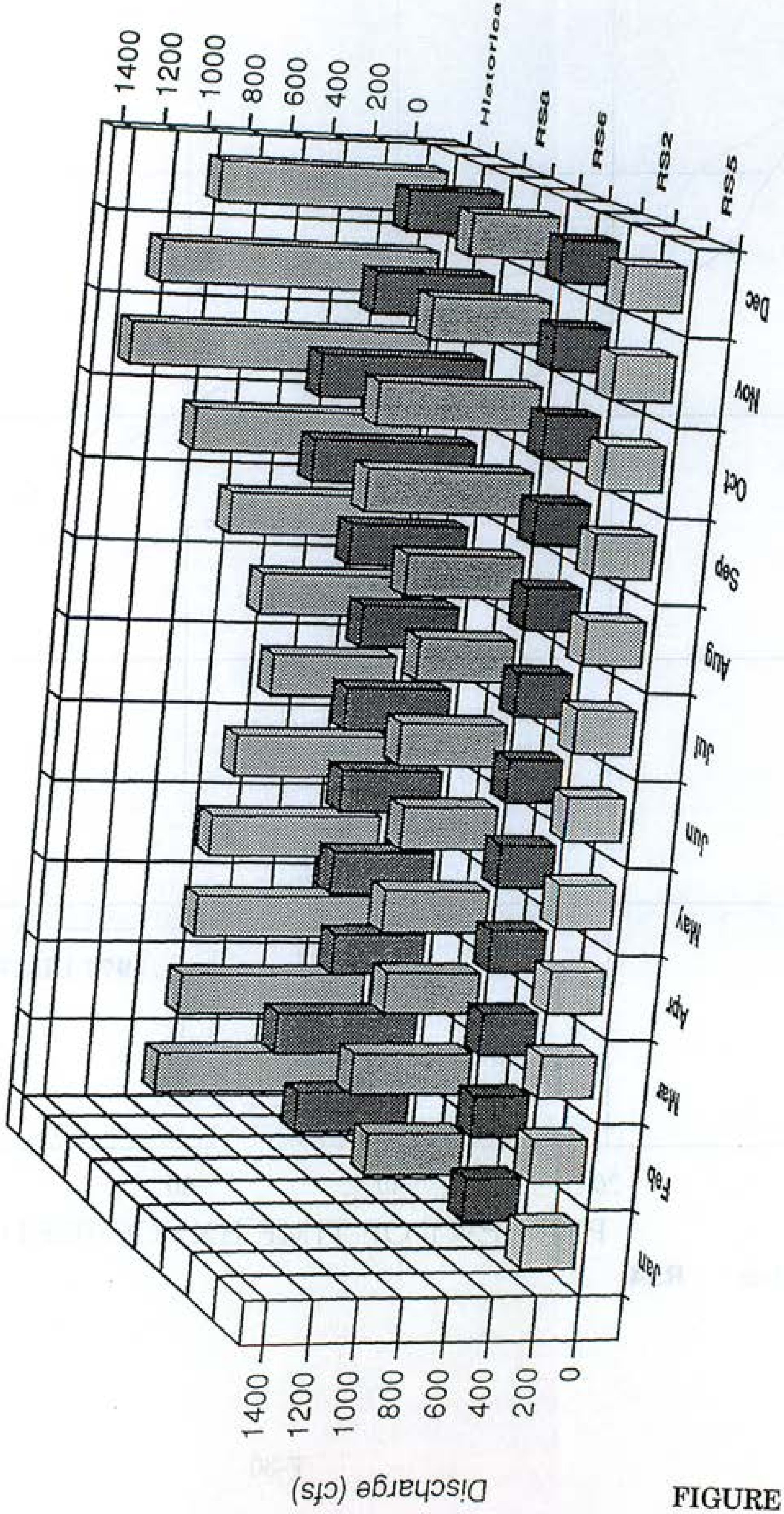


FIGURE D5

Historical Relationship between Lake Kissimmee Discharges and Fort Kissimmee Stages (1940 - 1961)

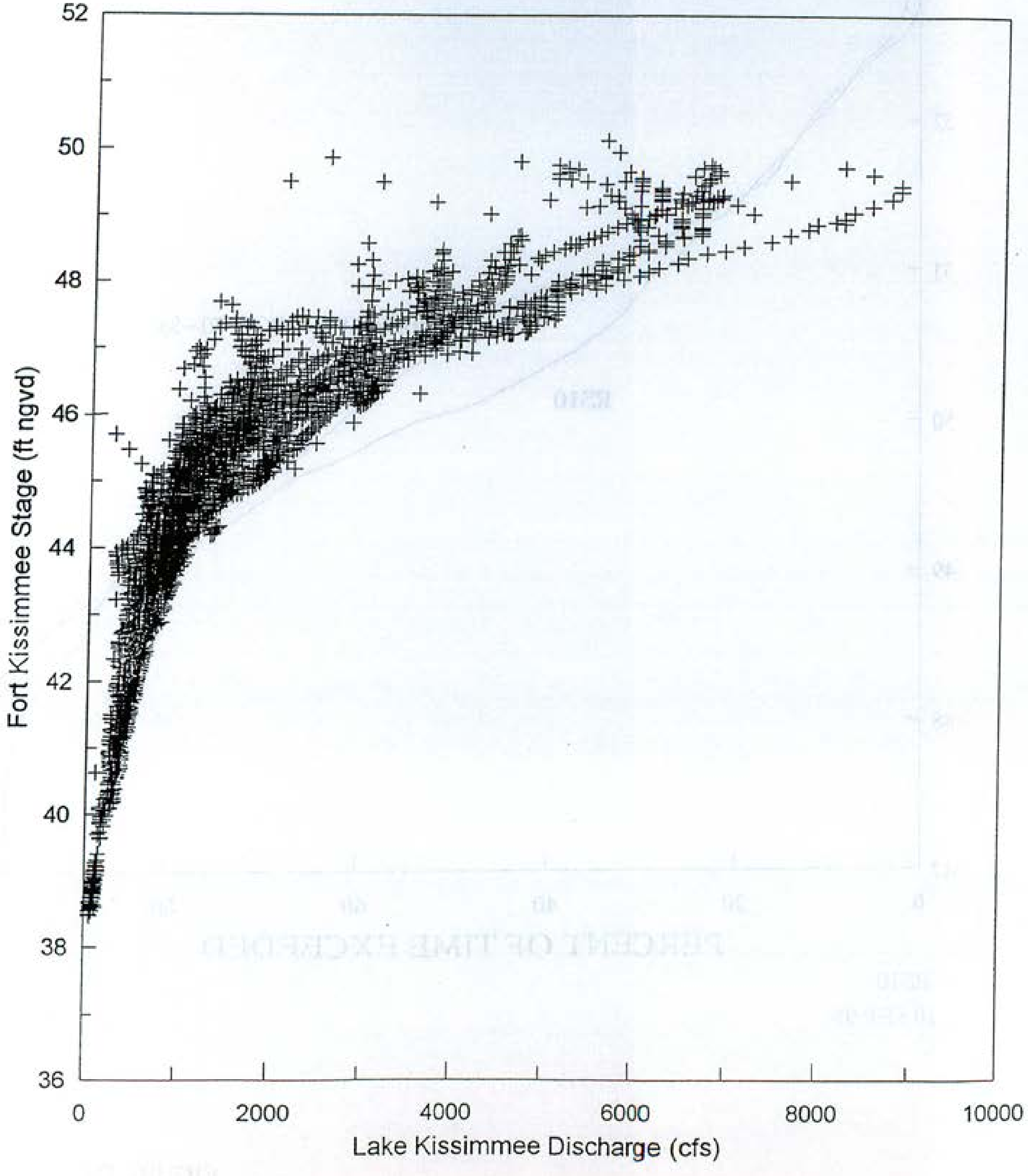
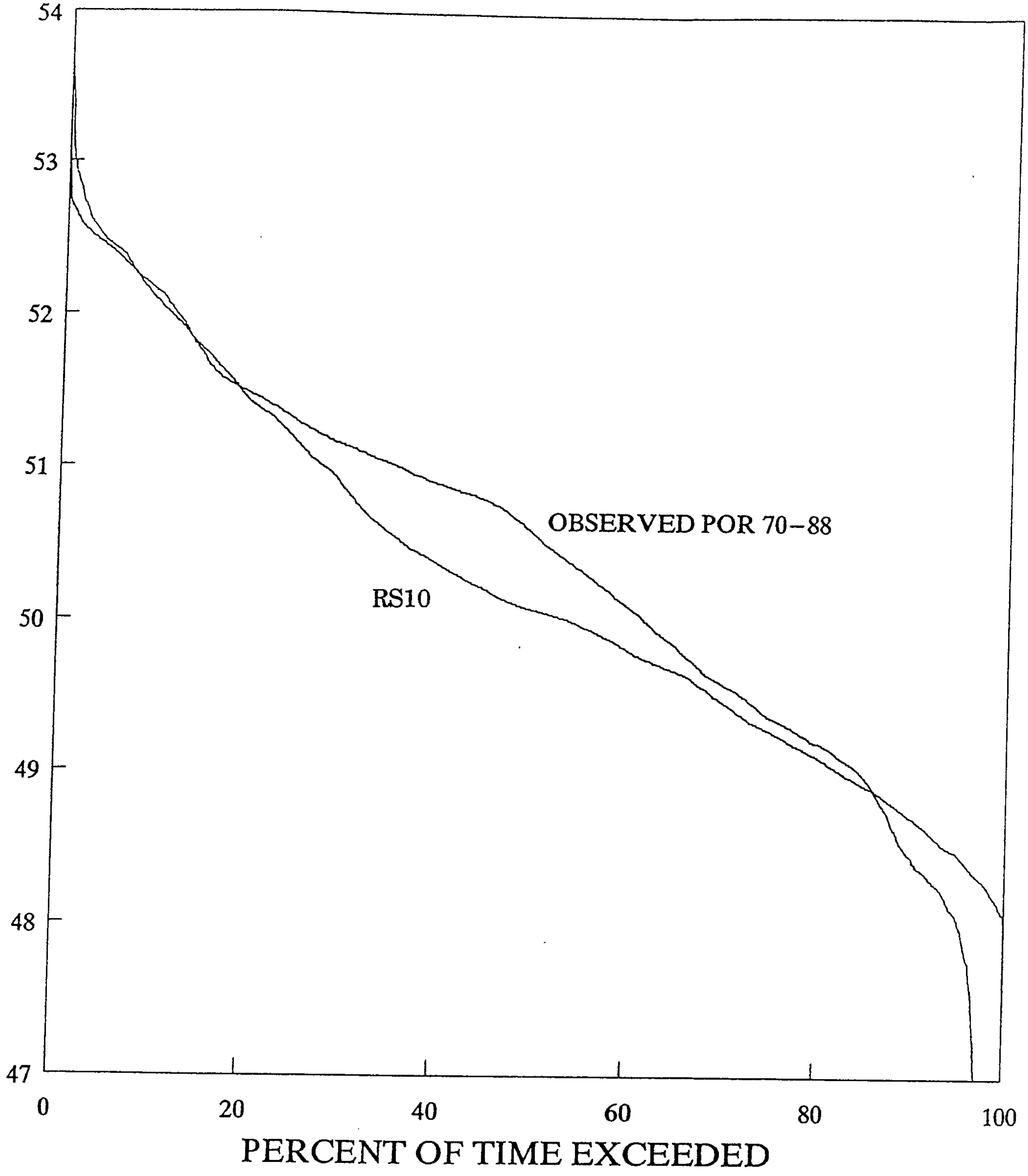
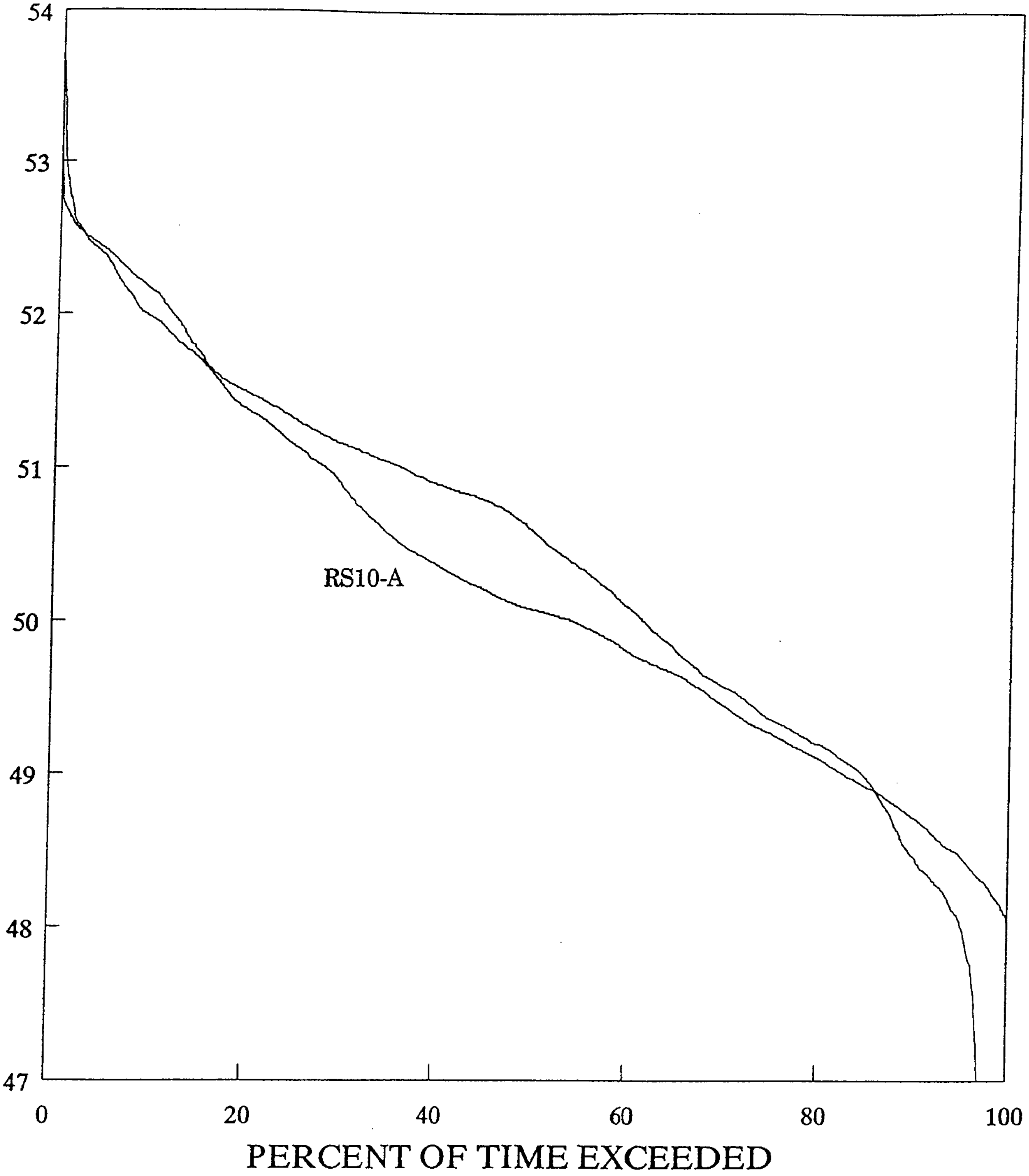


FIGURE D6



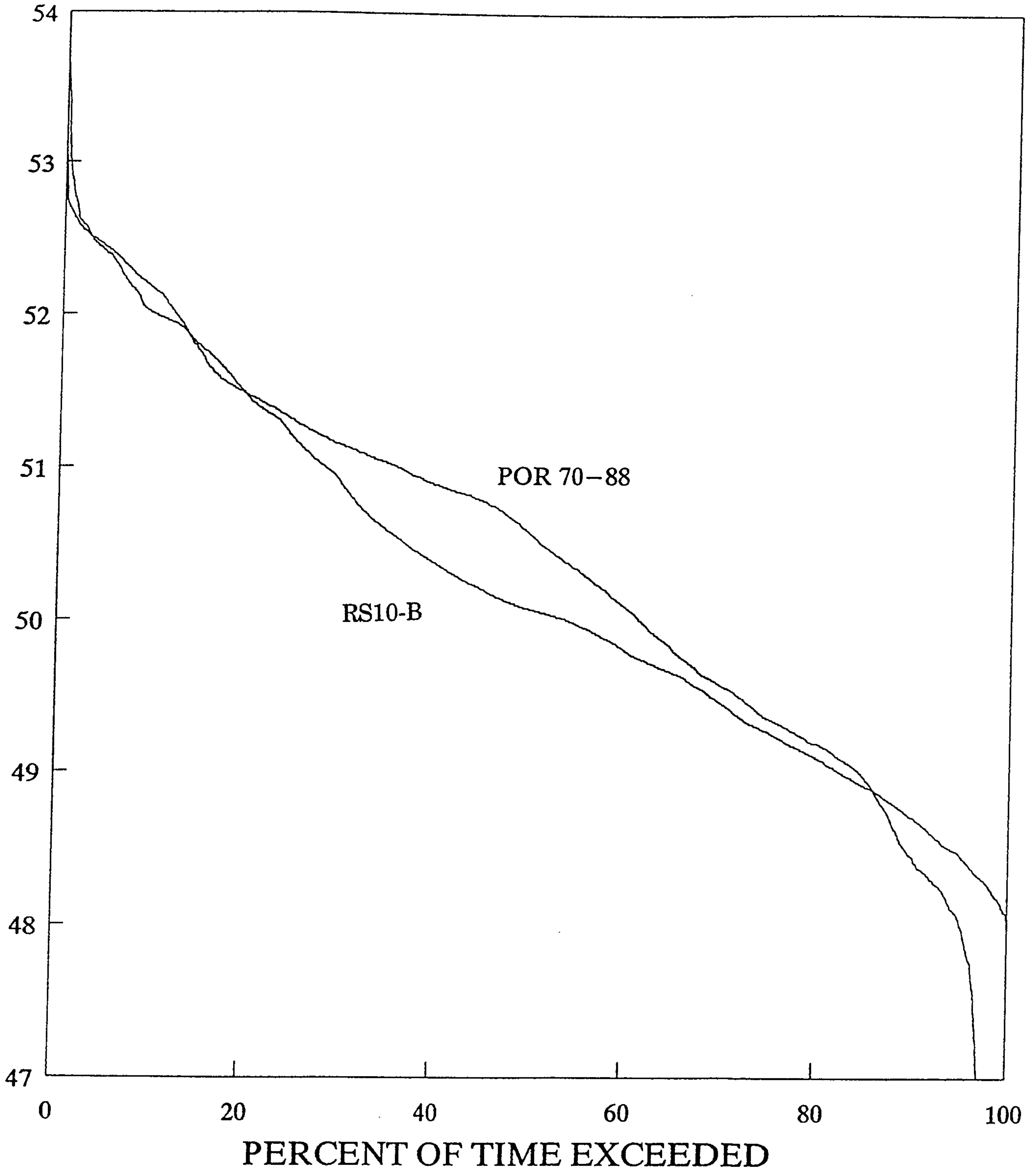
RS10
10 SEP 93

FIGURE D7



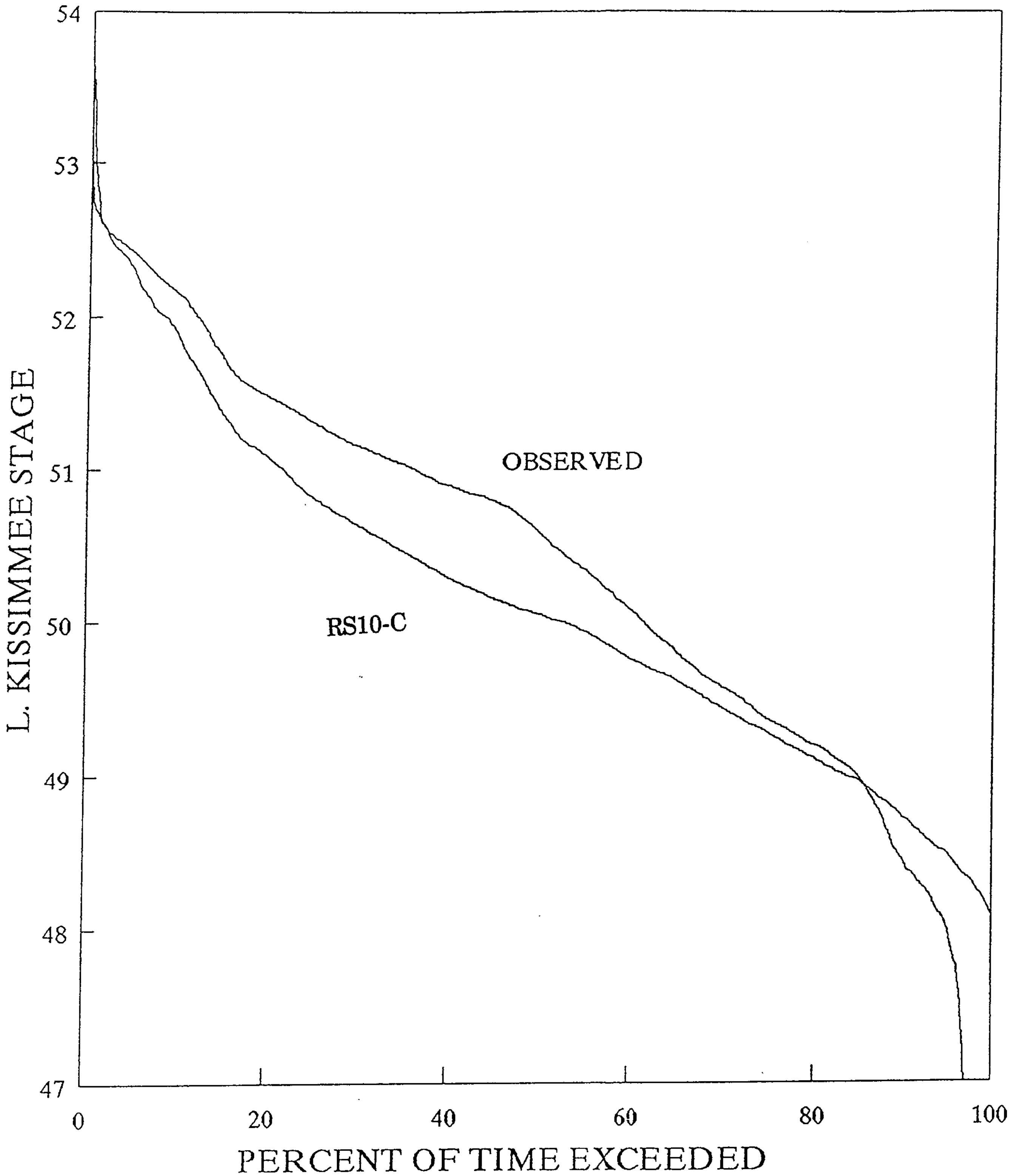
RS10-A
10 SEP 93

FIGURE D8



RS10-B
1 OCT 93

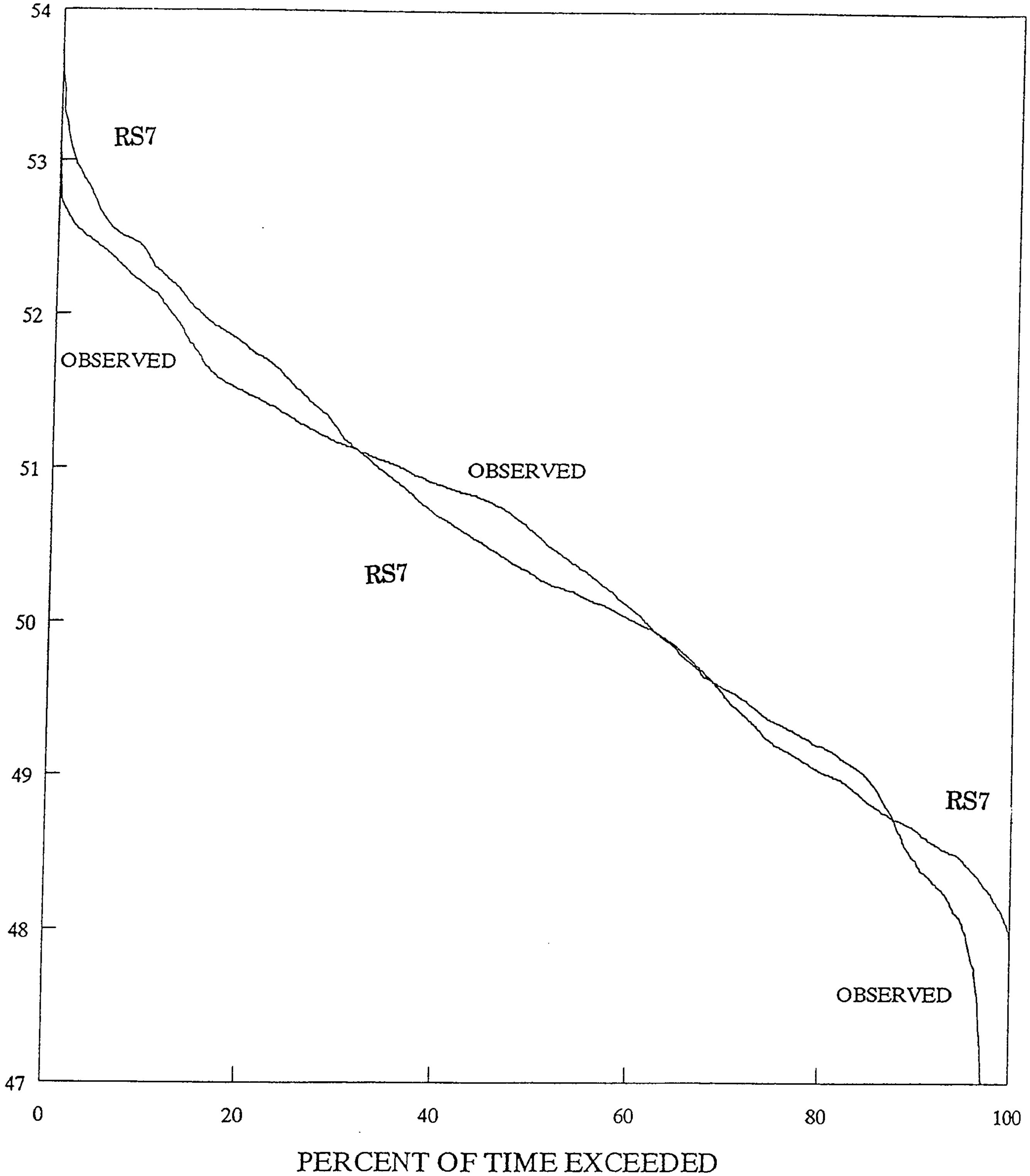
FIGURE D9



RS10-C

15 Nov 93

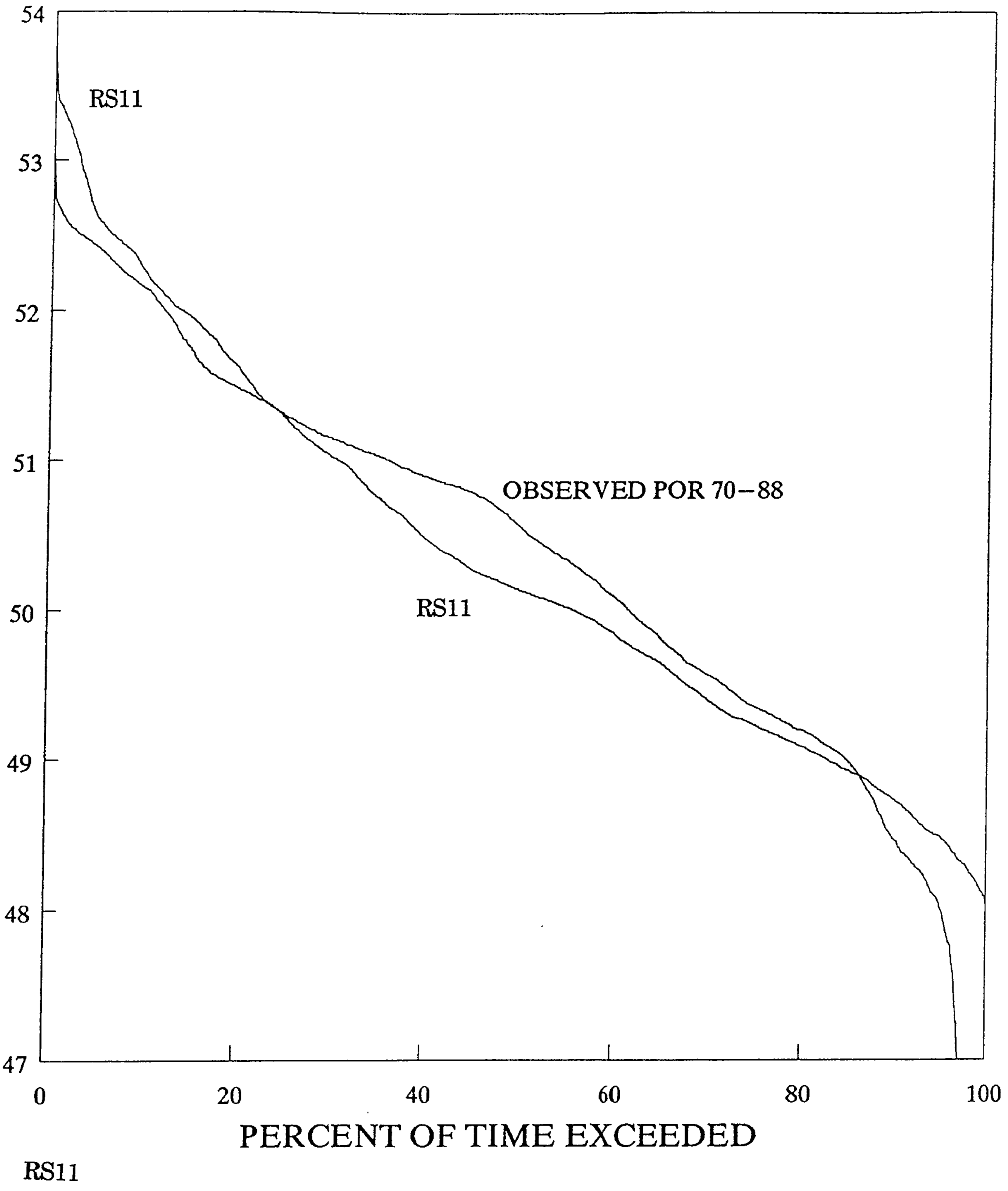
FIGURE D10



RS7

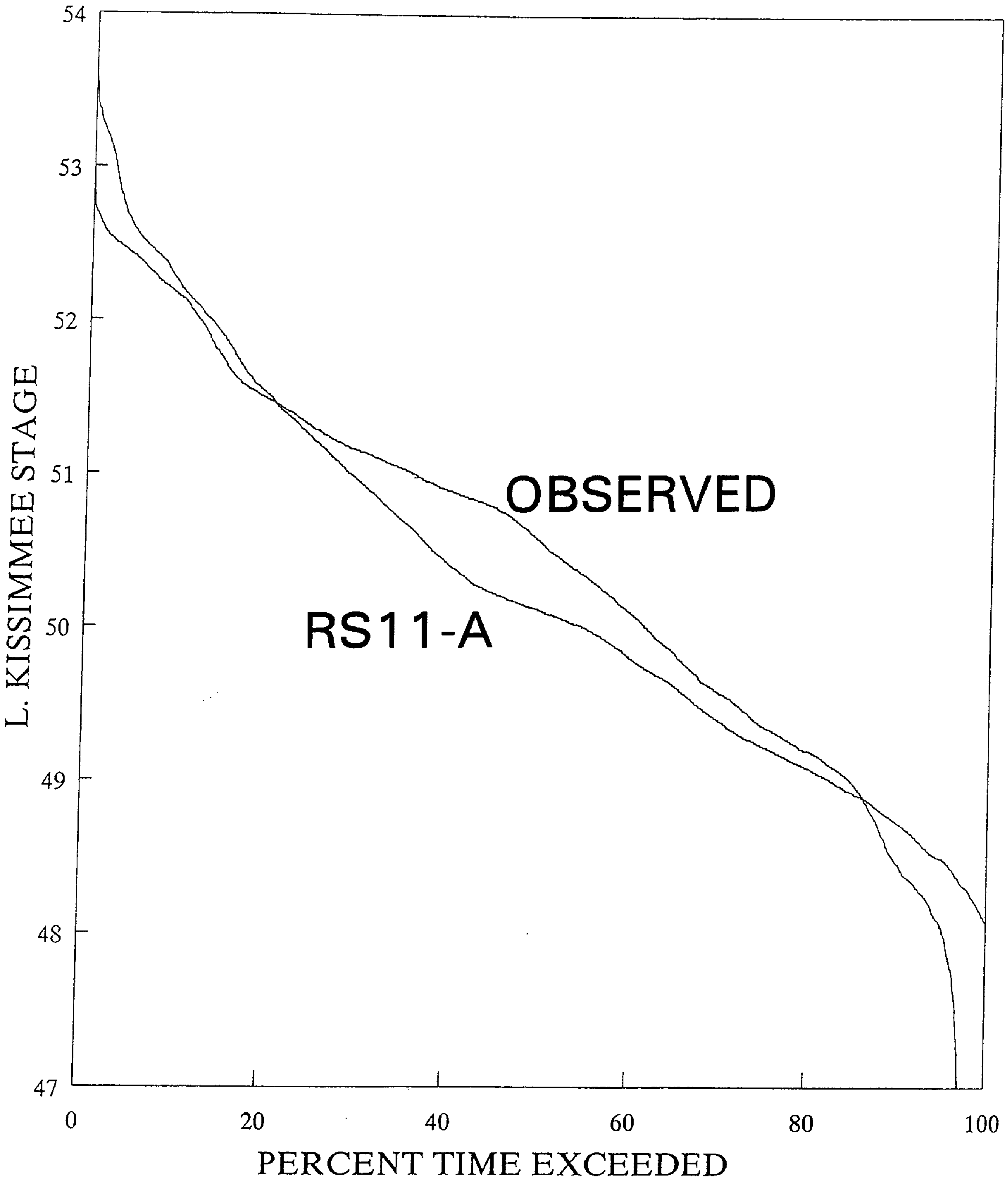
24 August 93

FIGURE D11



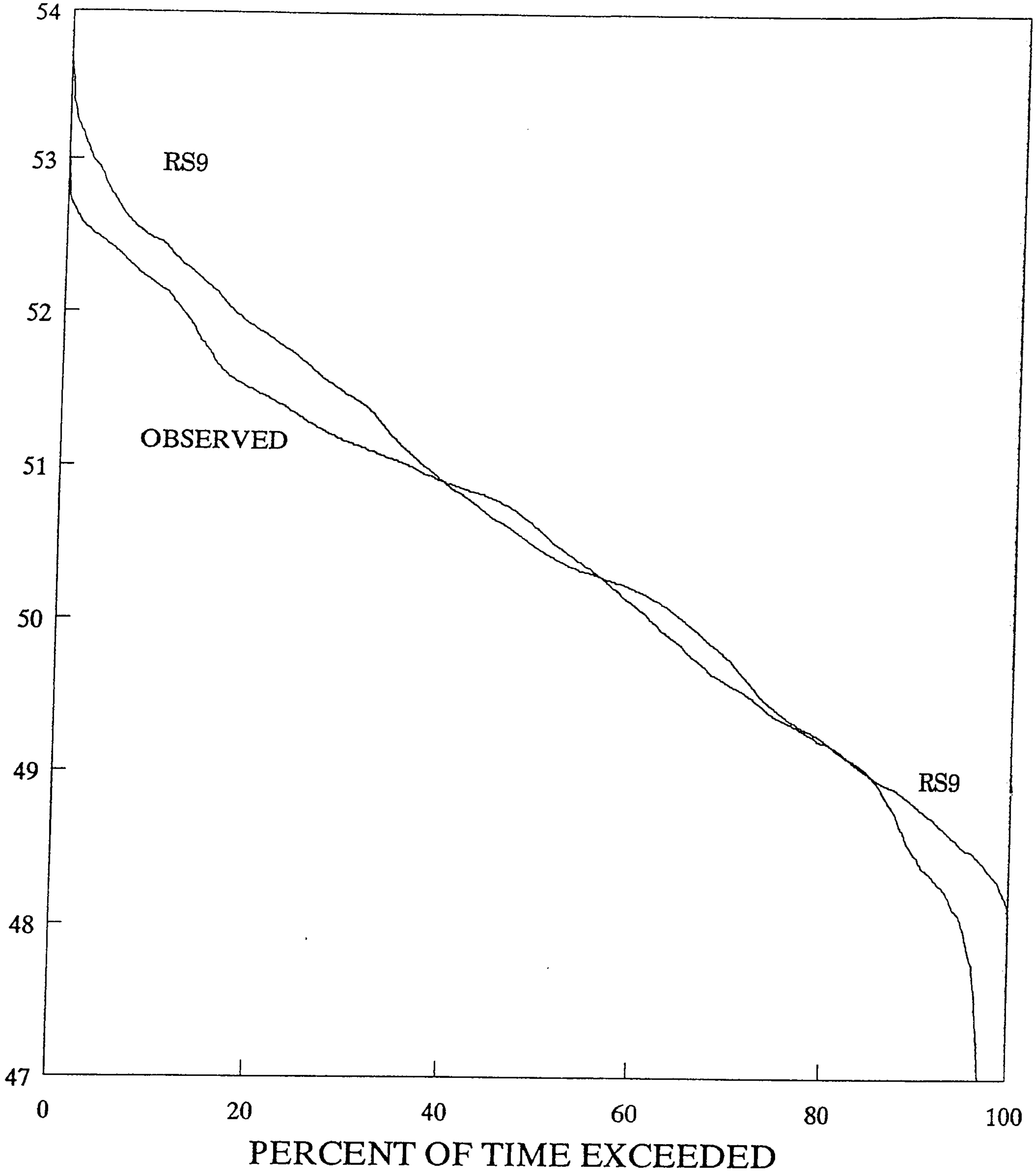
RS11
4 Oct 93

FIGURE D12



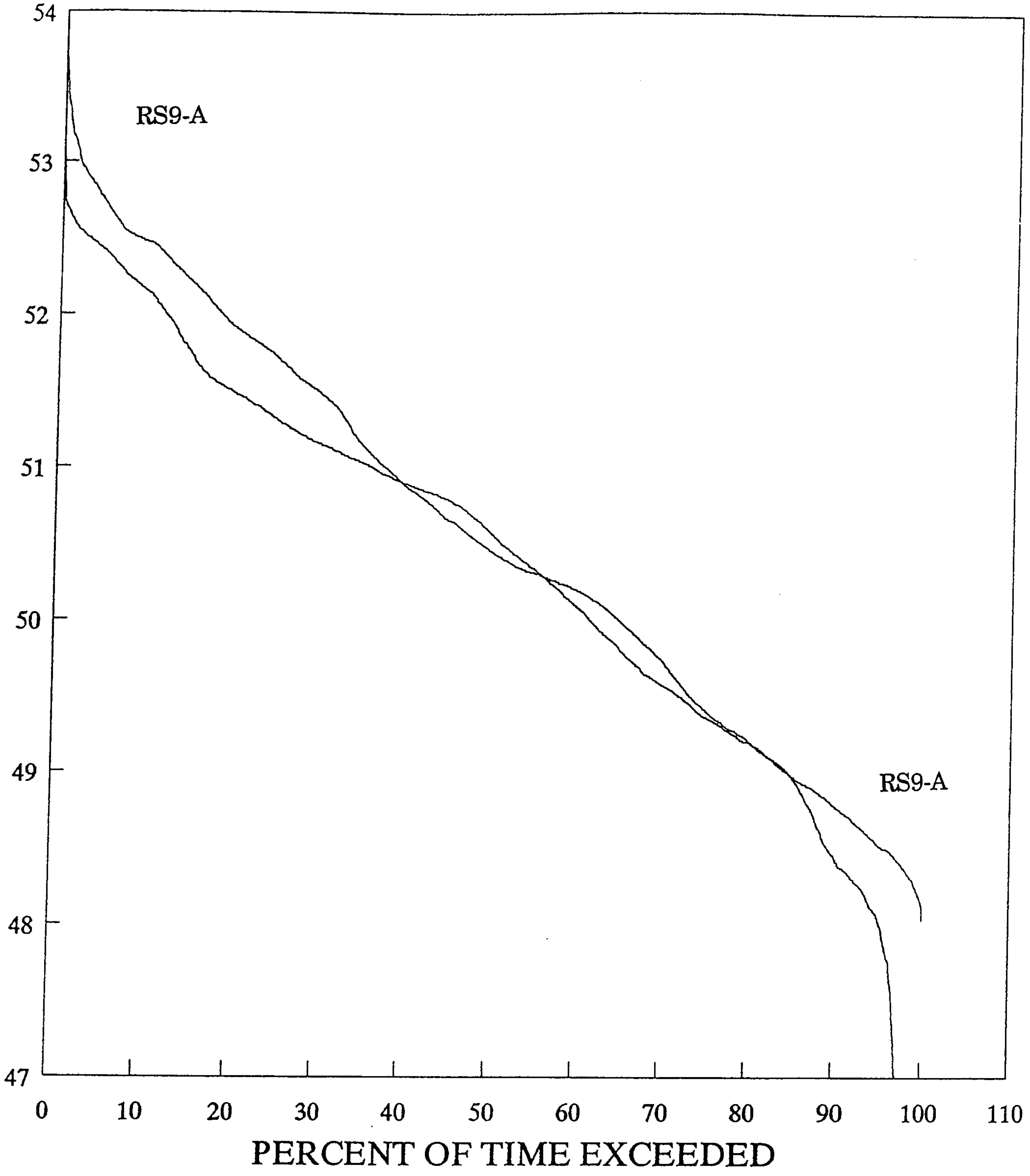
RS11-A
16 Nov 93

FIGURE D13



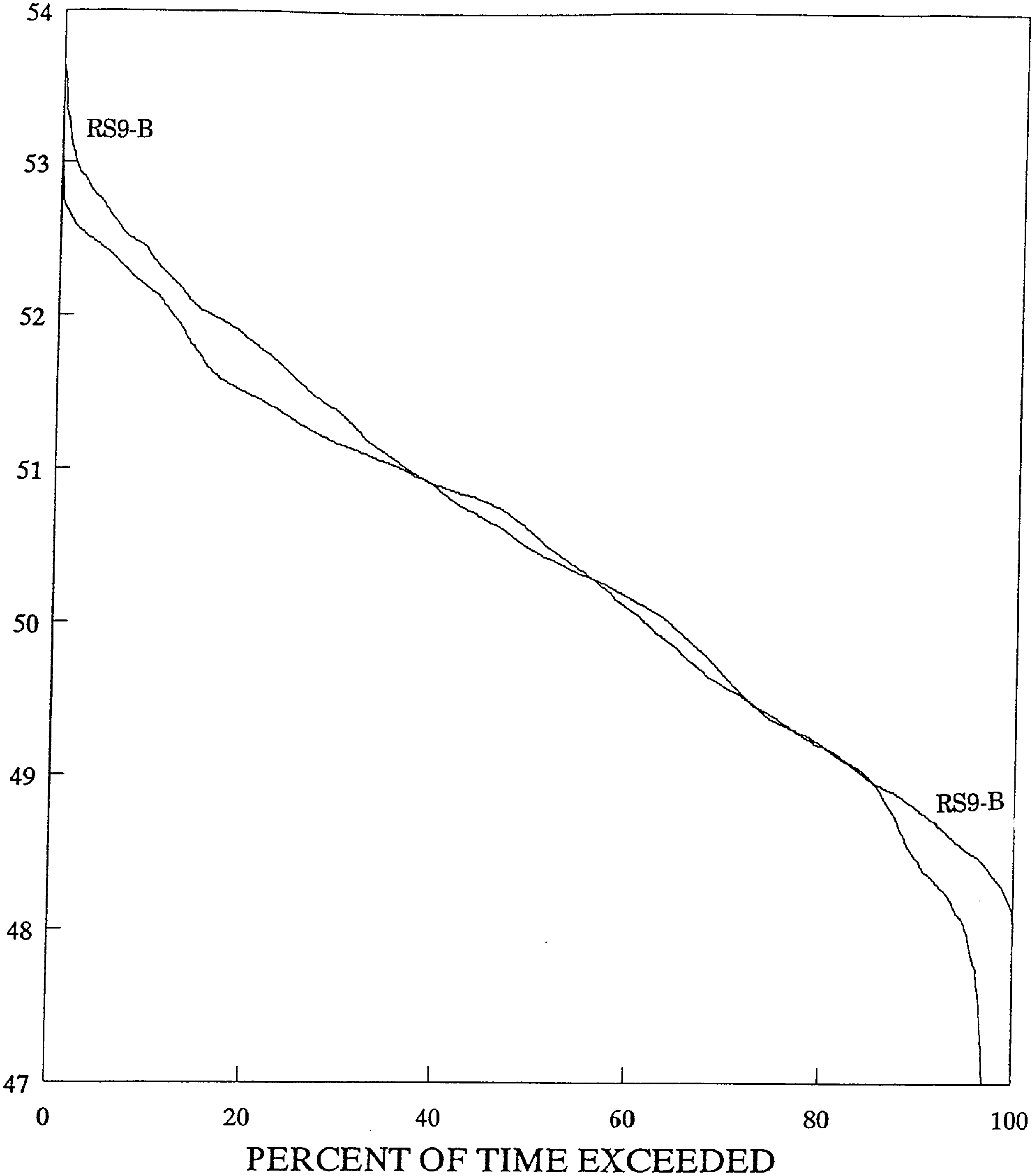
RS9
7 Sep 93

FIGURE D14



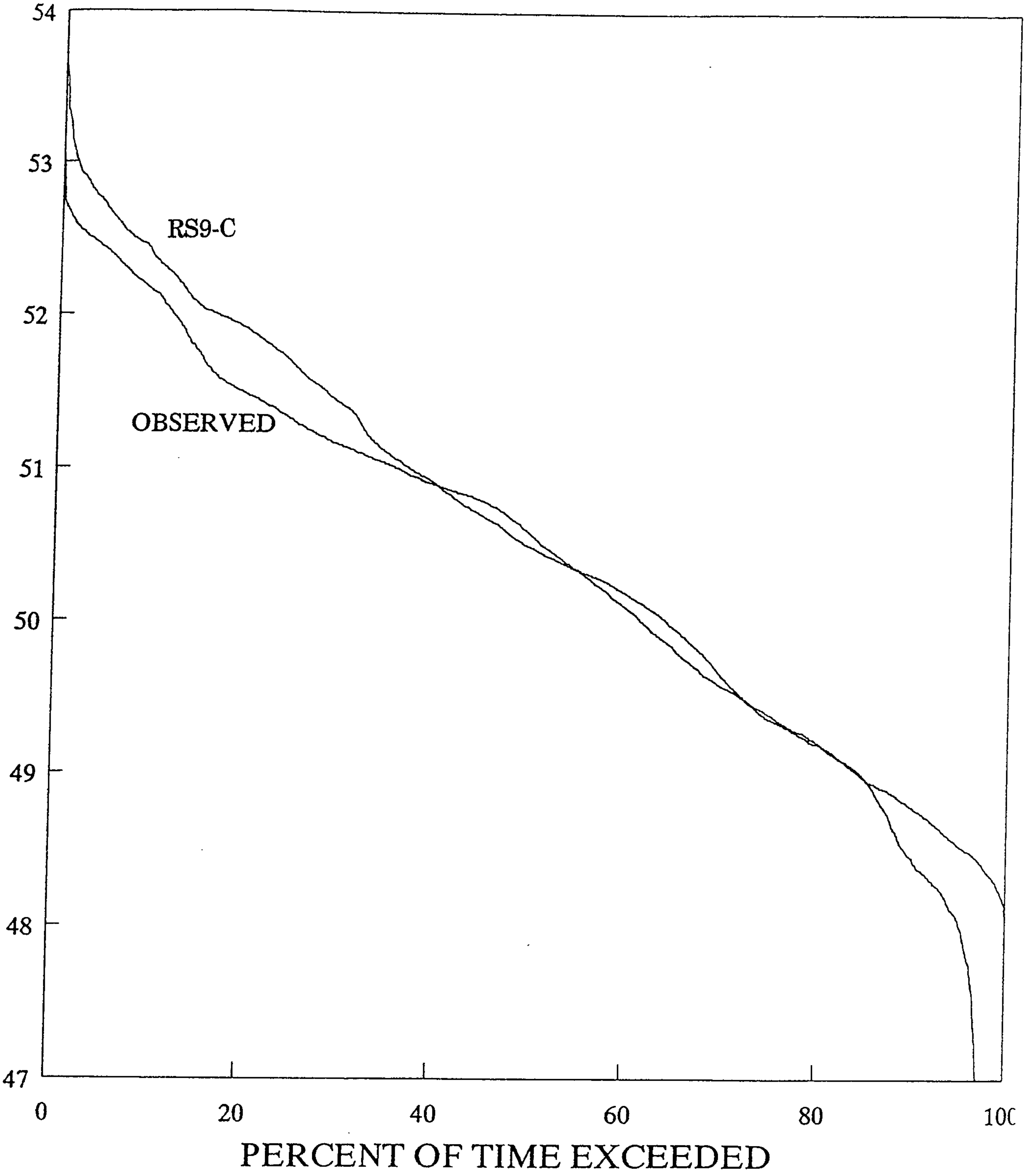
RS9-A
10 SEP 93

FIGURE D15



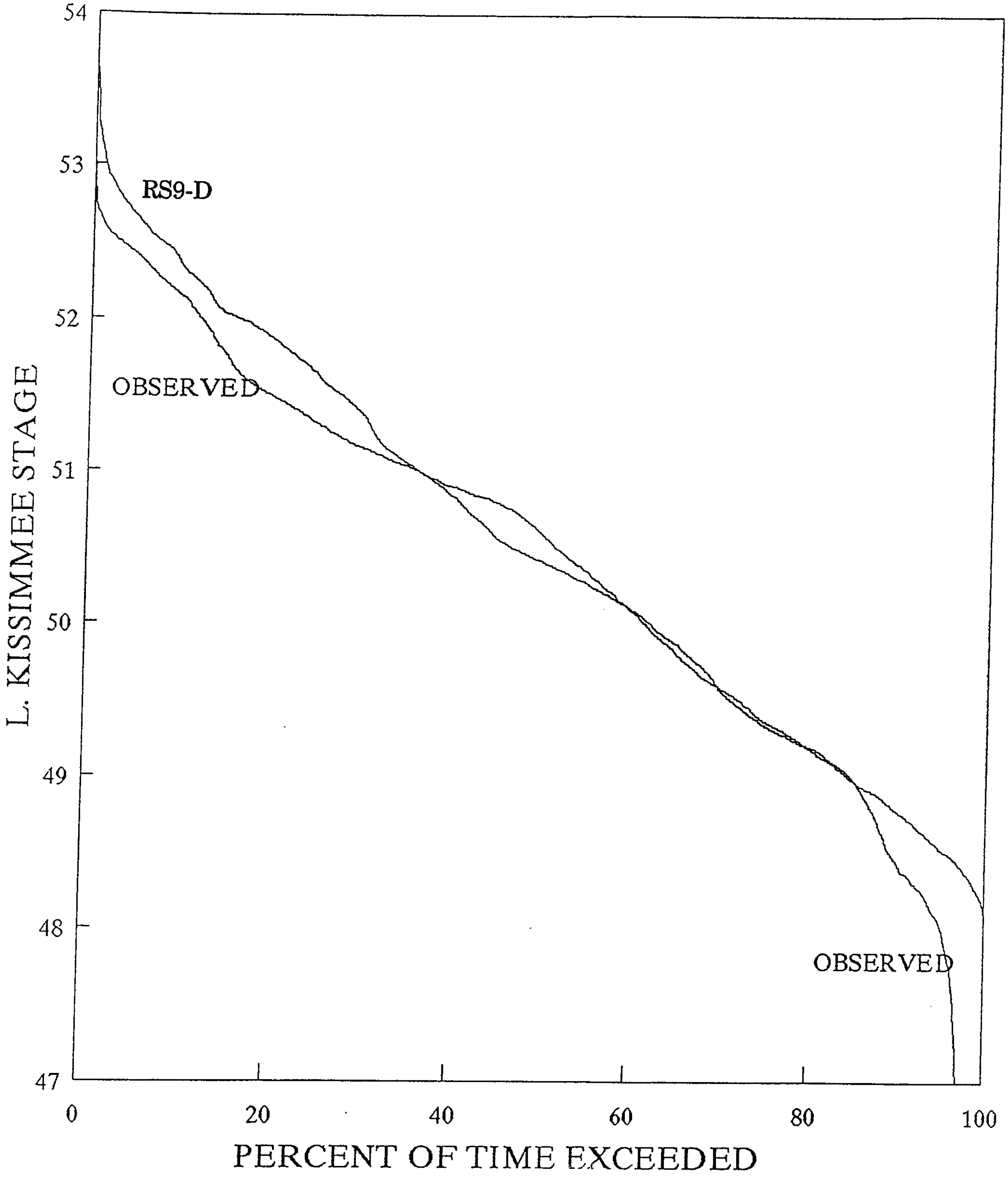
RS9-B
10 SEP 93

FIGURE D16



RS9-C
29 Sep 93

FIGURE D17



RS9-D
15 Nov 93

FIGURE D18

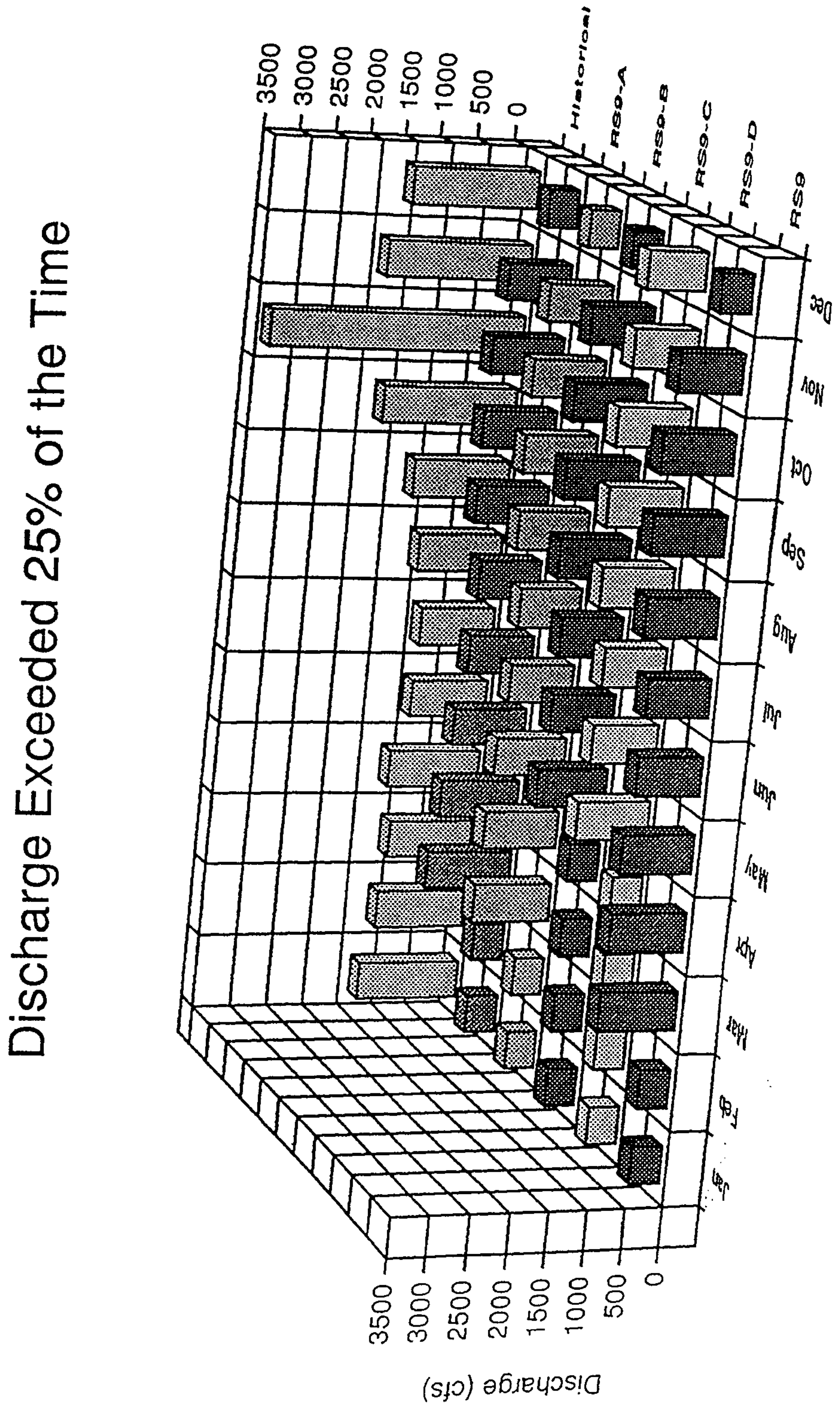

Discharge Exceeded 25% of the Time
Discharge (cfs)
3500
3000
2500
2000
1500
1000
500
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Historical
RS9-A
RS9-B
RS9-C
RS9-D
RS9

FIGURE D19

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX G

SOCIAL IMPACT ASSESSMENT

SOCIAL IMPACT ASSESSMENT FOR THE KISSIMMEE RIVER BASIN HEADWATERS REVITALIZATION PROJECT

SCOPE OF THE STUDY

The scope of this study is that upper portion of the Kissimmee River Basin included in Polk and Osceola counties. The social assessment for the Kissimmee River Headwaters Revitalization project will be conducted for both Osceola and Polk counties and the areas adjacent to the affected lakes.

PURPOSE OF THE STUDY

The purpose of this study is to identify and assess the social impacts of the work/changes in the upper basin carried out in support of the Kissimmee River Headwater Revitalization project and to assess the effects on the people living in the area adjacent to Cypress, Hatchineha, and Kissimmee lakes. The primary objective of this study is to optimize environmental improvements to the upper Kissimmee River Basin while reestablishing the discharges to the lower basin which are necessary to restore the ecological integrity of the Kissimmee River. Modifying the upper level of the existing Lake Kissimmee regulation schedule will provide higher fluctuations of water levels in the upper lakes. Although the upper level of the proposed lake regulation schedule would be increased by 1.5 feet, the schedule will be zoned to provide varying discharge capabilities based on season and water levels. Continuous discharges will reduce the likelihood that the lake will maintain or reach the top of the proposed lake regulation schedule. The project and subsequent increase in lake level elevations will impact local communities within the two counties and particularly areas surrounding the lakes. The present effort is an attempt to categorize and quantify changes in social and economic conditions that the Kissimmee River Basin Restoration Project will cause in the Upper Basin project area. This social assessment will focus on the displacement of houses, people, businesses, and farms. Some of the social factors that will be considered include impacts on population distribution, employment, income, housing stock, fiscal condition, and community cohesion.

EXISTING CONDITIONS

Osceola County, one of four counties that comprise the Orlando Metropolitan Statistical Area (MSA), is in the southeastern quadrant of the Orlando MSA. Osceola County's 1,350 square miles comprise approximately 35 percent of the 3,872 square miles of Metro Orlando. Most of the urban development in Osceola County is around the cities of Kissimmee and St. Cloud in the northwest corner near Orlando and Disney World. Service and tourist industries predominate in this area. The remainder of the county is rural/agricultural and is dominated by citrus, cattle, and timber industries.

Polk County is a single-county metropolitan area; the Lakeland-Winter Haven MSA. These two cities and a number of smaller towns contain most of the population. At 2,048 square miles, it is the fourth largest county in Florida. Polk County is at the center of Florida's industrial belt and contains notable phosphate mining, manufacturing, agricultural, tourist, and service sectors. Polk County produces almost 25 percent of the state's citrus crop.

Major highways servicing these counties are the Florida Turnpike, Interstate 4, Interstate 75, Highway 60, Highway 92, Highway 98, and U.S. Highway 441. U.S. 192 runs east-west and connects with Interstate 4 near Disney World. A number of major airlines service Orlando International Airport.

Many of the now permanent residents of Polk and Osceola counties moved to the area from the northern states to enjoy the benefits of climate and growth. Also, a large number of seasonal residents ("snowbirds") spend four to six months in the area to avoid cold weather in the North. These two counties enjoy a subtropical climate with warm summers and mild winters. The average annual temperature of this area is 72.7^0 Fahrenheit (F), with an average January minimum of 49^0F and an average August high of 93.9^0F. The average precipitation is 48 to 55 inches.

DEMOGRAPHIC CHARACTERISTICS

The 1990 Census indicated that the population of Polk County was 405,382, Osceola County's was 107,728, and the population of the State of Florida was 12,937,926. The population projections shown in Table 1 indicate that the rate of population growth in Osceola County is expected to greatly exceed that experienced by Polk County and Florida as a whole. The major factor in Osceola County's population increase of over 100 percent between 1980 and 1992 was the development of the Kissimmee-St. Cloud area as a result of Orlando's (Orange County) Disney World and other area tourist attractions. Also, the absolute increase of 70,473 persons was applied to a relatively small 1980 base population for the county. Polk County's population ranked eighth in the state according to the 1990 Census. Polk County showed an absolute increase in the same period of almost 100,000 persons, which was about 30 percent higher than its 1980 population figure.

Table 1. Population Projections
Osceola and Polk Counties and Florida

County/ State	1980	1990	1992	1995	2000	2005	Percent Change 1980-1990	Percent Change 1990-1992
Osceola	49,287	107,728	119,760	137,595	165,098	191,603	118.60	11.20
Polk	321,652	405,382	420,885	443,802	478,002	510,202	26.00	3.80
Orlando Metro[1]	804,774	1,224,852	1,300,848	1,426,888	1,618,994	1,802,504	52.20	6.20
Florida	9,746,961	12,937,926	13,424,416	14,275,000	15,573,000	16,805,000	32.70	3.80

[1] Orlando Metro area includes Lake, Orange, Osceola, and Seminole counties.

Source: *Florida Statistical Abstract, 1993*, 27th Edition. Bureau of Economic and Business Research, College of Business Administration, University of Florida and University of Florida Press.

As shown in Table 2, Polk and Osceola counties on the whole are ethnically diverse. Polk County population characteristics do not differ substantially from those of the State of Florida. Osceola County has proportionately fewer black citizens and more other citizens than either Polk County or the state. However, the population of the direct impact lakeshore area is almost all white in both counties.

Table 2. Racial Composition - 1992
Osceola and Polk Counties and Florida
(Percentage)

Race	Osceola (Percent)	Osceola (Study Area) (Percent)	Polk (Percent)	Polk (Study Area) (Percent)	Florida (Percent)
White	89.33	96.5	84.35	99.6	83.08
Black	5.48	0	13.42	0	13.60
American Indian Eskimo or Aleut	0.33	0	0.29	0.28	0.28
Asian or Pacific Islander	1.52	0.58	0.61	0.09	1.19
Other	3.34	2.91	1.33	0.18	1.85
Total	100.00	100.00	100.00	100.00	100.00

Source: *Florida Statistical Abstract, 1993*, 27th Edition. Bureau of Economic and Business Research, College of Business Administration, University of Florida and University of Florida Press.

Table 3 shows that the age structures of Polk and Osceola counties and the State of Florida are fairly similar. Osceola County has a smaller percentage of inhabitants over 65 than either the State of Florida or Polk County.

Table 3. Population Age Groups (Years)
Osceola and Polk Counties and Florida
(Percentage)

County/ State	0-14 years (Percent)	15-24 years (Percent)	25-44 years (Percent)	45-64 years (Percent)	65 + years (Percent)	Total (Percent)
Osceola	21.48	13.32	30.41	20.23	14.55	100.00
Polk	20.56	12.78	27.96	20.30	18.40	100.00
Florida	19.08	12.43	29.83	20.24	18.41	100.00

Source: *Florida Statistical Abstract, 1993*, 27th Edition. Bureau of Economic and Business Research, College of Business Administration, University of Florida and University of Florida Press.

The 1990 demographic characteristics of the study area are shown in Table 4. The total population for the census blocks in the portion of Osceola County within the direct impact area was 23 persons. These people are located in the area around Cypress Lake. Within Polk County, the population for the census blocks within the direct impact area was 1,068 persons. These people are located on the west side of Hatchineha and Kissimmee lakes.

Table 4. Selected Demographic Characteristics of the Lakeshore Study Areas and Polk and Osceola Counties

Characteristics	Osceola[1] (Study Area)	Osceola County Total	Polk[1] (Study Area)	Polk County Total
Population	23	107,728	1,068	405,382
Race (White)	22	96,231	1,064	341,952
Race (Black)	0	5,902	0	54,385
American Indian	0	360	3	1,158
Asian\Pacific	1	1,637	1	2,486
Other	0	3,598	0	5,401
Hispanic Origin[2]	0	(12,866)	(2)	(16,600)
School Age and Presumed Retired Persons				
Age (under 18)	4	89,503	93	318,601
Age (65 or older)	2	17,428	376	77,425

[1] Osceola Study Area = Lake Cypress
Polk County Study Area = Lakes Hatchineha and Kissimmee

[2] Persons of Hispanic origin may be of any race.

Sources: U.S. Department of Commerce, Economics & Statistics Administration Bureau of the Census; and 1990 Census of Population & Housing.

As can be seen from the tables, over 35 percent of the residents enumerated by the census are over 65 and are likely to be retired. The actual percentage is probably higher since many of their spouses are under 65 and not counted in this category. Also, many people retire before age 65.

Housing Stock

The 1990 Census reported a total of 186,225 year-round housing units in Polk County. Of this number, 109,885 were owner occupied, 46,084 were renter occupied, 30,256 were vacant. Of these, 13,130 were classified as being for seasonal or recreational use. The mean cash rent for rental dwellings was $273.00 per month. Osceola County, on the other hand, had a reported 47,959 year-round units. Of this number, 25,730 were owner occupied, 13,420 were renter occupied and 8,809 were vacant including 3,982 seasonal recreational units. The mean cash rent for rental dwellings was $292.00 per month for Osceola County.

The 1990 census housing characteristics of the lakeside study area are shown in Table 5. The areas adjacent to the lakes in Osceola County contained 17 housing units in 1990. Nine of these

(53 percent) were reported as vacant in census block statistics. According to informants, they were used only on weekends or seasonally. Of the 879 housing units in the lakeside areas along the west side of Hatchineha and Kissimmee lakes, 374 (43 percent) were reported by the census to be vacant and/or for seasonal use.

Table 5. Selected Housing Characteristics of the Lakeshore Study Areas and Polk and Osceola Counties

Characteristics	Osceola[1] (Study Area)	Osceola County Total	Polk[1] (Study Area)	Polk County Total
Housing Units	17	47,959	879	186,225
Owner (Occupied)	57	25,730	460	109,885
Renter (Occupied)	3	13,420	45	46,084
Total Vacant	9	8,809	374	30,256
Seasonal/Recreational Use (Vacant)[2]	NA	3,982	NA	13,130
Mean Value	$30,417	$75,700	$60,728	$61,000
Mean Rent	$362	$438	$273	$300

[1] Osceola County Study Area = Lake Cypress
Polk County Study Area = Hatchineha and Kissimmee lakes

[2] Vacant units intended for use only in certain seasons, for recreational or other occasional use throughout the year.

NA = Not Available.

Source: U.S. Department of Commerce, Economics & Statistics Administration, Bureau of the Census. 1990 Census of Population & Housing.

Labor Force/Employment

Table 6 shows the percentages of total population in various wage and salaried employment categories in Osceola and Polk counties and in Florida. The total and each category are presented as a percentage of the total population to facilitate comparison. Wage and salary workers comprise nearly half (47 percent) of Polk's employment, compared to approximately 38 percent for Osceola County and slightly over half (51 percent) for Florida as a whole. Trade and service employment sectors total 66 percent of wage and salary workers in Osceola County and 49 percent in Polk County. These figures indicate the place of trade and service sector employment to the economies of Osceola and Polk counties. The construction labor force is estimated at approximately 2,395 in Osceola County and 12,626 in Polk County.

As seen in Table 6, Polk County had an unemployment rate of 12.4 percent in 1992, compared to Osceola's 6.6 percent and Florida's 8.1 percent (Florida Department of Labor & Employment Security).

Polk County has been designated by the United States Department of Labor as a labor surplus area, which means that companies located in Polk County are eligible for preference in obtaining Federal contracts.

Table 6. Employment and Labor Force--1992
(As a Percent of Total Population)

Category	Osceola	Polk	Florida
Total Wage and Salary Employment	38.0	47.0	51.0
Agriculture Services	1.0	2.0	2.0
Manufacturing	2.0	5.0	4.0
Mining	0	1.0	0
Construction	2.0	3.0	3.0
Transportation/Public Utilities	1.0	2.0	2.0
Wholesale Trade	1.0	2.0	2.0
Retail Trade	11.0	9.0	10.0
Finance/Insurance/Real Estate	3.0	3.0	4.0
Services	13.0	12.0	17.0
Government	5.0	6.0	7.0
Unemployment Rate August (1993)	6.6	12.4	8.1

NOTE: Categories do not total due to rounding.

Source: Florida Department of Commerce--1992, Division of Economic Development. Regional Economic Information System, Bureau of Economic Analysis, In Cooperation with Florida Department of Labor and Employment Security.

Income

As shown in Table 7, Osceola County experienced a reduction in per capita income from 1989 to 1991. Polk County and Florida recorded a net increase in per capita income during the same period.

Table 7. Per Capita Income for Selected Years:
Osceola and Polk Counties and Florida

County/State	1989	1990	1991	Percent Change 1989-1991
Osceola County	$ 16,746	$ 16,893	$ 16,666	$ -0.48%
Polk County	$ 14,457	$ 14,906	$ 15,176	$ 4.97%
Florida	$ 17,904	$ 18,759	$ 19,087	$ 6.10%

Note: These data were derived by dividing each type of income by the total population of the area, not just the segment of the population receiving that particular type of income. Per capita is computed using Bureau of Economic and Business Research Florida Estimates of Population for intercensal years and Bureau of the Census data for 1990.

Source: Florida Department of Commerce--1992, Division of Economic Development. Regional Economic Information System, Bureau of Economic Analysis and Florida Department of Labor and Employment Security.

Lakeside Study Area Land Use

The proposed action will require acquisition of lands lying between the contours of 52.5 and 54 feet. Except in a few areas, lands necessary for the project will be acquired in fee to insure that project environmental and flood storage requirements are obtained. These lands consist of approximately 16,000 acres of rangeland, pasture, forests, and wetlands. Also, about 300 acres of urban or built-up lands will be required. Descriptions of some of the built-up areas given below are taken from material provided by the real estate section of the Jacksonville District Corps of Engineers (COE).

Lake Cypress RV and Fish Camp: This facility on Lake Cypress consists of a fish camp with a store, snack bar, manager's residence, and approximately 45 RV/trailer pads. It is located on the south side of a public boat launch and provides services to boat ramp users. On the north side of the launch area is a cluster of about a dozen privately owned cabins on three to four foot piers. Some are in a dilapidated condition. Each of the cabins has its own septic system.

Hatchineha Estates, Hatchineha Marina Lots, and L&M Estates: This area consists of approximately 306 lots, 48 of which are vacant. The lots are arranged along a system of dug canals so that each has water frontage. Almost all have docks or boat shelters. A few of the structures have over-water quarters in a second story over the boat shelter. Most of the homes in the area are built-in-place structures. Some are rather large, and two-story and brick veneer structures are not uncommon. Hatchineha Marina, located in this area, provides a boat ramp, gas, bait, and other boating/fishing services, as well as a small store and restaurant. The marina also has RV sites for rent. Each of the housing units in this area has its own septic system.

Grape Hammock Acres and Chandley Point: There are 57 housing units and 11 vacant lots in this area. Most of the houses are frame or cinder block construction. Two are mobile homes.

Grape Hammock Fish Camp: Grape Hammock Fish Camp contains approximately 22 acres and consists of 40 mobile home (MH) pads, 74 recreational vehicle (RV) pads, 11 cabins, 7 camp sites, 100 boat slips, and a manager's residence. Amenities include a store, recreation hall, two restroom/shower/laundromat facilities, outside storage area, and above-ground swimming pool. The MH sites are served by their own sewer system, whereas eight septic tank systems service the RV sites. The whole camp is provided water by an on-site well.

Shady Oaks Fish Camp: Shady Oaks Fish Camp is a portion of a 3,000-acre ranch containing an undetermined number of acres. The camp provides eight RV lots, 270 mobile home lots, boat slips, a convenience store/bait store, and a covered picnic shelter. The mobile homes all have septic tanks, which were installed and paid for by the tenants. The whole camp is provided water by an on-site well.

Rocks Fish Camp: Rocks Fish Camp is a portion of the same 3,000-acre ranch as Shady Oaks. Its approximately 67 acres of land contain 116 mobile home sites and some boat slips. The mobile homes all have septic tanks, which were installed and paid for by the tenants. The whole camp is provided water by an on-site well.

Oasis Marina: Oasis Marina is located on the south end of Lake Kissimmee on the west side. The marina provides lodging, fuel docking facilities for boat operators, and an access ramp into the lake. Along with a marina office and store, there are two residences, two cottages, a quadruplex cottage, two mobile homes, and additional hook-up facilities for eight trailer homes. All of the six existing septic tanks have top-of-tank elevations less than 56 feet MSL.

Tiger Lake: In the Tiger Lake Sub-division, only back lots of the property situated near the lake would be impacted with the exception of one structure. This particular structure is being built between the 52.5 and 54 feet flood level with a raised ground elevation of approximately 3 to 4 feet. However, flooding would occur around the raised structure making it unaccessible at the time of flooding. The developed areas along Bud's Fish Camp and the Lion's Fish camp consist of campers/trailer homes/RVs. Except for a about 11 trailers, 103.42 acres); 2 structures (1 frame and 1 brick), 5.22 acres, and sheds/barns, 8.12 acres. The rest of the land area is woodland, pasture (95.5 acres) and rangeland (191.7 acres). On 35.93 acres there is an improved unpaved airstrip. The structures between 52.5 feet - 54 feet elevation are shown in Table 8

TABLE 8
Lands Around Lake Tiger
Improvement Impacted Between 52.5 - 54.0 Feet Contour

LAND USE/ IMPROVEMENT	EST. ACREAGE
A-frame and pole barn	3.72
Double wide	2.73
Mobile Home/Barn	3.88
Mobile Home	3.00
Mobile Home	0.31
Imp. Pasture/Storage Shed	20.50
Double /wide >54.0 (entire acreage is not impaceted, approx. 50-75 %)	
No improvement, undeveloped	14.10
R/v, storage shed & single wide <54.0	1.72
Shed & Barn <54.0	5.03
Double wide <54.0 pasture	83.37
Two trailers & Barn <54.0	5.40
Two trailers <54.0	3.01
Barn <54.0	1.49
House <54.0	2.22
Fish camp w/R/V lots	5.13
Possible 1,000 ft. grass airstrip	36.93

Institutions and Services

Police protection is provided to the lakeside communities by the Osceola and Polk counties sheriffs' offices. Fire protection and emergency response services are furnished by nearby volunteer fire departments within each county. There are no schools in the lakeside areas, and school children are bussed to schools within the nearest towns. Churches range from small local chapels/churches observed along the roads leading to the lakeside study area to churches and temples within the towns nearby.

Other Factors

The proposed project has resulted in the formation of at least one activist interest group that opposes the Kissimmee River Restoration Plan. The group, which has about 500 members, is named *Realists Opposed to the Alleged Restoration,* but is best known by the acronym ROAR. However, most of its membership apparently have interests in areas below Lake Kissimmee. ROAR was formed to review the proposed project in its entirety. It has made contact with and received support from national private property interest organizations such as The National Taxpayers Union, Citizens for Constitutional Property Rights, the Institute for Justice, and the James Madison Institute.

Another factor to be noted is that both Osceola and Polk counties are in the National Flood Insurance Program. Under this program, any new construction or new residences built in flood plain areas must be built with the first floor at least one foot above the elevation of the 100-year flood in order to obtain flood insurance. Banks or mortgage institutions require flood insurance in designated flood plain areas before they will make a loan. Older structures can be "grandfathered" into the flood insurance program if they were built before the flood plain regulations became effective.

PROJECT IMPACTS

Acquisition and Displacement

Implementing the project will require the scheduled retention of water in Cypress, Hatchineha, Kissimmee and Tiger lakes to an elevation of 54 feet MSL during the course of each year. This is 1.5 feet higher than the currently authorized maximum programmed elevation of 52.5 feet MSL. The right to flood the area between the 52.5-foot contour and the 54-foot contour will be secured by buying the property in this zone. Most of this property is used for cattle grazing, wetlands, non-commercial forest and a small amount in crops.

<u>Agricultural Displacement</u>: Land use maps provided by the Jacksonville District COE were used to ascertain the areas of different land uses below the 54-foot contour. Around the three lakes, an estimated 6,069 acres of pasture and 1,707 acres of rangeland would be acquired. An additional 95.5 acres of pasture and 192 acres of rangeland could be affected around Lake Tiger in Polk County. Approximately 1700 acres of sod farm exist at the Rolling Meadows property adjacent to the south side of Lake Hatchineha. This area will more than likely be acquired as part of the project.

The impact on cattle production of flooding lakeside lands depends on whether the lands remain available for grazing on a lease basis. The current practice is for pasture fences to be to the lakeshore and extend into the water to a depth that keeps the cattle from wandering around the end of the fence into the next pasture. If this practice is maintained and the lands are leased back to the ranchers, the impact on production will be minimized. Cattle would simply adjust to the moving shoreline as water levels fluctuated. There would be some deterioration of pasture quality for part of the year. If the acquired area is fenced off from the lakeshore, the cattle production potential will be removed.

In previous studies on the Kissimmee River Basin, Jacksonville District COE agricultural economists calculated the relationships between factors contributing to economic loss to cattle producers and the duration of pasture flooding. These values were used in the present study to calculate a weighted average cost per acre per day of inundation. Two assumptions insured that the average cost per acre calculated for the present study resulted in a conservative estimate (i.e., maximized) of damages. The first, that there was as much improved as semi-improved pasture in the zone between 52.5 feet and 54.0 feet elevation was based on conversations with area agricultural agency personnel.

The second assumption was that improved and semi-improved pasture and rangeland are equally subject to innundation. A normal expectation is that improved pasture would be on higher ground and thus not as likely to sustain damages as semi-improved pasture or rangeland. On the land-use maps for the study both improved and semi-improved pasture lands were simply identified as pasture. Differential innundation was not calculated for pasture and rangeland categories as no detailed topography was shown between the 52.5 foot and 54.0 foot contours. Inspection of the land use maps seemed to show that lands identified as pasture were as likely to be proximal to the lakeside as those identified as rangeland. The Jacksonville District COE costs were in 1990 dollars. These costs were indexed to 1994 values by using the index of Prices Paid by Farmers for Production from the Survey of Current Business. The computations are shown in Table 9 and 10.

Table 9. Calculated Average Cost Per Day Per Acre Flooded For Cypress, Hatchineha, and Kissimmee Lakes

Land Use Type	Cost Per Day Per Acre Flooded	Total Number of Acres	Total Cost
Improved Pasture (1 cow per 3 acres)	$ 6.62	3,035	$ 20,088
Semi-Improved (1 cow per 5 acres)	$ 3.97	3,035	$ 12,047
Rangeland (1 cow per 15 acres)	$ 1.32	1,899	$ 2,507
Totals		7,968	$ 34,642

$ 34,642 / 7968 Acres = $ 4.35 acre per day (average)
$ 4.35 (1990 value) * 1.04 (index) = $ 4.52 (1994 value)

Table 10. Calculated Average Cost Per Day Per Acre Flooded For Tiger Lake

Land Use Type	Cost Per Day Per Acre Flooded	Total Number of Acres	Total Cost
Improved Pasture (1 cow per 3 acres)	$ 6.62	47.75	$ 316.11
Semi-Improved (1 cow per 5 acres)	$ 3.97	47.75	$ 189.57
Rangeland (1 cow per 15 acres)	$ 1.32	192.00	$ 253.44
Totals		287.50	$ 759.11

$759/288 Acres = 2.64 = acre per day (average)
$2.64 (1990 value) * 1.04 (index) = 2.75 (1994)value

Sources: Jacksonville District Corps of Engineers; and Gulf Engineers & Consultants, Inc.

The Jacksonville District provided a graph showing the exceedance curves for the pre-existing and proposed schedules under which the project lake levels would be managed. These graphs plotted lake levels between 52.0 and 54.0 feet on one axis against the percent of time the levels would be exceeded on the other. Lake stages were converted into acres flooded by assuming a constant slope to the land between 52.5 and 54.0 feet. The number of days of flooding for different numbers of acres was calculated by assuming an average expected annual cycle and converting percent of time to days (365 days/year base). These calculated stage/acres flooded by percent of time/days relationships under the existing and proposed regulation schedules were used to estimate the number of acres flooded for each duration period (in days). The acre/days were then multiplied by the weighted average value ($4.52 for Lake Cypress, Hatchineha, and Kissimmee) and ($2.75 for Lake Tiger) described above. Calculations of the damage estimates for the four lakes under existing (tables 11 and 12) and proposed regulation schedules (tables 13 and 14).

The recommended plan includes fee acquisition of the affected pasture land to mitigate induced damages. The 6,086 acres shown in table 13 and the 288 acres shown in table 14 are included within the 20,000 acres to be acquired. Because the affected pasture will be acquired and converted to wetlands, no induced damages will be realized.

Table 11. Damage Estimates for Pasture Flooding
Existing Regulation Schedule For Cypress, Hatchineha, and Kissimmee Lakes

Days Flooded	Acres Flooded	Cost per Acre per Day Flooded	Cost
1	2188	4.52	$ 9,890.07
2	625	4.52	$5,651.47
3	573	4.52	$7,775.03
4	522	4.52	$9,430.47
5	469	4.52	$10,596.51
6	417	4.52	$11,311.45
7	365	4.52	$11,558.28
8	313	4.52	$11,302.94
9	261	4.52	$10,609.27
10	209	4.52	$9,447.49
11	156	4.52	$7,770.77
12	137	4.52	$7,404.79
13	117	4.52	$6,860.07
14	97	4.52	$6,136.61
15	77	4.52	$5,234.42
16	57	4.52	$4,153.49
17	38	4.52	$2,893.83
18	18	4.52	$1,455.42
Total Cost			$139,482.39

Table 12. Damage Estimates for Pasture Flooding Existing Regulation Schedule Tiger Lake

Days Flooded	Acres Flooded	Cost per Acre per Day Flooded	Cost
1	103	2.75	$283.81
2	82	2.75	$451.79
3	75	2.75	$621.55
4	69	2.75	$753.88
5	62	2.75	$847.10
6	55	2.75	$904.25
7	48	2.75	$923.98
8	41	2.75	$903.57
9	34	2.75	$848.12
10	28	2.75	$755.24
11	21	2.75	$621.21
12	18	2.75	$591.95
13	15	2.75	$548.40
14	13	2.75	$490.57
15	10	2.75	$418.45
16	8	2.75	$332.04
17	5	2.75	$231.34
18	2	2.75	$116.35
Total Cost			$10,643.59

Sources: U.S. Army Corps of Engineers, Jacksonville District; and Gulf Engineers & Consultants, Inc.

Table 13. Damage Estimates for Pasture Flooding
Proposed Regulation Schedule For Lakes Cypress, Hatchinha, and Kissimmee

Days Flooded	Acres Flooded	Cost per Acre per Day Flooded	Cost
1	6086	4.52	$27,506.73
2	3628	4.52	$32,800.74
3	3277	4.52	$44,433.95
4	2926	4.52	$52,906.06
5	2575	4.52	$58,187.32
6	2224	4.52	$60,315.96
7	1872	4.52	$59,245.27
8	1763	4.52	$63,765.99
9	1654	4.52	$67,300.99
10	1544	4.52	$69,807.78
11	1435	4.52	$71,367.09
12	1326	4.52	$71,940.68
13	1217	4.52	$71,528.55
14	1108	4.52	$70,130.69
15	998	4.52	$67,683.38
16	889	4.52	$64,309.84
17	780	4.52	$59,950.57
18	671	4.52	$54,605.58
19	562	4.52	$48,274.87
20	452	4.52	$40,873.46
21	343	4.52	$32,567.05
22	234	4.52	$23,274.93
23	176	4.52	$18,274.09
24	118	4.52	$12,848.37
25	58	4.52	$ 6,585.64
Total Cost			$1,250,485.57

Table 14. Damage Estimates for Pasture Flooding Proposed Regulation Schedule For Lake Tiger

Days Flooded	Acres Flooded	Cost per Acre per Day Flooded	Cost
1	288	2.75	$792.00
2	172	2.75	$944.43
3	155	2.75	$1,279.38
4	138	2.75	$1,523.32
5	122	2.75	$1,675.38
6	105	2.75	$1,736.67
7	89	2.75	$1,705.85
8	83	2.75	$ 1,836.01
9	78	2.75	$1,937.79
10	73	2.75	$2,009.97
11	68	2.75	$2,054.87
12	63	2.75	$2,071.38
13	58	2.75	$2,059.52
14	52	2.75	$2,019.27
15	47	2.75	$1,948.80
16	42	2.75	$1,851.67
17	37	2.75	$1,726.15
18	32	2.75	$1,572.26
19	27	2.75	$1,389.98
20	21	2.75	$1,176.87
21	16	2.75	$937.70
22	11	2.75	$670.15
23	8	2.75	$526.16
24	6	2.75	$369.94
25	3	2.75	$189.62
Total Cost			$36,005.17

Sources: U.S. Army Corps of Engineers, Jacksonville District; and Gulf Engineers & Consultants, Inc.

As noted earlier, these calculations presume a constant slope of the land between elevations 52.5 feet and 54.0 feet and a relatively random mix of types of grazing lands. As also noted, inspection of the land use maps indicate that the latter assumption is not unreasonable for pasture and rangeland in the zone between 52.5 feet elevation and 54.0 feet elevation. The annual damages expected due to pasture flooding under the existing regulation schedule for Lake Cypress, Hatchineha, and Kissimmee are $139,482 and for Lake Tiger $10,644. Under the proposed regulation schedule these damages are estimated to be $1,250,486 and $36.005 annually. The net annual damages due to increased pasture flooding are estimated to be $1,111,003 and $25,362 respectfuly. It should be noted again that this is in the high end of the range of expected damages.

Effects on the local economy are problematic for losses in agricultural production due to pasture damage. The effect of diminished production will be offset for the land owner by the purchase price of the land acquired for flowage rights. Subsequent lease-back arrangements (if any) will undoubtedly take the reduced carrying capacity of the pasturage into account; therefore, the individual cattle producer will suffer little or no loss due to the project.

Commercial Displacement: All of the marina/fish camps around the three lakes will be impacted to a greater or lesser degree. The nature and extent of impacts and the consequences are both particular and problematic for each business. A comparison of the existing and proposed regulation schedule shows that the current regulated elevation of 52.5 feet will likely be exceeded approximately five percent of the time. On an annualized basis this is 18 days. Under the proposed regulation schedule the 52.5 foot elevation would likely be exceeded approximately seven percent of the time, or 25 days on an annualized basis. The actual effects of this change on business are likely to be limited. However, if the docks are raised they may then be too high to provide convenient access to boats when the water levels are reduced throughout the rest of the year. Owners have no compensable rights for impacts to their docks/boat sheds because the COE has preemptive navigability servitude/rights. Owners could actually be required to remove their docks if deemed necessary, although no such action is planned at this time. Some outbuildings as well as other dockside improvements such as fish cleaning houses, bait storage facilities, or gas pumps may be impacted by water at a 54-foot elevation. However, no primary structures have first-floor elevations less than 54 feet MSL and therefore would not be displaced due to flooding of the structure. The extent to which business owners might choose to relocate facilities or modify existing ones is unknown. Also unknown is whether businesses would remain viable if changes were made and debt was incurred, or if changes were not made and customers chose not to accommodate to the short-lived inconvenience and went elsewhere.

Field personnel talked with several marina operators. They were reluctant to discuss their businesses or future plans, since all maintained they were either in the process of negotiating with the South Florida Water Management District (SFWMD) or the COE or soon would be. Some complained that they had been contacted initially, asked to provide extensive information, and then had not been contacted again. Several mentioned that attempts to obtain clarification of their cases had been unsuccessful. No information as to the value business owners placed on their operations or what actions they expected to take was acquired.

Real estate appraisers for the SFWMD and COE have prepared estimates of the costs of relocation and flood proofing as well as the value of the properties potentially impacted by increasing lake levels. These estimates of acquisition costs for the fish camps and marinas around the lakes were combined with general acquisition costs for improvements made by tenants and the relocation costs associated with moving tenants as well as businesses. These were then compared with the projected costs of flood proofing the properties. The estimated cost for acquiring the businesses, homes, and mobile homes subject to impact was approximately $49 million. The estimated cost to floodproof the same properties was approximately $23 million (a difference of approximately $26 million). Floodproofing would also avoid the wholesale dislocation that would be produced by acquisition. Some facilities at particular marinas or fish camps will probably have to be relocated or otherwise modified, but the businesses will not have to be acquired for the needs of the project.

The extent to which a particular business is impacted and whether the business can remain viable under the changed conditions is problematic for each situation. If individual businesses close, they will likely be replaced at some time by a similar business if the demand for the service is great enough. The Kissimmee River Restoration project is unlikely to have long-term negative impacts on the economy of the Upper Basin region by causing marinas to go out of business.

Residential Dislocation: There are no primary residential structures with first-floor elevations at or below 54 feet MSL. Therefore, no housing units will need to be acquired and/or occupants displaced because the dwelling would be flooded. Some outbuildings, garages, patios, etc., will need to be elevated to 54 feet MSL or above.

Septic System Impacts: The impact of water level increases on septic systems of both homes and businesses is the most difficult to predict and deal with. All of the homes and businesses in the lakeside study area use septic tanks with drain fields to dispose of their sewage. Most are individual on-site below-ground installations with both the tank and the drain field below the general ground level. There are a few cluster systems in place where the effluent from several sources is disposed of in a common drain field. There are also a few mounded drain fields in the area.

To function properly, typical septic systems should have the discharge pipe invert at least two feet lower than the top of the septic tank and resting on at least six inches of gravel. The gravel layer should be at least one foot above the "seasonal high water table." If the lake elevation is increased to 54 feet MSL for part of the year, it would likely cause septic systems whose tanks/drain fields are too low to malfunction. This would create an intolerable health hazard as untreated sewage would be discharged to the Kissimmee.

Based on the criteria developed by the COE and the SFWMD, septic systems with a top of tank elevation of 56 feet or lower would be considered impacted under the operation of the modified lake regulation schedule. This is based on application of the vertical clearance requirement of 3.5 feet from the seasonal high water level. The seasonal high water level was taken to be the maximum scheduled lake elevation during the wet season, or 52.5 feet. Systems with higher elevations may experience some difficulty. However, these existing systems will be allowed to remain. A new system, meeting more stringent criteria, will be required only when the owner seeks a permit to repair an older system that has failed.

A survey was carried out by Bromwell & Carrier, Inc. (BCI) under contract to the SFWMD to identify septic systems and other facilities likely to be impacted by raising the water level in the lakes. A number of building lots with systems at or below 56 feet MSL were identified. These lots are located in Grape Hammock, Shady Oaks, and Oasis fish camps and in Hatchineha Estates.

Mounded systems are proposed as replacements in those areas where basic criteria for their use can be met. The criteria are: sufficient land to site a mounded system; mound could be sited with at least five-foot setbacks from property lines; and mound could be sited at least 150 feet from delineated bodies of water.

The proposed repair methods are as follows:

1. On-site mounded system: The repair for an impacted lot will require installation of a four-foot diameter manhole, a dosing pump station, and a raised mound. This repair is feasible if the raised 34'x44' mound can be sited on the lot and maintain 150-foot setbacks from water courses.

2. Off-site mounded system: In situations where the site did not meet setback requirements from bodies of water or the lot was too small, the raised mound could be sited on a vacant lot. The system would use the same 34'x44' raised mound and dosing pump station, but a two inch PVC force main would be used to deliver the effluent to a mound. The dosing pump would be selected to meet any additional head constraints imposed by a remote mound.

3. Cluster Systems: When several adjacent lots are too close to a water body or lot sizes are too small, a remote cluster system can be used. In this design, a mounded system is located off-site with a dosing pump station. Sewage effluent from two to six residences would be pumped to this central dosing pump station.

The following paragraphs describe the number of likely impacted systems and the possibility for using mounded systems in different locations.

Shady Oaks: Shady Oaks Fish Camp has 107 identifiable lots. The COE has determined that 85 lots would be impacted by annual operation of lake levels over 52.5 feet. The COE analysis determined that 59 of the impacted lots could be corrected by construction of on-site mounded systems. The remaining 27 lots could be corrected by construction of eight off-site mounded systems and seven off-site cluster systems.

Rocks Fish Camp: Rocks Fish Camp has 116 identifiable lots. The COE has determined that 77 lots would likely be impacted by annual operation over 52.5 feet. The COE analysis determined that 49 of the impacted lots could be corrected by construction of on-site mounded systems. The remaining 28 lots could be corrected by construction of two off-site mounded systems and nine off-site cluster systems.

Grape Hammock Fish Camp: The Grape Hammock Subdivision has 127 identifiable lots. The COE analysis has determined that 20 lots are likely to be impacted by annual operation over 52.5 feet. The COE analysis determined that 12 lots could be corrected by construction of an on-site mounded system. The remaining eight lots could be corrected by construction of two off-site cluster systems.

Hatchineha Estates: Hatchineha Estates has 306 identifiable lots. Hatchineha Estates mainly consists of single-family homes on water-front lots. A COE survey determined that 61 lots would be impacted by annual operation over 52.5 feet. Since the subdivision consists of waterfront lots situated on dug canals, 150-foot setbacks cannot be achieved. In addition, there are no vacant lots where off-site mounded systems could be placed to handle the sewage from several houses. Sewer lines with a package system or connection to an existing system several miles away are the only viable options for Hatchineha Estates. Table 11 details the septic tank repair options for the various impacted areas.

Table 11. Septic Tank Impacts

Fish Camps	Total Lots	Estimated Total Lots Impacted by Lake Operation Over 52.5 feet	Can Be Corrected by On-Site Mounded System	Can Be Corrected by Off-Site Mounded Systems	Off-site Cluster System (Number of lots)	Sewered Lots
Shady Oaks	107	85	58	8	7(19)	0
Rocks Fish	116	77	49	2	9(26)	0
Grape Hammock	127	12	4	0	2(8)	0
Hatchineha Estates[1]	306	61	0	0		61
The Oasis	6	6	0	0	1(6)	0

[1] Note the only method of correction is to connect the impacted lots to a sewer system.

Source: U.S. Army Corps of Engineers, Jacksonville District.

Package sewer treatment plants have also been suggested as an option for Grape Hammock, Shady Oaks, and Rocks Fish camps. If centralized treatment plants are installed, no housing units would need to be displaced. If sewage systems are not installed at the fish camps and mounded systems are used where possible, the housing units on 35 lots would still be subject to displacement. These are likely to all be mobile home sites. Whether the occupants are permanent or part-time residents is unknown.

Foregone Taxes: A number of acres of undeveloped land will flood with the increase in authorized water levels. These lands will be acquired and become publicly owned, thus removing them from the tax rolls of the two counties. Tables 12 and 13 detail the lost taxes for each county.

Table 12. Agricultural Land Use Tax Rates and Tax Values
Osceola County

Land Use	Total Acres	Assessed Value Per Acre	Tax Millage	Total Taxes
Pasture: 50% Improved Pasture Land	571	$ 217.00	0.0173085	$ 2,147
50% Semi-Improved Pasture	571	$ 138.00	0.0173085	$ 1,365
Forest	92	$ 252.50	0.0173085	$ 402
Rangeland	488	$ 75.00	0.0173085	$ 633
Wetland	614	$ 30.00	0.0173085	$ 318
TOTAL ACRES	2,337		OSCEOLA TOTAL	$ 4,865

Sources: U.S. Army Corps of Engineers, Land Use Maps for the Kissimmee River Basin; Osceola County Assessor's Office; and Gulf Engineers & Consultants, Inc.

Table 13. Agricultural Land Use Tax Rates and Tax Values
Polk County

Land Use	Total Acres	Assessed Value Per Acre	Tax Millage	Total Taxes
Pasture: 50% Improved Pasture Land	2,494.5	$ 225.00	0.01744	$ 9,788.42
50% Semi-Improved Pasture	2,494.5	$ 100.00	0.01744	$ 4,350.41
Forest	262	$ 300.00	0.01744	$ 1,370.78
Rangeland	1,843	$ 75.00	0.01744	$ 2,410.64
Wetland	1,965	$ 20.00	0.01744	$ 688.88
TOTAL ACRES	9,069		POLK TOTAL	$18,609.13

Sources: U.S. Army Corps of Engineers, Land Use Maps for the Kissimmee River Basin; Polk County Assessor's Office; and Gulf Engineers & Consultants, Inc.

Economic Impacts of Construction: Project implementation in the Upper Basin requires widening the connecting canals between Lakes Cypress, Hatchineha and Kissimmee, respectively, and increasing the size of the water control structure at the lower end of Lake Kissimmee. Dredging is expected to take about a year and cost $3.5 million. Construction of the water control structure will also take about a year and will cost about $4.5 million. These values, job types, and location were input into the *Economic Impact Forecast System* (EIFS) maintained by the Construction Engineering Research Laboratory (CERL) at Champagne, Illinois. EIFS estimated that the canal work would provide 17 man-years of direct employment and 77 man-years of induced employment in the region. The water control structure portion would provide 22 man-years of direct employment and 99 man-years of induced employment. The total impacts would be 39 man-years of direct employment and 176 man-years of induced employment.

These jobs represent a net plus for the local overall economy since the money comes from outside the region. The same is true for expenditures for sewer systems or for mounded septic systems since these are project expenses. The same ratios as for the canal and water control structure expenditures ($205,000 in project expenditures per direct job, $45,500 per induced job) can be used to estimate the economic effect of building package systems or installing mounded systems. Installing a sewer system for Hatchineha Estates, at an estimated cost of $2,158,293, would result in approximately 11 man-years of direct employment and 47 man-years of indirect employment. Sewer plants for Grape Hammock, Shady Oaks, and Rocks Fish Camps, at a cost of $3,630,288, would generate 18 man-years of direct employment in the local economy and 80 man-years of induced employment. If mounded systems are used at the three fish camps instead of a sewer plant, the project expenditures total approximately $1,251,600. This translates into six man-years of direct employment and about twenty-five man-years of induced employment.

The total estimated cost for floodproofing all properties in lieu of acquisition would be approximately $23 million. This cost would be for mainly construction type actions and would be borne by the project thereby constituting an infusion of money into the local area. Leaving out the $5.7 million for sewer systems leaves about $17.5 million in floodproofing expenditures. This would support approximately 85 man-years of direct employment and would generate almost 385 man-years of induced employment.

Given the large number of construction workers in the local labor force and the high unemployment rate in Polk County, it is unlikely that there would be a large influx of construction workers who would make demands on housing, schools, and other infrastructure.

Institutional/Service Impacts: Conversations with sheriff's office and fire department personnel, and emergency service providers indicated that the project would have no influence on the delivery of services to residents of the study area. No barriers to access or increased response times were anticipated.

School officials in both counties were contacted. Many children in the study area attend schools in the nearby towns. Officials said that any changes in the school population as a result of the project would be quite small and would be well within the capacity of the school system.

Potential Impact on Property Values: In general, the potential impacts fall into two categories. First, project implementation could bring about changes in general economic activity, which could in turn affect property values as increased (or decreased) business activity may bring with it increased (or decreased) demand for land in certain areas. Second, changes to properties directly brought about by a project could change values by changing amenities, access, or other factors which could make the property either more or less attractive. The extent and magnitude of these potential impacts is not necessarily expected to be large, widespread, or significant. We can only say that these are potential impacts, without detailed knowledge of the many variables that contribute to affect the market value of a particular piece of property, with or without a project.

For properties to be purchased by the Government as a part of project implementation, if a land owner were to be left with an "uneconomic remnant," its value would be negatively impacted. Land acquisition necessary to implement a project is conducted in a way to avoid such situations. Therefore, while this type of land value impact is potential, it is highly unlikely.

The potential exists for land value to be impacted for those properties whose septic systems will have to be modified or replaced with sewer systems because of the project. For those septic systems which will require replacement with a mounded system, there could be a negative aesthetic appeal impact, in that a smoothly landscaped area will have been replaced with a less attractive look. This effect could be offset to some extent by the fact that a fairly new septic system is better than an older one, in combination with the fact that the property owner may not have had to pay for the change, if it will have been paid for by the Government. For those properties whose septic systems would be replaced with sewer systems, property values could potentially be enhanced.

There is likely to be a reduction in the amount of property subject to local taxes, in that private property will be purchased for project use. In order to fund the same level of local government services with a reduced tax base, the potential exists for property taxes to be raised on the remaining taxable property in the area. This could in turn have a negative impact on property values.

If transportation access to a property is affected by the project, or if there is a change in transportation patterns, there is a potential for some property values to be impacted. Such effects are neither expected nor known, but could be a source of impact.

If recreation activity in the area changes significantly because of the project, there could be a resulting impact on some property values. More activity means more spending, which means more income, more business activity, and more demand in some areas for land. Similarly, the depressing effect of less activity has the potential for a negative impact.

There are a number of fish camps operating in the project area with water access and recreational facilities. Existing regulations make it unlikely that new additional activities of this type would be able to obtain the necessary permits to operate in the future, while permits for existing operations to a large extent have been grandfathered in. Given this situation, if property acquisition for the project were to restrict access points to the lake, or to restrict recreational activity access at existing fish camp operations, the remaining access points to the lake could become more intensely used and more valuable following project implementation.

With the project, the establishment of a conservation easement for a particular property would have the potential to negatively impact property value because of possible lake view amenity reduction. Without the conservation easement, a lakeside property owner can mow the grass right up to the water's edge. Establishing a lakeside conservation easement is likely to eventually result in a wooded area where there previously will have been a mowed area. The decreased lake view amenity could have a depressing effect on such properties' values. Those properties which still would have lake views would be fewer in number, potentially having the effect of increased value.

The values of those lakeside properties with bulkheads, boathouses, docks and piers which will be permitted to be modified (at the owner's expense), have the potential to be impacted. If a boat house or dock, for example, will require modification to be usable under the new lake level regime, a potential buyer would possibly be willing to pay more for a property with such a modification than without."

General Impacts--Short and Long Term: In the short term, the economies of local communities and the counties in the region will be stimulated by an infusion of monies from outside the region through project expenditures. This will particularly benefit the retail sector. Most of the economic benefit will be in the form of wages for construction labor. The Polk-Osceola-Orange county region has a large construction work force. Most of the work would not be very specialized, so there would be little reason to import labor. The benefits may be dispersed over much of the multi-county region, since construction workers often commute considerable distances for work and would spend most of their wages where they live.

The study area will have a considerable improvement in its infrastructure (sewage, water, roads, etc.) that will increase property values and make for a more satisfying place to live for most people. Both permanent and temporary residents in the study area may suffer temporary inconvenience while floodproofing and other construction is being carried out. These impacts can be reduced if the work is scheduled during periods when the "snowbirds" are not in residence.

Some people with interests in the area have joined the citizen's organization "ROAR." The activity associated with the project may well engender more localized, homeowner, or neighborhood associations. This could work to foster community cohesion within the different localities of the study area. Once started because of a common purpose, many such organizations continue because of the social aspects among like people with similar interests and circumstances.

The SFWMD and the COE have both said that no new regulations are envisioned. Concern has been expressed that raising the lake level will put the area more at risk for major flooding. However, because of the increased carrying capacity of the canals and increased discharge capacity of the water control structure at the lower end of Lake Kissimmee, the stage for a 100-year flood is projected to be somewhat lower than under present conditions. No changes are called for in flood insurance requirements, and exposure to flooding damage would be reduced.

Public health should be positively impacted over both the short and longer term by the actions taken as a result of the lake level increase. Local septic systems will be required to be brought up to standard. Central sewer systems may even be the preferred route. The potential for sewage contamination of water bodies, even though very slight with upgraded septic systems, would be far less likely with centralized package systems. Docks, boat houses, and other facilities will be upgraded, lessening physical dangers. Ground shaping to promote surface drainage should reduce mosquito breeding sites within residential areas.

Central sewage systems have a number of advantages over mounded systems. Mounded systems continue to be impacted by water level fluctuations. If water levels stay high enough for long enough, the effluent cannot percolate downward and can seep out at the edges of the mound. This can be unsightly, odorous, and even somewhat unhealthy. For the most part, however, septic systems are adequate from a health standpoint if built to standard. Central systems are healthier in that waste processing is removed from residential areas. Central systems could be especially beneficial around waterfront areas because they are largely unaffected by water level/ground water level fluctuations. Mounded systems are unsightly and are a constant reminder of their function when most people would prefer to put such things out of mind. Also, mounds take up space and remove an area from use for any other purpose. Mounds constrain passage since paths go around septic mounds. Property values are reduced because of the yard area taken up by a mound and because of its negative aesthetics. Central systems, on the other hand, are aesthetically benign since they are hidden and the land can be used for other more desirable purposes. Property values are increased, and the area is more attractive overall.

There are no obvious economic benefits from simply increasing the lake levels. Some people have commented that with higher water they have less difficulty getting their boats into the canals and to their docks.

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APPENDIX H

REAL ESTATE SUPPLEMENT

APPENDIX H

REAL ESTATE SUPPLEMENT

TABLE OF CONTENTS

PLATES

EXHIBITS

APPENDIX H

REAL ESTATE SUPPLEMENT

CHART OF ACCOUNTS

O1	LANDS AND DAMAGES			
O1A	PROJECT PLANNING	$	$	100,000
O1B--	ACQUISITIONS			
O1B20	BY LS OBTAINED	$		2,910,000
01B40	REVIEW OF LS			172,000
O1C--	CONDEMNATIONS			
O1C20	PREPARATION BY LS	$		150,000
O1C30	BY GOVT ON BEHALF OF LS			2,040,000
O1E--	APPRAISALS			
O1E30	BY LS	$		1,369,000
O1E50	REVIEW OF LS			102,000
O1F--	PL 91-646 ASSISTANCE			
O1F20	BY LS	$		393,000
O1F30	REVIEW OF LS			66,000
O1G--	TEMPORARY PERMITS/LICENSES/RIGHTS-OF-ENTRY			
O1G20	BY LS	$		100,000
O1G40	REVIEW OF LS			34,000
O1G60	DAMAGE CLAIMS			10,000
01M00	PROJECT RELATED ADMINISTRATION ENVIRONMENTAL AUDITS BY LS			403,000
O1R--	REAL ESTATE PAYMENTS			
O1R10	LAND PAYMENTS			
O1R1B	BY LS	$		40,300,000
O1R20	PL 91-646 ASSISTANCE PAYMENTS			
O1R2B	BY LS	$		2,970,000
TOTAL REAL ESTATE COSTS (EXCLUDING CONTINGENCIES)		$		51,119,000
TOTAL REAL ESTATE CONTINGENCIES (RD)	$20,448,000			
TOTAL REAL ESTATE COSTS (RD)		$		71,567,000

STATEMENT OF PURPOSE

This Real Estate Supplement is tentative in nature for planning purposes only and both the final real property acquisition lines and the estimate of value are subject to change even after approval of this Project Modification Report.

PROJECT AUTHORIZATION

A general comprehensive plan for flood damage prevention for central and southern Florida was brought about by the drought of 1944-45, and the hurricane of 1947 which caused wide-spread flooding. The inclusion of the Kissimmee basin in the comprehensive plan was directed, pursuant to Public Law 534, dated 1947.

The comprehensive plan for the existing flood control system was presented in the report to the Chief of Engineers on Central and Southern Florida, published as House Document Numbered 643, Eightieth Congress, Second Session, 1948. It was authorized by the Flood Control Act approved 3 September 1954 (Public Law 780, 83d Congress, 2d Session). The existing flood control project works in the Kissimmee basin conform closely with the general plan outlined in the 1948 report to Congress. The major lakes of the upper basin, which are used as water conservation reservoirs, are connected by channels, in most cases channels excavated in the 1880's, but enlarged to varying degrees under the Congressionally authorized plan. Nine control structures regulate water levels and flows into the lake channel system. A 56-mile canal now connects Lake Kissimmee with Lake Okeechobee. Canal 38 (C-38), some 48 miles in length from Lake Kissimmee to Structure 65 (S-65E), and the previously constructed borrow canal below S-65E of some 8 miles to Lake Okeechobee, comprise this watercourse. Five structures control water elevation in the canal and regulate flows originating in both the upper and lower basins. These structures also have locks which provide year-round navigability within and through the Kissimmee basin.

Work in the upper basin was started in the early 1960's. Regulation of the levels in some of the major lakes started in 1964. Work in the lower basin started shortly thereafter with the lower control structure, S-65E, being completed in mid-1964. In 1965, control of flows and water levels in the Kissimmee basin started under this project. Channel excavation of C-38 was completed in late 1970.

The Kissimmee River Headwaters Revitalization Project was authorized under Section 1135 of the Water Resources Development Act of 1986 (P.L. 99-662), as amended, based on benefits derived for the environmental restoration of the Kissimmee River Basin, and Section 101 of the Water Resources Development Act of 1992 (P.L. 102-580, October 31, 1992). The Environmental Restoration of the Kissimmee River, Florida, Feasibility Report was prepared by the Jacksonville District in December 1991 as authorized under Section 116(h) of the Water Resources

Development Act of 1990 (P.L. 101-640). The Feasibility Report is the foundation of this Project Modification Report.

Construction of the Kissimmee River Restoration Project and the Kissimmee River Headwaters Revitalization Project were merged into the single project called the Kissimmee River, Florida Project authorized by Section 101(8) of the Water Resources Development Act of 1992. On March 25, 1994, a Project Cooperation Agreement was executed between the Department of the Army and the South Florida Water Management District (SFWMD). The unique cost-sharing requirements applicable to this Project were authorized by Section 101 of the Water Resources Development Act of 1992, Public Law 102-580.

Costs will be shared 50/50 by the Corps of Engineers and South Florida Water Management District, as the non-federal sponsor. The sponsor will be reimbursed for any LERRD's costs above 50 percent of the total project costs. Should the sponsor's contributions of LERRD's not equal the 50 percent cost share, the sponsor will be required to pay 50 percent of other designated costs not to exceed 50 percent of the total project costs.

The project modification report for the upper basin segment of the Kissimmee River Florida Project was prepared in accordance with authority provided under Section 1135.

PROJECT LOCATION AND DESCRIPTION

The Kissimmee River basin study area contains approximately 3,000 square miles and is located in south central Florida extending from Orlando southward to Lake Okeechobee. Lake Kissimmee was originally the principle source of the Kissimmee River, but the construction of connecting canals between the upper chain of lakes now places the source just south of Orlando. The northern portion of the basin, the upper basin, is comprised of approximately 1,595 square miles and is sometimes referred to as the "Headwaters". The upper basin contains a series of lakes some of which are interconnected by canals and managed by water control structures.

The upper basin occupies parts of Osceola, Orange, and Polk Counties. This area is bounded on the north by the lakes of the Orlando area, on the west by the Peace River basin, on the south by Kissimmee River and on the east by the upper St. Johns River basin.

The lower basin contributes lateral inflow to the Kissimmee River. The lower basin consists of a 48 mile channel called Canal 38 (C-38) and six water control structures; between Lake Kissimmee and Lake Okeechobee. Five of the water control structures form pools with constant water surface elevations. The lower basin receives flow from the upper basin through Lake Kissimmee at S-65. The Lake Istokpoga basin is a 422 square mile tributary to the lower basin, though only a portion of these historical flows now reach the Kissimmee River.

This supplement addresses the modification to the Kissimmee River Restoration Study (House Document 102-286 dated April 7, 1993) approved for the lower basin, subject to further studies of the Headwaters Revitalization portion of the project. This report addresses Lakes Kissimmee, Tiger, Cypress, and Hatchineha in the upper basin above State Road 60 where the basin's largest lake, Lake Kissimmee, discharges into the Kissimmee River, as shown on Plate 8- 1.

RECOMMENDED PLAN

In accordance with Section 1135 guidance and the 1992 authorizations, the improvements to the upper basin must be in place and operational in order to obtain restoration benefits in the Kissimmee River. The Headwaters project is an authorized component of the larger Kissimmee River Florida Project. Specific project outputs of the Headwaters component were tied directly to the outputs of the Kissimmee River Restoration Plan as detailed in the 1991 Feasibility Report. Thus, the primary objective of the headwaters revitalization is to provide necessary discharges to obtain the environmental benefits for the lower basin, thereby improving the quality of the environment by restoration or improvement of degraded habitats to their natural integrity, productivity, stability, and biological diversity. Plan development for this study was centered around the development of a modified Lake Kissimmee regulation schedule and operational criteria which would first achieve the environmental benefits associated with the restoration of the lower Kissimmee River which could then be modified to improve environmental conditions within the upper basin. If the Headwaters project is not implemented, the hydrologic conditions required for successful restoration of the Lower Basin ecosystem could not be achieved.

Construction of the C-38 and regulation of the upper basin lakes has reduced the flood threat in the upper and lower basins enabling more extensive land uses to occur. However, it also led to a number of environmental impacts such as loss of fish and wildlife habitat. Because of the environmental nature of this project, an analysis in support of an NED Plan was not conducted for this study. The opportunity to achieve additional environmental benefits in the headwaters while maintaining the flood damage prevention for the study area was a secondary objective of this study and report.

The Corps of Engineers and the State of Florida, with the U. S. Fish and Wildlife Service as a cooperating agency, have studied alternative modifications to the regulation schedule and water control structures of the lakes in the upper basin. This study has been conducted in accordance with current Federal water resources planning procedures and guidelines, with assistance and support from numerous State and Federal agencies.

Modifications to the existing Lake Kissimmee regulation schedule are necessary to meet two of the five hydrologic conditions that must be established to restore the lower basin ecosystem. The recommended plan for the Headwaters provides for re-establishment of continuous flow with duration and variability characteristics comparable to that of prechannelization conditions by reestablishing the base regulation schedule at 54 feet. Increasing the upper level of lake regulation will expand the littoral zone of the upper basin lakes. Modification of the schedule will provide greater and more natural fluctuations of water levels in the lakes enhancing the peripheral marsh habitats.

The establishment of the 54-foot base regulation schedule was the result of the following. Under natural conditions, the lake surfaces had a range of fluctuation of approximately 6 feet, 75 percent or more of the time. The current schedule is regulated over a 4-foot range. In order to provide more natural flowage conditions, the seasonal water storage had to be increased at the upper end of the lake levels. Based on a sensitivity study by the South Florida Water Management team, it was determined that approximately 100,000 acre-feet of additional water storage was required to provide for longer durations and seasonal variability of flow to the lower river basin. The storage available at 54 feet is 545,000 acre -feet, or approximately 100,000 acre-feet above the existing schedule range.

The Fish and Wildlife Coordination Act Report dated April 1994 and cover letter dated June 30, 1994, from the U. S. Department of the Interior, recommended operational flexibility to increase periods of inundation between the 52.5 and 54-foot contours to increase environmental benefits. Coordination with Fish and Wildlife and the South Florida Water Management District environmental experts resulted in a determination by the Corps of Engineers that it will be beneficial to extend duration of water storage at the 54 foot regulation schedule when this can be accomplished without detrimental impacts to flood control. This will increase wetlands and provide even greater environmental benefits in the upper basin. The simulated period (1970 to 1988) on which the projected benefits were based was drier than historic wet seasons (1929-1960). By increasing the depth to 54 feet N.G.V.D. for a longer period of time, wetlands will be restored to higher elevations than the simulations indicate.

The project in the upper basin consists of necessary structural and operational modifications to the upper chain of lakes. Environmental benefits will be realized in the upper basin as a result of enlarged littoral zones in Lake Kissimmee, Lake Cypress and Lake Hatchineha and in the lower basin as a result of re-establishing the historic seasonal timing of inflows.

The overall objective of this plan is to optimize environmental improvements to the upper basin of the project, while reestablishing discharges to the Lower Basin that are necessary to restore the ecological integrity of the Kissimmee River. This consists of upper basin works which include modification to regulation schedules, channel enlargement and modification of structure S-65. Flood control regulation has impacted environmental resources in the upper and lower basins. Because of the range of water level fluctuations and maximum annual lake stages, which have been reduced, the outer fringe of littoral wetlands surrounding the lakes has been drained and associated fish and wildlife values have diminished.

An additional objective is to provide increased potential for recovery of several endangered and threatened species, while not jeopardizing any remaining listed species. The U.S. Fish and Wildlife Service has determined that the modification of the regulation schedule will benefit the endangered bald eagle, crested caracara, Florida snail kite, Florida grasshopper sparrow, wood stork, and eastern indigo snake. State listed species of special concern are the sandhill crane, the American alligator, least tern, limpkin, snowy egret, little blue heron, and the tricolored heron. This increased storage capacity and expanded littoral zone would result in expanded riparian and wetland feeding habitat and increased food supply.

The upper basin includes the area tributary to the upper chain of lakes (Tohopekaliga and East Tohopekaliga, Hart, Mary Jane, Myrtle, Preston, Alligator, Gentry, and Lake Cypress). Upper basin lakes also include Lakes Marion, Hatchineha, Pierce, Rosalie, Weohyakapka, Tiger, Marian, Jackson and Kissimmee.

The upper basin is characterized by numerous lakes ranging in size from a few acres to 54 square miles. The total surface area of these lakes at normal water surface elevations is more than 10 percent of the total area in the upper basin. Lake levels are controlled by a system of canals and control structures.

Modification of the regulation schedule for the upper chain of lakes will provide the necessary storage and regulation schedule modifications to approximate the historical flow characteristics to achieve or exceed the benefits ascribed to the Kissimmee River Restoration. This will provide higher fluctuations of water levels in four lakes (Kissimmee, Hatchineha, Cypress and Tiger) since no structures control the flow of water between these lakes. The water levels are controlled with a single outflow structure at the south end of Lake Kissimmee, S-65 and inflow control by S-61, 63 and 63A. Lake Jackson was removed from the study area since the Florida Game and Fish Water Fish Commission has constructed a structure to allow regulation of Lake Jackson apart from the other lakes. Lake Rosalie was also not included in the study area as a steel sheet pile weir, G-103, partially separates the lake from the canal connecting it with Lake Kissimmee. The natural outlet of Lake Rosalie is Rosalie Creek, a meandering stream at the south end of the lake which discharges into Lake Tiger.

The recommended plan will increase the quantity and quality of the wetland habitat in the upper basin lake littoral zones to benefit fish and wildlife. More natural fluctuations of water levels will enhance the peripheral marshes of the lakes through reducing buildup of organic sediments and will maintain the same level of flood protection as is provided by the existing flood control project.

The recommended plan authorized in 1992 is being reviewed to reduce impacts to residential areas in the lower limits of the backfill. When the H&H modeling is complete, results will be included in future design memorandum and real estate requirements will be reanalyzed.

COMPONENTS OF RECOMMENDED PLAN AND REAL ESTATE INTERESTS REQUIRED

a. Modify the existing lake regulation schedule from 52.5 feet NGVD to 54.0 NGVD to restore the lower basin, Kissimmee River and to expand the upper basin, Lake Kissimmee littoral zone. The operational flexibility to store water to the revised regulation schedule of 54.0 on an "as needed" basis requires acquisition of land in fee or perpetual easements to insure the minimum project requirements are obtained. As a result of the recommended regulation schedule, lands between the existing 52.5 foot regulation schedule and the proposed 54.0 foot regulation schedule will be flooded when necessary to obtain water storage required to meet lower basin and upper basin requirements. Fee is required in agricultural areas where land uses would be detrimental to the environmental benefits being achieved for this project. Fertilization, mowing, chopping, cultivating, and other agricultural practices are not consistent with environmental practices. Fee acquisition or perpetual easements will assure that environmental goals are achieved and that flexibility is available to manage the regulation schedule as necessary to achieve the greatest environmental benefits without impacting flood control. An incremental analysis cannot be prepared for the operational flexibility requirements due to unknown factors and an incremental analysis was not prepared by the Jacksonville District for the environmental benefits. Acquisition of a lesser estate could result in a reduction of real estate costs. However, this lesser estate would not provide real estate requirements for project purposes as determined by the Attorney's Opinion, January 1996.

The following estates are required: fee title; fee title with reservations of riparian rights as well as grazing (beef cattle only); fee title with reservations of riparian rights as well as road access in several parcels; a perpetual flowage easement over the Celebration lands; perpetual conservation/flowage easements in dense residential areas and on State park lands (Three Lakes Management Area and Lake Kissimmee State Park);perpetual conservation/flowage easements with the right to prohibit, remove or fill septic systems in Hatchineha Estates; Water Inundation Easements; and perpetual flowage easements surrounding Lake Tiger where environmental benefits will not be realized in the areas between 52.5 and 54.0 feet impacted by the recommended regulation schedule. Land acquisition of approximately 20,800 acres bordering the four lakes impacted by the increased storage and restoration will be required.

a.1. Fee is recommended in accordance with Draft Chapter 12, ER 405-1-12, and Draft Interim EC 1105-2-206, which states "the use of a real property interest less than fee for any permanent project modification purpose must be approved . . ." Traditional acquisition policy based on hydrologic stage frequencies, will not provide adequate levels of interests in project lands. This is based on an inability of operational flexibility for obtaining and/or increasing the performance of the project environmental outputs. Extending the duration of water storage at the 54-foot regulation schedule will increase wetlands and provide greater environmental benefits in the upper basin as well as providing the necessary flow to achieve environmental restoration of the lower basin. It is hydrologically feasible, and desirable, during future wet years to store water at or near the 54-foot elevation for sustainable periods to achieve greater environmental benefits. The benefits of the environmental outputs cannot be measured quantitatively nor has an incremental analysis been performed. The purpose of this project modification is to attain environmental restoration in the Kissimmee River (lower basin) while providing the same flood protection in the headwaters and attaining environmental benefits in the chain of lakes. The restrictions required to achieve the environmental goals would prohibit fertilizing, chopping, mowing, weeding, and cultivating practices which would render the lands unusable for highest and best use which is agricultural. It is estimated that the appraised value of a Perpetual Conservation/Flowage or Perpetual Flowage Easements on impacted lands would approach fair market value or be tantamount to fee value. Therefore, fee title is recommended to assure operational flexibility and protection of the environmental benefits as outlined in Table 9-1 and 9-2, with lesser estates in some areas where the environmental benefits will be minimal or non-existent. A standard flowage easement does not provide for the restrictions of land use detrimental to the environmental aspects of the upper and lower basins.

a.2. Where reservation of grazing (beef cattle only), riparian and/or road access will not interfere with project purposes, these reservations have been incorporated into the fee estate and coordinated with Fish and Wildlife Service as well as the project sponsor.

b. Canal widening for C-36 and C-37 that connect the affected lakes to flatten the flood profile and prevent increased flood stages. By enlarging these canals the tailwaters of Lake Tohopekaliga and Gentry could be reduced to prevent the need for structural modifications or land interests upstream of Lake Cypress. Dredged material will be placed on the existing canal spoil areas within the adjacent rights-of-way owned in fee and permanent easements by South Florida Water Management

District for operation and maintenance, dredging, fill, and spoil disposal for the existing project. It is anticipated that access to construction areas will be by existing maintenance roads available for the current project. However, should additional access become necessary Temporary Road Access easements will be required during the construction period.

c. Increase outlet capacity at water control structure S-65. Modifications to the existing structure will be needed to reduce higher flood stages in Lake Kissimmee and to provide higher discharge capacity. The increase in outlet capacity will be provided by the addition of two concrete bays on the east side of the existing three bay structure as well as enlarging the exit and entrance channels. Modifications will be within the existing right-of-way owned in fee by South Florida Water Management District and a temporary disposal area will be required. Possible relocation of an existing utility pole may be required; however, relocation will occur within the existing right-of-way, which is owned in fee by the local sponsor and certified for the existing project.

d. It was determined that there are parcels that have septic tanks which will be impacted by the project. Parcels in areas where an onsite cure is permittable and feasible (mounded septic tanks) were appraised using the Water Inundation Easement. Parcels which cannot be cured would be acquired in fee. There are 61 parcels where no onsite cure is permittable or possible in Hatchineha Estates. These parcels were appraised in fee acquisition. A Perpetual Conservation/Flowage Easement will be acquired over approximately 120 of the lots impacted below 54.0 N.G.V.D. If the sewer system alternative is implemented, the 61 lots impacted will also require the Perpetual Conservation/Flowage Easement. This estate will be less restrictive in residential areas to allow property owners to mow and maintain their lawns.

d.1. The COE has studied has studies and proposed an engineering solution in lieu of land acquisition. The construction of a sewer treatment plant was recommended for Hatchineha Estates as a result of the engineering study and if constructed will be a non-Federal responsibility. A perpetual conservation/flowage easement with the right to prohibit existing and future septic tanks, and the right to fill and remove exiting septic tanks, as well as a release will be acquired from landowners required to participate in the hookup to the recommended sewer treatment plant. Should the sewer treatment plant alternative be implemented credit to the sponsor for LERRD's will be set at a fixed ceiling of the COE estimate for construction as the "cost to cure" in lieu of fee acquisition of the impacted tracts. See Compensation for Impacted Residential Septic Systems, page H-14.

e. Breaching of existing local levees. Lands up to the 54-foot contour will be periodically reflooded with the implementation of the recommended regulation schedule. Throughout Lakes Kissimmee, Hatchineha and Cypress, several farm levees were constructed by private landowners. Plate 8-1, Project Plan Plate, shows the location of these levees. Three were identified by the USFWS in their Coordination Act Report and two more were identified later in the study. These levees have encroached upon the historic lake littoral zone, separating the large, historic, lake bottom marshes from the lakes. In each case, either drainage canals or pump stations are in place to drain surface water run-off into the adjacent lake.

e.1. It has been determined in an engineering analysis that the levees would not provide adequate protection for lands behind the levees which will be inundated as part of the project requirements for water storage. These lands are not considered a separable project area; therefore, an incremental analysis was not prepared. While a quantitative environmental incremental analysis was not performed, a modified qualitative analysis was prepared which describes the potential for increases in environmental performance for the recommended lake regulation schedules.

e.2. Lands behind the five levees are required for water storage to meet the restoration requirements for the Lower Kissimmee River Basin and, as an incidental benefit will provide additional areas for environmental enhancement in the Upper Basin. The removal of these levees will provide full storage capacity required for maintenance of the existing flood control project and for environmental restoration and benefits. The removal or partial removal of the levees will enhance the hydroperiod on the interior portions of the property presently being protected by the levees, allowing for expansion of the lake littoral zone of the upper basin. The levees will be breached at a minimum of 100 foot gaps every one thousand feet along the levee alinement. This alternative would be less expensive than degrading the entire levee, and would provide areas for upland habitat to remain.

e.3. An analysis was performed to demonstrate the cost effectiveness of breaching the levees. Table 7-6 describes the levees and analysis based on the value of wetlands and the habitat value outputs as detailed by the USFWS in their Coordination Act Report. Breaching of the levees would restore an additional 1,350 acres of marsh for a total additional littoral marsh of 7,236 acres. Fee acquisition is recommended behind these levees to assure availability for operational flexibility and protection of the environmental outputs. No interest is required in lands below 52.5 feet which are subject to navigation servitude. These lands were protected from inundation only by the privately constructed levees.

f. The lands north of Lake Hatchineha known as Celebration lands (Walker Ranch) are owned by the Celebration Company a subsidiary of the Disney Corporation as mitigation lands for other lands of the Celebration Company and other subsidiaries of the Disney Corporation. The conditions of a Department of the Army permit and Department of Environmental Protection Permit issued December 1992, required the Celebration Company to purchase these lands in fee for mitigation purposes. The lands are to be managed by the Nature Conservatory, a non-profit corporation with fee title being conveyed to the Nature Conservatory in stages. The permit also required the Celebration Company to convey a Perpetual Conservation Easement to the State, South Florida Water Management District, Florida Game and Freshwater Fish Commission, and the Nature Conservation. The Celebration Company conveyed a perpetual conservation easement dated December 22, 1992 to the Nature Conservatory, the South Florida Water Management District, the Florida Game and Fresh Water Fish Commission and the State of Florida Department of Environmental Regulation. This easement restricts the use of the property for environmental purposes. The additional right to flood, flow and store water on the property for flood control purposes is required for the Kissimmee Headwater Revitalization Project; therefore, a Perpetual Flowage Easement is recommended for the Celebration lands.

g. Approximately 5,986 acres of land below 52.5 feet NGVD, located between Lakes Cypress and Kissimmee were previously made available for the existing Flood Control Project by Perpetual Flowage Easements. These lands are now required in fee to support the operational flexibility of the schedule and environmental restoration purposes of the project. The lands are upland and surrounded by elevations exceeding 52.5 feet NGVD. These lands have been determined not to be subject to navigation servitude as they are not hydrologically connected to the lakes. With the increase in regulation schedule and inundation of these as well as surrounding lands to 54.0 feet, it is now necessary to include these lands in acquisition of fee for the water storage requirements and to comply with environmental restoration of the project. The valuation will be for the difference between the value of interest previously provided and the value of the required fee estate.

GOVERNMENT-OWNED LAND IN PROJECT AREA

Three Lakes Management Area and Lake Kissimmee State Park:

The portion of Three Lakes Management Area that is within the project consists of 1,261.51 acres and is owned in fee by the State of Florida. Lake Kissimmee State Park is also owned in fee by the State of Florida and contains approximately 472.20 acres within the project area. It has been determined based on conclusions in the Attorney's Opinion dated January 1996, that Perpetual Conservation and Flowage Easement are recommended for acquisition in these areas. Existing uses of the lands and management practices by the Trustees of the Internal Improvement Fund (State of Florida) are not available for flood control nor environmental benefits between the 52.5 and 54.0 foot contours.

APPRAISAL INFORMATION

A Gross Appraisal Report was prepared by the South Florida Water Management District in cooperation with the Jacksonville District, Real Estate Division. This gross appraisal covered the areas discussed in this report has been approved. The following information was extracted from this report.

The Kissimmee River Headwaters Revitalization Project, (now referred to as the Kissimmee River Project), consisting of the necessary structural and operational modifications, will increase the highest regulation pool in four headwater lakes (Kissimmee, Hatchineha, Cypress, and Tiger) from elevation 52.5 to elevation 54 feet. The project area extends from approximately 12 miles south of the City of Kissimmee to structure S-65 at the south shore of Lake Kissimmee.

Environmental benefits will be realized in the upper basin as a result of enlarged littoral zones in Lakes Kissimmee, Cypress, and Hatchineha. Modification of the regulation schedule for the upper chain of lakes will restore the ability to simulate the historic seasonal flow from Lake Kissimmee to the lower basin (along the Kissimmee River southward to Lake Okeechobee) and provide higher fluctuations of water levels.

Property types in the area are generally restricted to agricultural use (mostly cattle grazing, some row crop, sod and citrus), ranchette subdivision, mobile home parks, single family residential and limited commercial use. See land use maps located at Plate 4-2.

Population in the area is small with most residential development being situated around the lakes. The predominate land use is and will be for some time, agricultural -- including cattle ranching, citrus production and sod farming. Land values have remained stable over the past few years. There are no incorporated areas within the neighborhood.

Much of the area's development is related to fishing and boating. All of the lakes in this area are connected by canals or creeks. Lake Kissimmee and upper chain of lakes form the first link in South Florida's massive watershed, which also includes Lake Okeechobee and the Everglades. This hydrologic system is the source of fresh water for the underground Biscayne Aquifer which serves South Florida.

In conclusion, the neighborhood consists of the rural areas of eastern Polk County and west Osceola County located in close proximity to the Kissimmee Chain of Lakes. This area is east of the developed portions of Polk County and south of the municipalities of Kissimmee and St. Cloud. The area is agricultural in nature and is sparsely populated.

Highest and Best Use: The highest and best use for most of the subject properties was considered to be for continued agricultural and recreational uses.

Agricultural/Commercial: Most of the properties are utilized for agricultural purposes, primarily for grazing, and have been for years. These are owner/operated ranches specializing in cow/calf operations with sod production and hunting leases as side operations. The wetlands and uplands have been valued similarly as equally productive. Current uses require use of both wetland for access to the water and the uplands for cattle grazing, sod farming, hunting, etc. The dual land uses are equally productive and therefore valued similarly. If another use was in transition, the wetlands may be less valuable.

Residential: The highest and best use for those subject properties containing at least five acres or located within platted subdivisions was considered by the individual appraisers to be for continued single family residential development. For those properties containing less than five acres and not being a "lot of record" by Polk County prior to May 1, 1991, the highest and best use was considered for assemblage to an adjacent, larger parcel having single family development potential.

RELOCATION ASSISTANCE (PUBLIC LAW 91-646, AS AMENDED BY PUBLIC LAW 100-17)

Under this project there is an estimated total of 123 residences and eight (8) commercial businesses affected under Public Law 91-646. This total includes the 61 parcels impacted at Hatchineha Estates which will be require relocation if the septic system alternatives are not implemented. Of the 123 residences, approximately 50 are permanent residence trailers to be relocated which would qualify for full relocation benefits as real property.

Estimates of costs to comply with Public Law 91-646 total $2,970,000.00. This figure represents an average payment of $23,500 for each of the 123 residential acquisitions homes for a total of $2,890,000.00 and $10,000 for each of the 8 commercial acquisitions for a total of $80,000. These payments allow for expenses incurred for recording fees, transfer taxes and costs for prepayment of pre-existing mortgages incident to conveying real property to the Sponsor. Also included in this figure, for residences, are the costs associated with providing displaced persons with comparable decent, safe and sanitary housing.

AVAILABILITY OF REPLACEMENT HOUSING

An Availability of Housing Survey was performed by South Florida Water Management District and indicates that there is sufficient decent, safe and sanitary replacement housing for persons affected under the project. The Local Sponsor will document with a written report on specifics of available housing.

ACQUISITION/ADMINISTRATIVE COST ESTIMATES

Estimates of project acquisition/administrative costs for both the Local Sponsor and the Federal Government are explained below. South Florida Water Management District provided cost estimates for the non-Federal costs.

Based on South Florida Water Management District's experience, it is estimated that 20% of the total parcels to be acquired will result in condemnation, refer to Exhibit C. The ownership data used in calculating the acquisition/administrative costs includes a total of 344 ownership tracts.

Based on the above data, the estimated Federal acquisition/administrative costs (rounded) are as follows:

Project Planning	$ 100,000
Review of Acquisitions (344 x $500)	172,000
Condemnations by Govt on behalf of L.S. (68 x $30,000)	2,040,000
Review of Appraisals (344 x $300)	102,000
Review of PL 91-646 Assistance (123 x $540)	66,000
Review of Temporary Permits (344 x $100)	34,000
Total Federal Acquisition/Administrative Cost	$2,514,000

Applying the unit costs provided by the Local Sponsor for this project, the estimated non Federal acquisition/administrative costs (rounded) are as follows:

Acquisitions: 287 x $ 6,000 =	$1,722,000	
12 x 8,000 =	96,000	
45 x 24,275 =	1,092,000	
Total Acquisition Cost		$2,910,000
Condemnations (administrative preparations)	150,000	
Appraisals:		
Administrative Costs (Review, etc.):		
287 x 1,000 =	$287,000	
12 x 5,000 =	60,000	
45 x 7,460,000 =	336,000	
	683,000	
Appraisal (contract costs)		484,000
Title (policies)		202,000
Total Appraisal Cost		$1,369,000
PL 91-646 Assistance (131 x $3,200)		393,000
Temporary Permits		100,000
Damage Claims		10,000
Environmental Audits (contract)		403,000
Total Non-Federal Acquisition/Administrative Cost		$5,335,000

RELOCATIONS, STRUCTURES, AND FACILITIES

There are no known relocations of public facilities to be affected by the upper basin portion of the Kissimmee River Project although there is a possibility of a utility pole relocation required at S-65. It is presumed at this time that the existing rights-of-way are sufficient to support any relocations that may arise, together with the fee lands to be acquired adjacent to the current project right-of-way. If the utility pole relocation is required outside the existing right-of-way, a relocations plan will be prepared and real estate addressed at that time.

NON-FEDERAL OPERATION/MAINTENANCE RESPONSIBILITIES

The South Florida Water Management District, as the Local Sponsor of the projects, will operate and maintain during life of the project at 100% local cost, pursuant to the directions and guidelines of the United States Government.

NON-FEDERAL AUTHORITY TO PARTICIPATE IN THE PROJECT

The South Florida Water Management District was created by virtue of Florida Statutes, Chapter 373, Section .069. The South Florida Water Management District was created to further the State policy of flood damage prevention, preservation natural resources of the State, including fish and wildlife, and to assist in maintaining the navigability of rivers and harbors. (There are other enumerated purposes, but they are not directly applicable to this project.) The South Florida Water Management District is specifically empowered to "Cooperate with the United States in the manner provided by Congress for flood control, reclamation, conservation, and allied purposes in protecting the inhabitants, the land, and other property within the district from the effects of a surplus or a deficiency of water when the same may be beneficial to the public health, welfare, safety, and utility". (Section 373.103)

To carry out the above purposes, the South Florida Water Management District is empowered to "...hold, control, and acquire by donation, lease, or purchase, or to condemn any land, public or private, needed for rights-of-way or other purposes, and may remove any building or other obstruction necessary for the construction, maintenance, and operation of the works; and to hold and have full control over the works and rights-of-way of the district". The term "works of the district" is defined by Section 373.019 to be "those projects and works, including, but not limited to, structures, impoundments, wells, and other water courses, together with the appurtenant facilities and accompanying lands, which have been officially adopted by the governing board of the district as works of the district". Section 373.139 specifically empowers the South Florida Water Management District "...to acquire fee title to real property and easements therein by purchase, gift, devise, lease, eminent domain, or otherwise for flood control, water storage, water management, and preservation of wetlands, streams and lakes, except that eminent domain powers which may be used only for acquiring real property for flood control and water storage".

The eminent domain power is potentially limited to the above cited purposes and a resort to Federal acquisition might be required if it is construed that South Florida Water Management District's power is limited to the above cited purposes (flood control, water storage or district works). The question essentially becomes whether the governing board's adoption of the project as a district works allows use of its eminent domain powers under Section 373.086 or whether the project is for flood control and/or water storage purposes. The restoration project provides for water storage in the historic flood plain and continues the flood control capabilities of the project with non-structural features having been substituted for structural.

The Corps of Engineers was requested by letters from South Florida Water Management District dated September 1, 1994, and Governor Lawton Chiles dated November 23, 1994, to acquire interests in land needed for the project as agent for the South Florida Water Management District where it has been determined that such interests must be acquired through the filing of eminent domain actions. By letter dated January 6, 1995, Deputy General Counsel (Civil Works and Environment) Earl Stockdale advised that the Corps will perform the requested land acquisitions on the sponsor's behalf only for those lands and real estate interests needed for the Federally authorized project. Upon approval of this report, the Corps of Engineers, Jacksonville District and the South Florida Water Management District will enter into a condemnation agreement delineating the parties' responsibilities in this area.

South Florida Water Management District's Real Estate Division has extensive acquisition experience and has acquired 80 percent of the lands needed for the project and is currently acquiring the remaining lands. South Florida Water Management District is budgeting to acquire the balance of the lands.

ENGINEERING ALTERNATIVES FOR IMPACTED RESIDENTIAL SEPTIC SYSTEMS

Hatchineha Estates and Grape Hammocks subdivisions are residential areas where on-site septic tanks will be impacted by the increase in groundwater levels as a result of the increase in regulation schedule to 54.0 NGVD. All septic tanks located with top of tank below the 56-foot elevation must be replaced with mounded septic tanks or if onsite cure is not possible, be acquired in fee. An engineering analysis was completed by the Jacksonville District of several alternatives.

The results of this analysis indicated the most viable, cost effective alternative for Hatchineha estates construction of a sewer treatment plant. There are approximately 306 lots in Hatchineha Estates with an estimate of 61 impacted with no means of an onsite cure. This subdivision consists of waterfront lots situated on man-made canals, and 150-foot setbacks cannot be achieved. In addition, there are no vacant lots where off-site mounded systems could be placed. These septic systems do not meet current permitting criteria, but were "grandfathered" in for zoning purposes because they were built long before the zoning laws were developed.

Construction of a sewer system has been determined to be the feasible alternative to land acquisition as a least cost alternative for Hatchineha Estates. The non-Federal sponsor has indicated a preference to construct a sewer system in lieu of acquisition and further analysis of the alternative will be performed and a decision made prior to submission of a feature design memorandum for this area. In the event that a sewer system is constructed, the Perpetual Conservation/Flowage Easement would be acquired for lands between the 52.5 and 54.0 foot contours to support project purposes and would prohibit existing and future septic tanks as well as a release will be acquired from owners required to participate in the hookup to the system.

The estimated construction cost including construction, supervision and inspection and contingencies is $2,834,000 for the residences impacted versus estimated real estate costs of acquisition, 91-646 relocation, administration and contingencies totalling $9,260,000. The construction cost estimate is based on a Jacksonville District Corps of Engineers analysis. The sponsor will receive credit for fee acquisition if the sewer treatment system is not implemented. The project sponsor may receive LERRD's credit as a "cost to cure" if the sewer treatment system is implemented, with a maximum set at the COE estimate for construction of the sewer treatment plant .

Parcels with septic tanks in Grape Hammock which can be cured by relocating on existing property with mounded septic tanks required a Water Inundation Easement. These ownerships include four impacts lots which can be cured by onsite mounded systems. These lots were also considered damaged due to relatively large land area required for the mounded systems and associated loss of use.

The remaining impacted lots in Grape Hammocks, Shady Oaks, and Rocks Fish Camp will require either fee acquisition (if they cannot be cured onsite), Perpetual Conservation/Flowage Easements or Water Inundation Easements (for the onsite mounded systems).

HAZARDOUS AND TOXIC WASTES (HTW)

A Civil Work Audit of Property Impacted by the upper basin portion of the Kissimmee River Project was performed by the Jacksonville District and a report dated February 24, 1995 indicated that there is no contamination evident in the lands being acquired for the project in the upper basin. A report from the South Florida Water Management District received in the interim indicates that two cattle dipping vats are located on lands being acquired. These lands will be cleaned prior to certification of lands under the State of Florida "amnesty" program at the expense of the landowner or the sponsor. This effort will be closely coordinated with the Jacksonville District to assure compliance with the CERCLA regulations. The sponsor is preparing a Remediation Plan for completion in mid-January which will be closely coordinated with the Jacksonville District and the Florida Department of Environmental Protection. Cleanup costs will be borne by the landowner or the sponsor and will not be project costs.

The relocation of electrical structures will be accomplished on existing project lands. PCB's have been phased out from the Corps of Engineers projects. In recent years, Corps of Engineers scopes of work have included in the project specifications requirements for contractors to remove all hazardous wastes generated during construction. Cleanup costs, if PCB's were discovered, would be at the sponsor or electrical companies expense and will not be project costs.

RECREATION LANDS

There are no known separable recreation lands included within project lands. Recreational development on project lands will be within the fee taking boundary which will preclude requirements for additional estates.

OUTSTANDING RIGHTS

Known outstanding rights include easements for roads, power lines and communications cables.

MINERAL RIGHTS

Based on South Florida Water Management District's experience to date, there is a minimal amount of outstanding mineral rights in the project area. These mineral rights will be acquired by the Local Sponsor to the greatest extent possible.

TIMBER/VEGETATIVE COVER

Proposed acquisition of lands for project implementation will not consist of any area which will include standing timber or other vegetative cover that has significant recreation or scenic value, therefore, there will be no reservation of standing timber for the proposed acquisition. Standing timber has been determined to have no merchantable value.

TOWNS AND CEMETERIES

There are no known towns or cemeteries located within the project area.

CULTURAL RESOURCES

A Cultural Resource Study for the project area has been completed. The results of this study will be used to develop a plan should any areas be found in the lands required for the project. (See also paragraph 4.13 CULTURAL RESOURCES.)

ESTIMATED COST OF LANDS, EASEMENTS, RIGHTS-OF-WAY AND RELOCATIONS (LERR) FOR THE PROJECT

The following is a summary of estimated real estate costs for subject project.

1. Lands and Damages
Lands (20,807.54 acres total)

<u>Agricultural Lands</u>

Fee Simple: 18,375.01 acres	$ 22,827,000
Temporary Disposal Easement: 10.00 acres	28,000
Perpetual Conservation/Flowage Easement: 1,922.88 acres	1,303,000
Improvements:	0
Severance Damages:	3,633,000
Total Lands and Damages (Rounded)	$ 27,800,000

Commercial Lands	
Fee Simple:	
247.29 acres	$ 1,462,000
Perpetual Conservation/Flowage Easement:	
9.04 acres	44,000
Improvements:	2,437,000
Severance Damages:	857,000
Total Lands and Damages (Rounded)	$ 4,800,000
Residential Lands	
Fee Simple:	
51.66 acres	$ 1,648,000
Perpetual Flowage/Inundation Easement:	
191.66 acres	2,045,000
Water Inundation Easement:	
4 ownerships	28,000
Perpetual Conservation/Flowage Easement:	
120 ownerships	82,000
Improvements:	3,876,000
Severance Damages:	4,000
Total Lands and Damages (Rounded)	$ 7,700,000
TOTAL LANDS AND DAMAGES	$40,300,000
2. Acquisition-Administrative costs	
Federal	2,514,000
NonFederal	5,335,000
3. Public Law 91-646	2,096,000
4. Contingencies: 40% (Rounded)	20,098,000
Total Estimated Real Estate Costs	$ 70,343,000

* CONTINGENCIES: A 40% contingency is recommended to be used in connection with this project. Typically, a real estate contingency factor of 25% is added to the total real estate project cost, to cover uncertainties associated with elements such as valuation variance, negotiation latitude, condemnation awards and interest, and refinement of boundary lines during ownership verification. For this report, a contingency factor of 40% has been applied. The contingency is higher due to the magnitude of the project area, limited information available in some areas, the lack of boundary lines in some dense residential areas, unknown costs to be determined during refinement of boundary surveys, final decision on septic tank alternative, the potential for condemnation awards exceeding the number anticipated, and resulting legal issues including sovereign lands and other potential requirements to be determined during refinement of the project in preparation of contracts. Real estate requirements will be reanalyzed during preparation of the Feature Design Memoranda for each segment of the project.

REAL ESTATE ACQUISITION SCHEDULE

The majority of project lands for the upper basin portion of the Kissimmee River Project are scheduled to be acquired by January 1, 1996, with any exceptions being condemnations which may be required for the upper basin. This schedule and Real Estate Supplement has been coordinated with South Florida Water Management District.

Certificates of title, individual tract appraisals, and land surveys will be accomplished by the Local Sponsor and monitored by the Corps of Engineers. Condemnations will be performed by the Corps of Engineers on behalf of the local sponsor.

ATTITUDE OF LANDOWNERS

The Project Modification Report was coordinated with the South Florida Water Management District who has held public meetings with landowners potentially being impacted by the implementation of the project. It has also been coordinated with other agencies, including the Fish and Wildlife Service. The attitudes of the landowners in the upper basin have been varied. The residents are generally receptive, with several expressing concerns for the detrimental impacts to their land use. In areas where less restrictive easements could be utilized without detrimental impact to the environmental benefits, the non-standard estates were developed to meet the needs of the public as well as the landowners.

ESTATES TO BE ACQUIRED

STANDARD ESTATES:

1. Fee Title:

The fee simple title to (the land described in Schedule A) (Tracts Nos. _____, and ____), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

2. Flowage Easement (Permanent Flooding): (To be used on the Disney Celebration Lands)

The perpetual right, power, privilege and easement permanently to overflow, flood and submerge (the land described in Schedule A) (Tract No. ____ and ____) in connection with the operation and maintenance of the Kissimmee River, Florida Project as authorized by the Act of Congress (Public Law 103-126) and the Water Resources Development Acts of 1988 and 1992, and the continuing right to clear and remove any brush, debris and natural obstructions which in the opinion of the Grantee, may be detrimental to the Project, together with all right, title and interest in and to the structures, improvements situate on the land; provided that no structures for human habitation shall be constructed or maintained on the land, that no other structures shall be constructed or maintained on the land except as may be approved in writing by the Grantee, and that no excavation shall be conducted and no landfill placed on the land without such approval as to the location and method of excavation and/or placement of landfill; the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the project for the purposes authorized by Congress or abridging the rights and easement hereby acquired, provided further that any use of the land shall be subject to Federal and State laws with respect to pollution.

3. Temporary Disposal/Borrow Area Easement

A temporary assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. ____, ____, and ____), for a period not to exceed ________, beginning with date possession of the land is granted to the Grantee, for use by the Grantee, its representatives, agents, and contractors as a (borrow area) (work area), including the right to (borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the Kissimmee River, Florida Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

4. Temporary Access Road Easement

A temporary assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. ___, ___ and ___), for a period not to exceed ________, beginning on the date possession of the land is granted to the Grantee, for the location, construction, operation, maintenance, alteration and replacement of (a) road(s) and appurtenances thereto by the Grantee, its representatives, agents and contractors; together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstruction and other vegetation, structures, or obstacles within the limits of the right-of-way; (reserving, however, to the owners, their heirs and assigns, the right to cross over or under the right-of-way as access to their adjoining land at the locations indicated in Schedule B); 5/ subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

NON-STANDARD ESTATES:

5. Fee Reserving Riparian Rights and Reserving Perpetual Road Easement

(To be used only where acquisition of property cuts off access to remaining property of grantor)

The fee simple title to (the land described in Schedule A) (Tracts Nos. _, _ and _), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving unto Grantor, his heirs, successors and assigns, a perpetual easement for ingress and egress, over and through the property, to the waters of Lake(s) (Kissimmee, Cypress, Hatchineha, Tiger) abutting the property for the benefit of remaining contiguous property presently owned by Grantor for the purpose of exercising only the following rights to said waters: access to the water, the right to navigate, and fish. The reserved rights enumerated herein are restricted to non-commercial uses, and are subject to any and all federal, state, or local laws and rules relating to the use of the property including obtaining any permits which may be required thereby and are subordinate to the right of the Grantee, its successors and assigns to flood and submerge the land, at any time, in connection with the construction, operation and maintenance of the Kissimmee River, Florida Project. Use or access to said waters by Grantors, its agents, guests, or invitees of the Grantor, its successors and assigns, for the benefit of remaining contiguous property is permitted provided Grantor does not charge a fee therefor and the Grantor shall not exclude the public from use of the property.

Also reserving to the Grantor, his heirs, successors and assigns, a perpetual access road easement along the existing roadway as depicted on Exhibit " " attached hereto and made a part hereof, for ingress and egress over and across the property described herein to the remaining contiguous property presently owned by the Grantor, provided however that the right of access for ingress and egress is subordinated to the right of the Grantee, its successors and assigns to flood and submerge the land in connection with the construction, operation and maintenance of the Kissimmee River, Florida Project. The Grantee shall not be obligated to maintain said access road easement. Grantor may raise the existing road, at its sole cost and expense, only upon the written permission of the Grantee and provided that such raising does not interfere with the authorized purposes of the Kissimmee River, Florida Project. Provided, further, however, that the Grantee reserves the right to reasonably approve the size and placement of culverts in and elevations of the elevated road and that any elevation of the surface of the road will not impede the surface flow of water in any direction.

6. Fee Reserving Riparian and/or Grazing Rights

The fee simple title to (the land described in Schedule A) (Tracts Nos. _, _ and _), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving unto Grantor, their heirs and assigns, a perpetual easement for ingress and egress, over and through the property, to the waters of Lake (Kissimmee, Cypress or Hatchineha) abutting the property for the benefit of remaining contiguous property presently owned by Grantor for the purpose of exercising only the following rights to said waters: access to the water, the right to navigate, fish, and bathe. The reserved rights enumerated herein are restricted to non-commercial uses, and are subject to any and all federal, state, or local laws and rules relating to the use of the property including obtaining any permits which may be required thereby and are subordinate to the right of the Grantee, its successors and assigns to flood and submerge the land, at any time, in connection with the construction, operation and maintenance of the Kissimmee River, Florida Project. Use or access to said waters by Grantors, its agents, guests, or invitees of the Grantor, its successors and assigns, for the benefit of remaining contiguous property is permitted provided Grantor does not charge a fee
therefor and the Grantor shall not exclude the public from use of the property.

Also subject to a reservation in favor of the Grantor reserving the right to possess and occupy the property for the purpose of grazing cattle (beef cattle only), however, such right is subordinated to the right of the Grantee, its successors and assigns to flood and submerge the land, at any time, in connection with the construction, operation and maintenance of the Kissimmee River, Florida Project.

7. Perpetual Flowage: (To be used on Lake Tiger)

The perpetual right, power, privilege and easement to regularly or at any time and for any length of time to overflow, flood and submerge the land described on Schedule A, Tract Nos. ____ ____ and ______ in connection with the operation and maintenance of the Kissimmee River, Florida Project, as authorized by Public Law 103-126 and the Water Resources Development Acts of 1988 and 1992, together with all right, title and interest in and to the timber, structures and improvements situate on the lands, except (here identify those structures not designed for human habitation) and providing that no structures shall be constructed or maintained on the land except as may be approved in writing by the representative of the Grantee in charge of the Project, and further that the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the Project for the purposes authorized by Congress or abridging the rights and easement hereby acquired.

8. Perpetual Conservation and Flowage Easement (Permanent Flooding): (To be used on Lake Kissimmee State Park and Three Lakes Management Area [State Lands] and in Residential Areas) (the language in bold will be inserted in those deeds in areas (Hatchineha Estates) where the existing septic systems can not be raised and a sewer system is being installed to provide an alternative to septic systems and the landowner is not willing to voluntarily attach to the sewer facilities and will be used in Hatchineha Estates -the other 120 lots where septic tanks are not impacted by the project but which hook-up to the sewer system)

The perpetual right, power, privilege and easement permanently to overflow, flood and submerge the land described on Schedule A, Tract Nos. ____ ___ _____ in connection with the operation and maintenance of the Kissimmee River, Florida Project, as authorized by Public Law 103-126 and the Water Resources Development Acts of 1988 and 1992, and the continuing right to clear and remove any brush, debris and natural obstructions which, in the opinion of the representative of the Grantee in charge of the Project, may be detrimental to the Project, together with all right, title and interest in and to the timber, structures and improvements situated on the lands, and provided that no structures and improvements shall be constructed or maintained on the land; and provided that the Grantor is prohibited from constructing, operating or maintaining any existing or future septic system on the remaining contiguous land of the Grantor described on Schedule B, and that the grantee may enter onto the remaining contiguous land of the Grantor described on Schedule B to fill in or remove any existing septic system or to take other action to render the septic system inoperable; and further that the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the Project for the purposes authorized by Congress or abridging the rights and easement hereby acquired; the Grantor is expressly authorized to use said real property as a native pasture for grazing purposes (beef cattle only) in accordance with sound, generally accepted agricultural practices; provided further that any use of the land shall be subject to federal, state and local laws with respect to pollution and provided further that no fertilizers or chemicals of any kind or description are used, spread or distributed on the aforesaid property.

In addition to the restrictions set forth above, the following shall be prohibited except with the express written permission of the Grantee:

(a) The placement or construction of docks, dikes, pilings, boathouses, piers or any water control activities.

(b) Dumping or place of soil or other substance or material as landfill or dumping or placing of trash, waste, unsightly or offensive materials, or excavation, dredging, removal of loam, soil, peat, gravel, rock or other substance or material of any type.

(c) Removal or destruction of trees, shrubs or other vegetation. This includes mowing or aerating land or earth moving activities of any kind.

(d) Dairy operation of any type will not be permitted.

The Grantor reserves the right to construct fences at any location on the above described property of any nature whatsoever, so long as they do not impede the flow of water or affect the quantity of water that may be stored on the property and provided that no fences are constructed parallel to the shore of the lakes below elevation 52.5 feet N.G.V.D. The Grantee shall not have any responsibility to monitor, maintain or replace all or any portions of the fence.

9. **Water Inundation Easement (Structures Remain):** (to be used in areas where the existing septic system can be raised)

The perpetual right, power, privilege and easement permanently to flood and inundate with water to ground elevation ______NGVD the land described in Schedule A (Tracts ______) in connection with the operation and maintenance of the Kissimmee River, Florida Project as authorized by Public Law 103-126 and the Water Resources Development Acts of 1988 and 1992; provided that no structures for human habitation shall be constructed or maintained on the land and provided further that no existing or future septic system or other structures shall be constructed, operated or maintained on the land which requires ground water elevation below 56 feet NGVD; the above estate is taken subject to existing public easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the project for the purposes authorized by Congress or abridging the rights and easement hereby acquired.

10. Utility and/or Pipeline Easement: (To be used for installation of sewer pipelines-Easement from County)

A perpetual and assignable easement and right-of-way in, on, over, across and under (the land described in Schedule A) (Tract Nos. ___ and ___) for the purpose of locating, constructing, excavating, operating, maintaining, altering, repairing, and replacing of underground wastewater sewer facilities and pipelines; together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions and other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowner, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject , however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

11. Perpetual Flowage/Inundation Easement: Alternative Estate to Perpetual Conservation and Flowage Easement: (to be used in areas where the existing septic system can not be raised and sewer system is being installed to provide alternative to septic tanks and landowner will not willingly attach to sewer facilities) Easement should encompass entire property of Grantor-Full legal description of all Grantor's property including lands above 54.0 feet.

The perpetual right, power, privilege and easement permanently to flood and inundate with water to ground elevation 54 feet NGVD; the land described in Schedule A (Tracts ______) in connection with the operation and maintenance of the Kissimmee River, Florida Project as authorized by Public Law 103-126 and the Water Resources Development Acts of 1988 and 1992; provided that no structures for human habitation shall be constructed or maintained on the land below ground elevation 54 feet NGVD; **and provided, further, that the Grantor is prohibited from constructing, operating or maintaining any existing or future septic system on the land; and provided further that the Grantee may enter onto the land to fill in or remove any existing septic system or to take other action to render the septic system inoperable**; the above estate is taken subject to existing public easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the project for the purposes authorized by Congress or abridging the rights and easement hereby acquired.

12. Release (for use where landowner agrees to connect to wastewater sewer utility)

The South Florida Water Management District is the local sponsor for the operation and maintenance of the Kissimmee River, Florida Project (the "Project"), as authorized by Acts of the United States Congress as authorized by Public Law 103-126 and the Water Resources Development Acts of 1988 and 1992. The Project includes raising water levels in the Kissimmee River and the Kissimmee Chain of Lakes, including lake ___________ to elevation 54.0 feet NGVD.

The use of a septic system for wastewater disposal service to Owner's property, as legally described in the attached Exhibit "A", incorporated herein by reference (hereinafter "Owner's Property"), will adversely impacted by the Project.

The South Florida Water Management District has provided the Owner access to a wastewater sewer utility system to service Owner's Property in lieu of Owner's use or operation of any existing or future septic system.

In consideration thereof, Owner hereby releases the South Florida Water Management District, the State of Florida, and the United States of America and their successors and assigns, from any claim, loss, damage, demand, cost, including attorney's fees, expense, cause of action, or judgment (hereinafter collectively "claim") which Owner now has or may hereinafter have in perpetuity with regard to impacts of the Project on Owner's use or operation of any existing or future septic system on Owner's Property.

Owner further shall not install a septic system or use any existing septic system on Owner's Property. The district may enter onto Owner's Property to fill in or remove any existing septic system or to take other action to render the septic system inoperable.

JUSTIFICATION FOR REAL ESTATE INTERESTS RECOMMENDED

In accordance with ER 405-1-12, a permanent flowage easement would normally be required for flooding lands between the 52.5 and 54.0 foot contours for flood control purposes. However, in the Draft Chapter 12, ER 405-1-12 as well as EC 1105-2-206, fee title is required for environmental, fish and wildlife mitigation, projects. Acquisition of approximately 20,800 acres of land bordering the three lakes and Lake Tiger is recommended to provide the necessary storage requirements for the Lower Kissimmee River Basin and expansion of the Upper Kissimmee Basin wetlands. The recommended plan is expected to at least achieve and probably exceed the environmental benefits to the Kissimmee River Restoration Project. Approximately 7,236 acres of littoral wetlands will be realized by implementation of the proposed regulation schedule. Operational flexibility in the regulation schedules is required to incorporate flexible management strategies to meet or exceed the varying and unforeseen needs of both the Kissimmee River Upper and Lower Basins. The Government needs to right to adjust the schedule for frequency, depth (not to exceed the 54.0 foot regulation schedule) and duration at any time for any length of time. In addition, the fee title acquisition will allow greater environmental outputs for the restoration project in both the lower and upper basins. These benefits will be achieved by providing a wider range between high and low water levels in the upper basin. The tables provided at 9-1 and 9-2 indicate the environmental outputs to be realized. An incremental analysis was not prepared to indicate qualitative environmental outputs. An real estate incremental analysis was also not prepared. The acquisition of less than the recommended estates could result in reduction in land costs. However, a lesser estate would not provide the real estate requirements of the project for, not only the environmental benefits, but the operational flexibility. The reduction in real estate costs now could result in higher costs in the future to re-evaluate the schedule and discharges for adjustments and resulting acquisition of additional interests to provide for operation of the regulation schedule. A lesser estate would also not be consistent with the environmental restoration purposes of this overall project.

The fee acquisition is required to meet the project requirements. The real estate analysis has been prepared consistent with level of detail of remainder of the elements of this study. The Attorney's Opinion dated January 1996, concludes that the fee acquisition is necessary in cited areas to achieve the operational flexibility and environmental enhancements of the recommended plan. Referenced opinion also supports the following recommendations of estates to be acquired.

The Perpetual Conservation/Flowage easements are recommended in densely populated areas where environmental benefits will be realized by permitting landowners to retain ownership of their property with restrictions to prohibit activities on easement lands that would be detrimental to or interfere with the Federal project. This will include Hatchineha Estates located on Lake Hatchineha and the State Park lands which are not protected nor managed to provide protection for environmental restoration or benefits to be obtained by the new regulation schedule.

The Perpetual Flowage Easement is recommended for lands surrounding Lake Tiger and for the Celebration mitigation lands. A Takings analysis was prepared for the Lake Tiger area. Impacts of flooding of these lands will be significant and the estate was drafted based on the standard flowage easement with additional restrictions to prohibit activities not consistent with project purposes. The environmental benefits for Lake Tiger are very minimal. The primary economic impact is to lands used for grazing. Therefore, a lesser estate is recommended for project purposes. Lake Tiger is connected to Lake Kissimmee through Tiger Creek, a small meandering natural stream. Since Lake Tiger and Lake Kissimmee are at essentially the same natural ground elevation and since no water control structure is currently installed on Tiger Creek, the peak flood stages for the two lakes are intrinsically linked and are nearly identical for floods above elevation 54 feet. Outside of isolating Lake Tiger and installing a substantial pump station, there is no structural alternative to insure that Lake Tiger with-project stages can be reduced below those of Lake Kissimmee. Therefore, acquiring the Perpetual Flowage Easement to assure the operational flexibility of the schedule and to protect the lesser degree of environmental benefits achieved in this area are required. The Perpetual Flowage Easement is also required for flood control and water storage on the Disney Celebration Lands.

(3) The remaining lands required are in areas where ground water elevation will impact septic tanks in isolated areas requiring Water Inundation Easements (Structures Remain), Fee Simple for parcels where there is or will be no cure; and a Perpetual Conservation/Flowage Easement and a release for those parcels to hookup to an alternative sewer treatment system for the Hatchineha Estates.

RECOMMENDATION REGARDING ESTATES BEING ACQUIRED BY LOCAL SPONSOR

Perpetual Conservation and Flowage easements or Perpetual Flowage easements are recommended only where fee acquisition is not required to provide the maximum environmental benefits. These areas include residential areas, State of Florida Trustee of the Internal Improvement Funds (T.I.I.F.) lands, and mitigation lands owned by the Celebration for Disney, Inc. The Perpetual Conservation Easement which has been acquired in several agricultural areas by the Local Sponsor is sufficient to support the needs of the restoration project. The sponsor has not acquired interests in the Lakes Hatchineha and Tiger areas since they are awaiting approval of the non-standard estates to initiate acquisition. A Perpetual Flowage easement will be required for the Celebration for Disney, Inc. mitigation lands.

The Perpetual Flowage easements the sponsor has obtained will have to be revised to eliminate zones for flooding which may be adjusted for operational flexibility after analyzing the revised regulation schedule.

Fee estates with reservations to the grantor have been acquired by the sponsor in some agricultural areas . The areas which have been acquired in fee by the sponsor have been recommended in fee to assure that fertilization, chemical treatments, aerating, burning, mowing, chopping, clearing, diking, fill or water control activities which are not consistent with environmental restoration purposes of the projects are prohibited.

The Jacksonville District has coordinated with the sponsor during the planning process. The sponsor has been advised of the risks of proceeding with acquisition prior to approval of real estate requirements in this report. The sponsor is aware of the risks during the crediting process and the risk of additional real estate interests being required.

SOVEREIGN LANDS AND NAVIGATION SERVITUDE

While is it clear that the State of Florida, pursuant to Florida case and statutory law, owns fee title to the ordinary high-water line as it existed at the time of the establishment of statehood, the exact location of the ordinary high-water line on the Upper Basin lakes has not been determined.

There have been several studies, reports and articles written that have attempted to determine the location of the ordinary high water line on the upper chain of lakes. However, none of the conclusions reached by these articles have been accepted by the State of Florida as proof of the location of the ordinary high water line.

An Attorney's Opinion prepared January 1996, concluded that the only lake where the ordinary high water line has been decided for state sovereign land purposes is Lake Hatchineha.

In MacNamara v. Kissimmee River Valley Sportsman's Association and Board of Trustees of the Internal Improvement Trust Fund, 1994 W.L. 558430 (Fla. App. 2nd Dist 1994), the court was requested to determine where the location of the ordinary high water line on Lake Hatchineha. A property owner constructed a fence on a spoil island below what was claimed to be the high water line and was prohibiting hunters from entering the spoil island. The Trustees' intervened in the action and agreed to be bound by the results. The court held that the ordinary high water line for Lake Hatchineha was at 52.5 feet mean sea level and that all lands below 52.5 feet were state sovereign lands. The establishment of the ordinary high-water line at 52.5 feet was based on the current regulation schedule for Lake Hatchineha.

The State of Florida has determined that without extensive surveys of the lands surrounding the upper basin lakes and probably without extensive, lengthy, and expensive litigation, the ordinary high water line cannot be determined and that, therefore, it will not assert its claim of ownership to any individual parcel in the Kissimmee River and its headwaters provided that the South Florida Water Management District acquired the parcels by means of voluntary acquisition and complied with other terms of a resolution signed by the Trustees of the Internal Improvement Trust Fund.

The same studies, reports and articles were reviewed to determine the location of the ordinary high-water line on the upper basin lakes for purposes of the federal navigation servitude.

The above referenced Attorney's Opinion also addressed navigation servitude and the following reflects discussion and conclusion in this opinion.

In March 1975, the U. S. Army, Corps of Engineers, Jacksonville District prepared a Navigability Study of the Kissimmee River and its Tributaries. While this study is unapproved, it concluded that for navigability purposes the ordinary high water line on Lakes Cypress, Hatchineha and Kissimmee was located at 52.5 feet mean sea level. Based on this study; the lack of data on the location of the historic ordinary high water line for the lakes; the fact that for the current project, the South Florida Water Management District was required to acquire lands below the 52.5 foot contour; and to establish the location of the ordinary high water line would require extensive surveys of all the lands surrounding the upper basin lakes, the recommendation of the Jacksonville District is that acquisition of interests in lands between the 52.5 and 54.0 foot contour is justified for the proposed project modification.

The recommendation of the Jacksonville District is that the ordinary high water mark for the purposes of the state sovereign lands and the Federal Navigation servitude extends to at least the 52.5 foot elevation and that establishing the requirement for acquisition of interests in lands between 52.5 and 54.0 feet is justified based on: (1) the lack of data on the location of the historic ordinary high water line for the three lakes at the time of statehood; (2) the fact that for the existing Kissimmee River project, the South Florida Water Management District was required to acquire lands below the 52.5 foot contour in the upper basin lakes; and (3) to establish the location of the ordinary high water line would require extensive surveys of all the lands surrounding the upper basin lakes.

Navigation Servitude is being applied to lands located below 52.5 feet NGVD in navigable waters of Lake Kissimmee, Lake Cypress, Lake Hatchineha and Lake Tiger. However, upland areas not hydrologically connected to the lakes, i.e. lands between Lake Cypress and Lake Kissimmee, are excluded from the navigation servitude.

PRE-PROJECT CONDITIONS

The following discussions and conclusions were taken from the Attorney's Opinion dated January 1996.

Based on the modeling of the recommended plan, water level stages will not exceed historic conditions. For the period 1929 to 1960 (pre-existing project), water level stages exceeded 48.5 feet, 79% of the time; 52.0 feet, 40% of the time; 52.5 feet, 16% of the time and 54.0 feet 6% of the time. Current modeling of the recommended plan indicates the water level stages will exceed 48.5 feet, 93% of the time, 51.0 feet 36% of the time; 52.5 feet 8% of the time; and 54.0 feet 0.1% of the time.

The regulation schedule for the existing flood control project underwent a series of modifications (1956, 1976, and 1982) prior to a final regulation schedule being established. Current modeling is based on the period from 1970 to 1988, which was a much drier period than the period from 1929 to 1960. The anticipated benefits of the recommended plan are that in addition to hydrologic regimes that will effectively accomplish the integrated environmental restoration objectives for both the upper and lower basins, the new regulation schedule will provide operational flexibility for fine-tuning the restoration plan and adaptive management of the recovering and restored ecosystem. Following implementation, the regulation schedule may be re-evaluated. Potential modification of the regulation schedule would be based upon future hydrologic performance and results of the project's comprehensive restoration evaluation program in both the upper and lower basin. It may be probable to modify the schedule to maintain higher lake stages in the lakes for longer durations and still provide the necessary inflows to achieve the lower basin restoration. Alternatively, adjustments may be required to facilitate restoration of the lower basin. Without an interest in the lands surrounding the lakes, operational flexibility will depend on a continuing analysis of proposed modifications to the regulation schedules to determine that a "taking" will not occur. Future water storage capabilities would also be lost if an interest in these lands is not acquired.

MAPS

For the purpose of this report, the Jacksonville District and the Local Sponsor established the perimeter boundaries of the project. In the upper basin the limits are between the contours at elevation 52.5 and 54 feet, NGVD with the addition of the approximately 5,986 acres of uplands below 52.5 feet located between Lakes Cypress and Kissimmee. These lands are surrounded by elevations of greater than 52.5 NGVD and are required for water storage, operational flexibility and environmental benefits.

The maps shown as Plates H-1 thru H-10 were computer generated from maps furnished by the Local Sponsor. Final segment/acquisition maps and tract descriptions will be prepared in coordination with the project sponsor.

EXHIBIT B

SOUTHEAST CORNER OF LAKE KISSIMMEE LOOKING NORTHEAST
HYATT AND MACK PROPERTIES ON RIGHT SIDE OF PICTURE

SOUTHEAST SIDE OF LAKE KISSIMMEE LOOKING NORTH
THREE LAKES WILDLIFE MANAGEMENT AREA IN FOREGROUND

EXHIBIT B

EAST SIDE OF LAKE KISSIMMEE LOOKING NORTH
RAWLIN OVERSTREET PROPERTY IN FOREGROUND

NORTHEAST SIDE OF LAKE KISSIMMEE LOOKING NORTH
SOUTHPORT RANCH PROPERTY IN FOREGROUND

EXHIBIT B

NORTHEAST CORNER OF LAKE KISSIMMEE LOOKING NORTH
BILL JOHNSTON PROPERTY IN FOREGROUND
BRONSON PROPERTY AT TOP OF PICTURE

SOUTHEAST SIDE OF LAKE CYPRESS LOOKING NORTH AT BRONSON PROPERTY

EXHIBIT B

EAST SIDE OF LAKE CYPRESS LOOKING NORTH
RAWN FISH CAMP IN FOREGROUND

WEST SIDE OF LAKE HATCHINEHA LOOKING SOUTHEAST
AT IMAGINATION FARMS PROPERTY

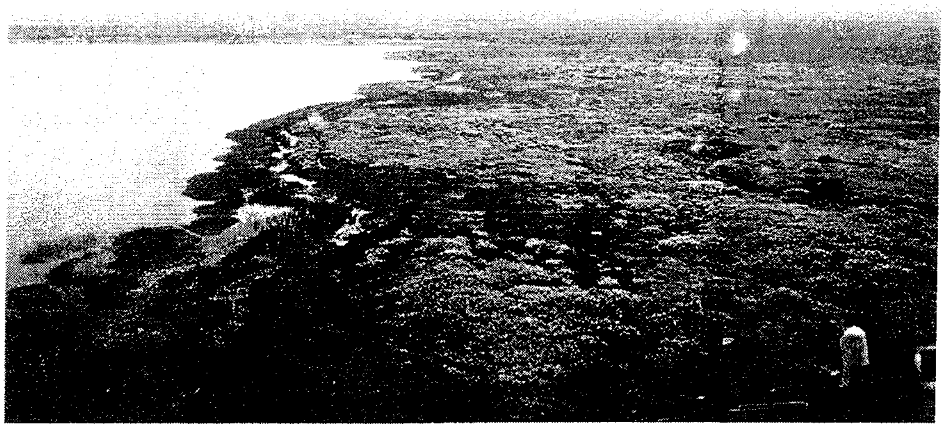
EXHIBIT B

SOUTHWEST CORNER OF LAKE HATCHINEHA LOOKING SOUTHEAST
ROLLING MEADOW SOD FARM IN FOREGROUND

WEST SIDE OF C-37 LOOKING SOUTHEAST
RAY LEIS PROPERTY (KISSIMMEE RIVER PARK) IN FOREGROUND

EXHIBIT B

NORTHWEST CORNER OF LAKE KISSIMMEE LOOKING SOUTHEAST



NORTH SIDE OF LAKE TIGER LOOKING SOUTHWEST

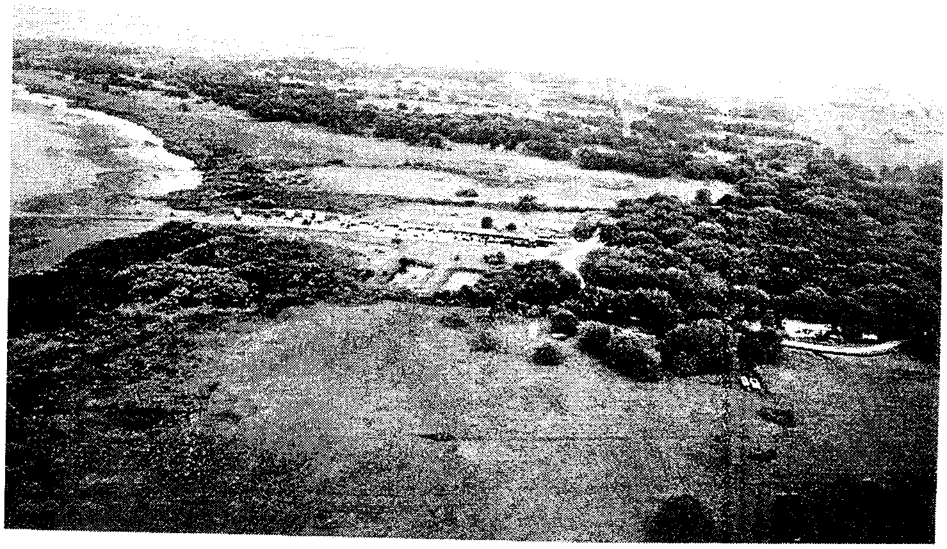
EXHIBIT B

NORTHWEST SIDE OF LAKE TIGER LOOKING SOUTHWEST
LIONS CAMP IN CENTER OF PICTURE

WEST SIDE OF LAKE TIGER LOOKING SOUTH
BUD'S FISH CAMP IN FOREGROUND

EXHIBIT B

SOUTHWEST CORNER OF LAKE TIGER LOOKING SOUTHEAST



SOUTH SIDE OF LAKE TIGER LOOKING EAST
CAMP TIGER IN CENTER OF PICTURE

data\kcol\gross95

EXHIBIT B

SOUTHEAST SIDE OF LAKE TIGER LOOKING NORTHEAST

NORTHEAST CORNER OF LAKE TIGER LOOKING NORTH

EXHIBIT B

NORTHWEST SIDE OF LAKE KISSIMMEE LOOKING SOUTHEAST
MILES PROPERTY IN FOREGROUND

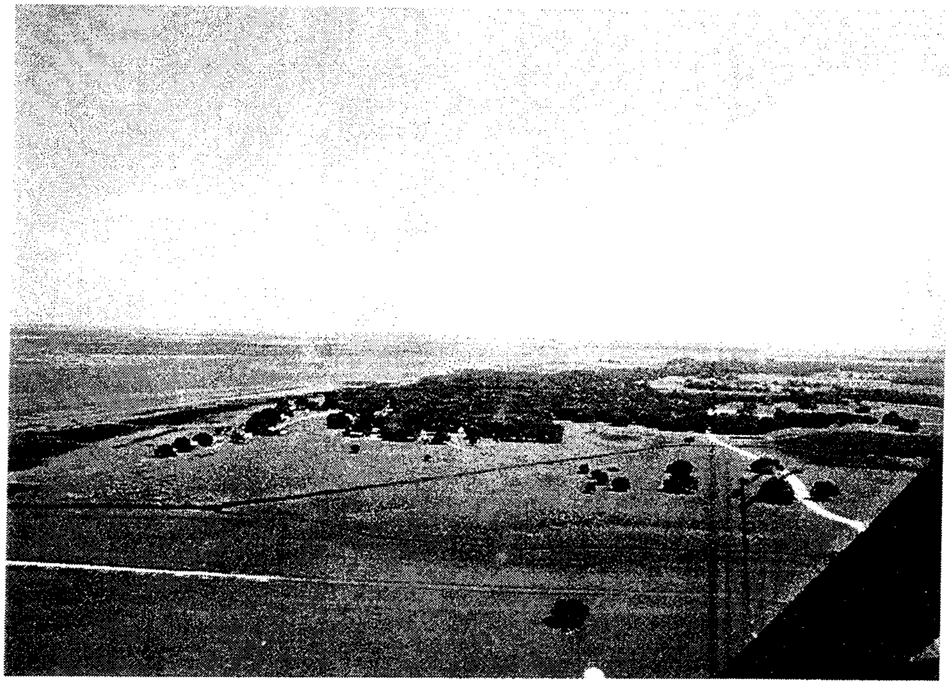
WEST SIDE OF LAKE KISSIMMEE LOOKING SOUTH

EXHIBIT B

SOUTHWEST SIDE OF LAKE KISSIMMEE LOOKING SOUTHEAST
BRAHMA ISLAND ON LEFT SIDE OF PICTURE

SOUTHWEST SIDE OF LAKE KISSIMMEE LOOKING SOUTHEAST
ROCKS FISH CAMP IN CENTER OF PICTURE

EXHIBIT B



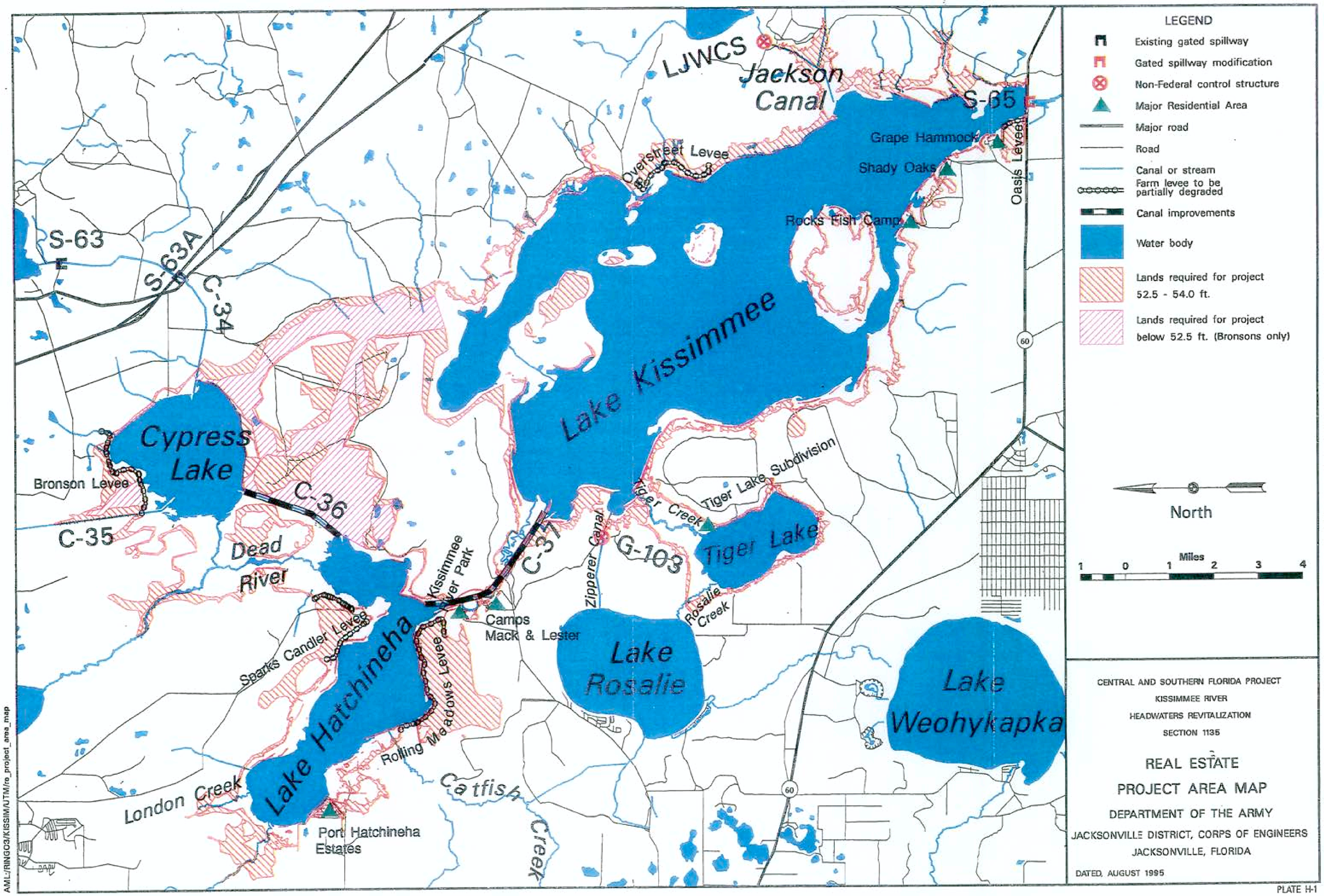
SOUTHWEST SIDE OF LAKE KISSIMMEE LOOKING SOUTHEAST
SHADY OAKS FISH CAMP IN CENTER OF PICTURE

SOUTHWEST CORNER OF LAKE KISSIMMEE LOOKING SOUTH
GRAPE HAMMOCK FISH CAMP IN CENTER OF PICTURE

EXHIBIT B

SOUTHWEST CORNER OF LAKE KISSIMMEE LOOKING WEST
OASIS MARINA ON LEFT SIDE OF PICTURE

SOUTHWESTERLY VIEW OF HATCHINEHA ESTATES



CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

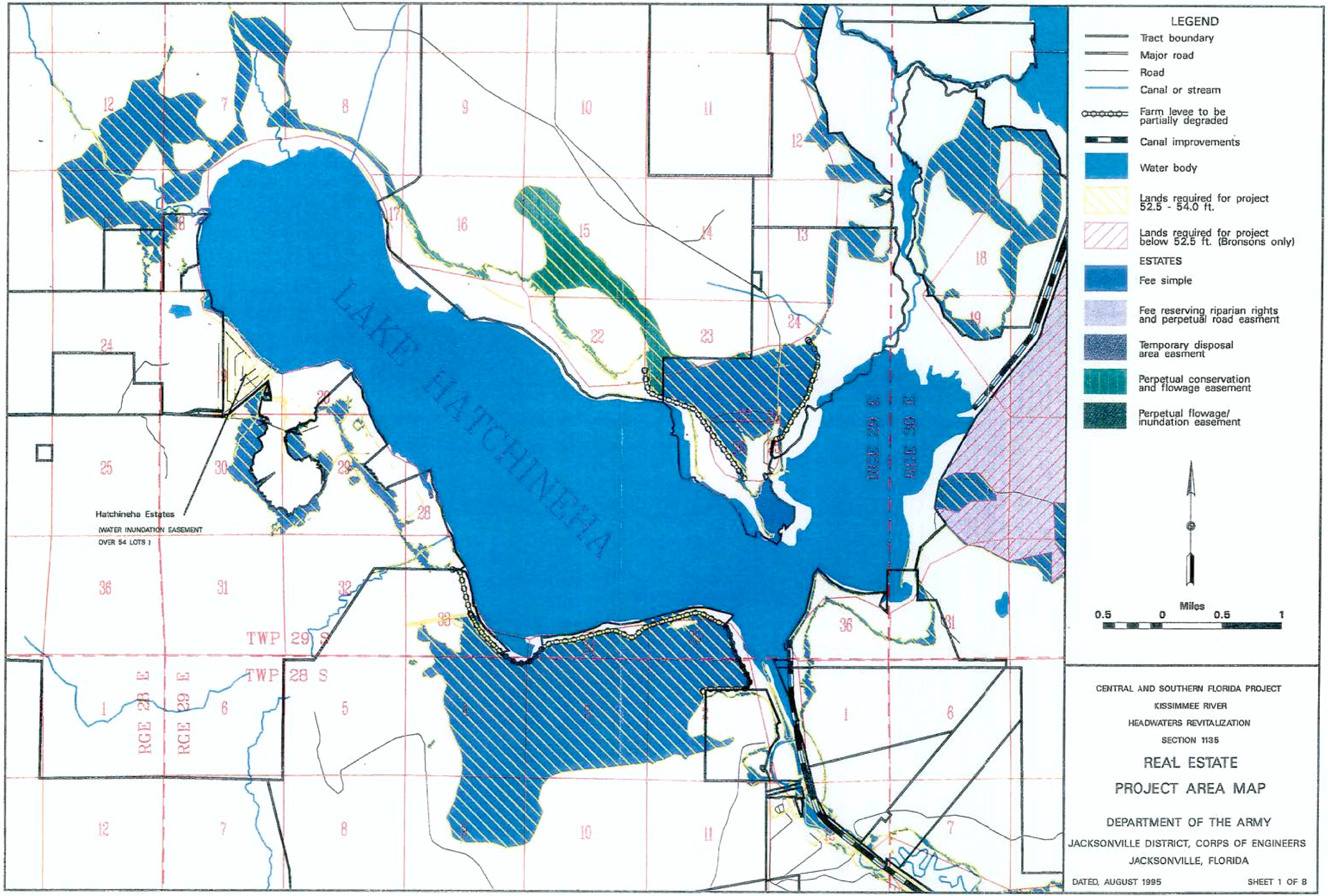
REAL ESTATE
PROJECT AREA MAP

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

AML:/RINGO3/KISSIM/UTM/re_project_area_map

PLATE H-1



CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

REAL ESTATE
PROJECT AREA MAP

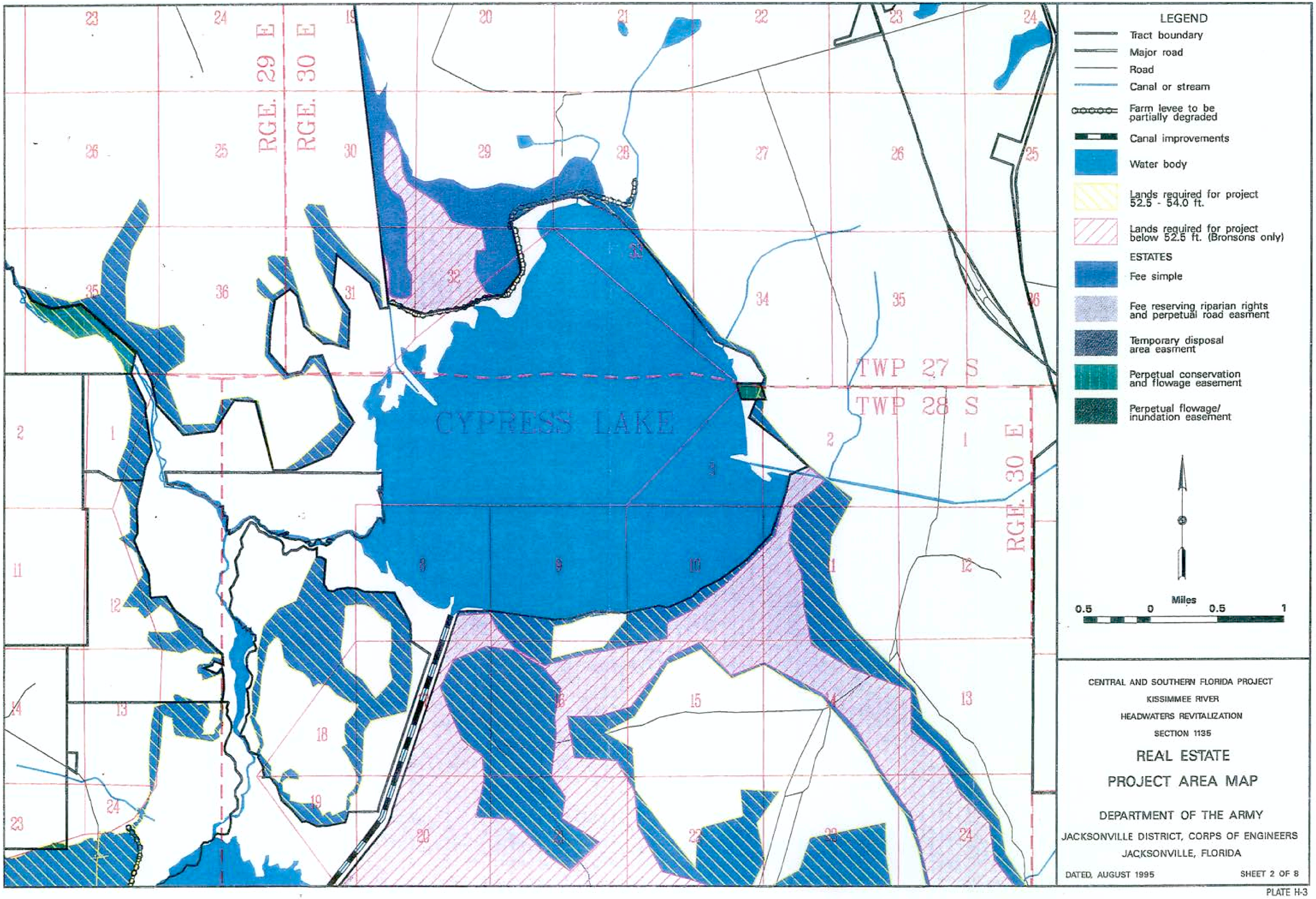
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

SHEET 1 OF 8

AML:/HOME/MATZ/KISSIMMEE/kissim_upper_basin_plots

PLATE H-2



CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

REAL ESTATE
PROJECT AREA MAP

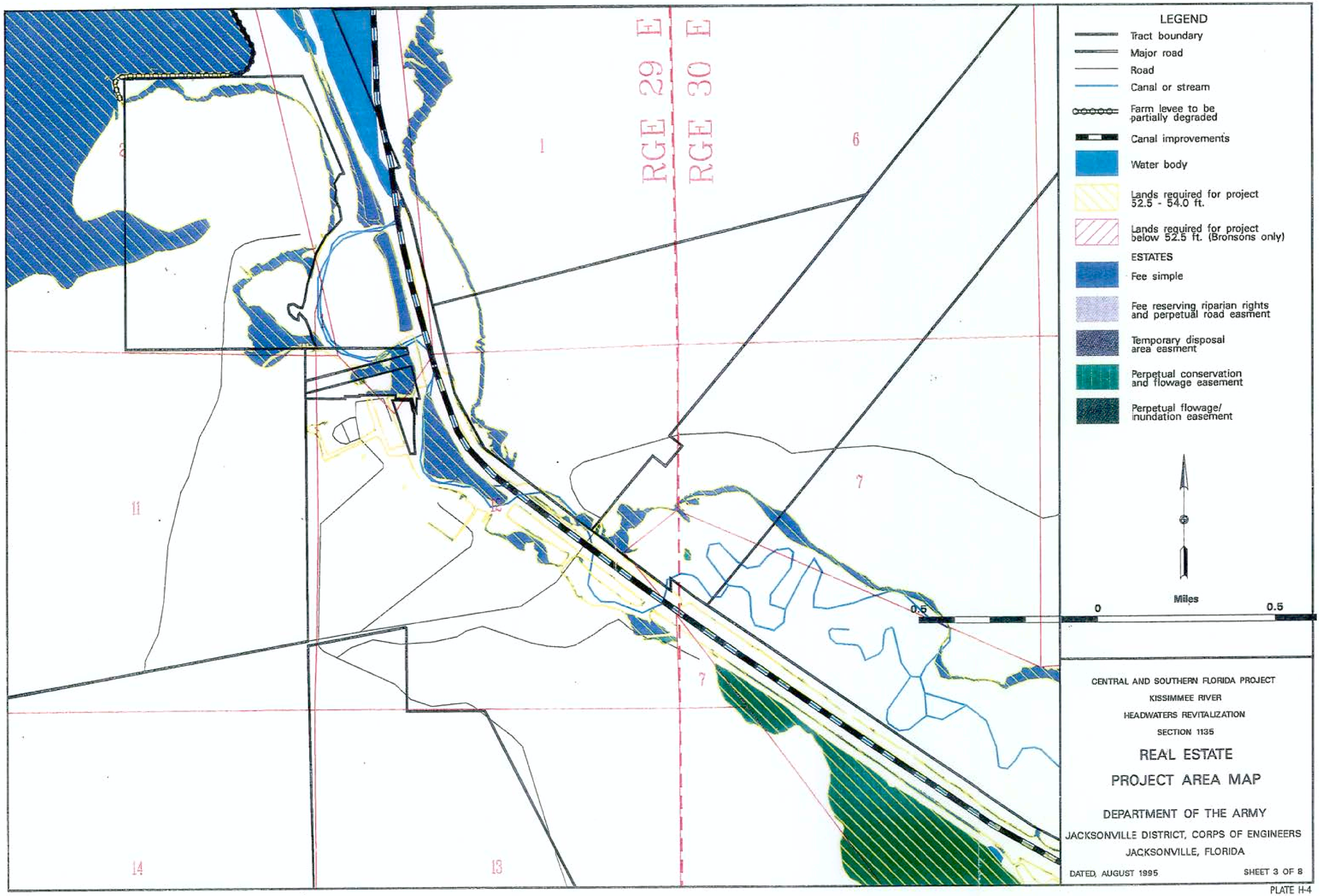
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

SHEET 2 OF 8

PLATE H-3

AML:/HOME/MATZ/KISSIMMEE/kissim_upper_basin_plots



CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

REAL ESTATE
PROJECT AREA MAP

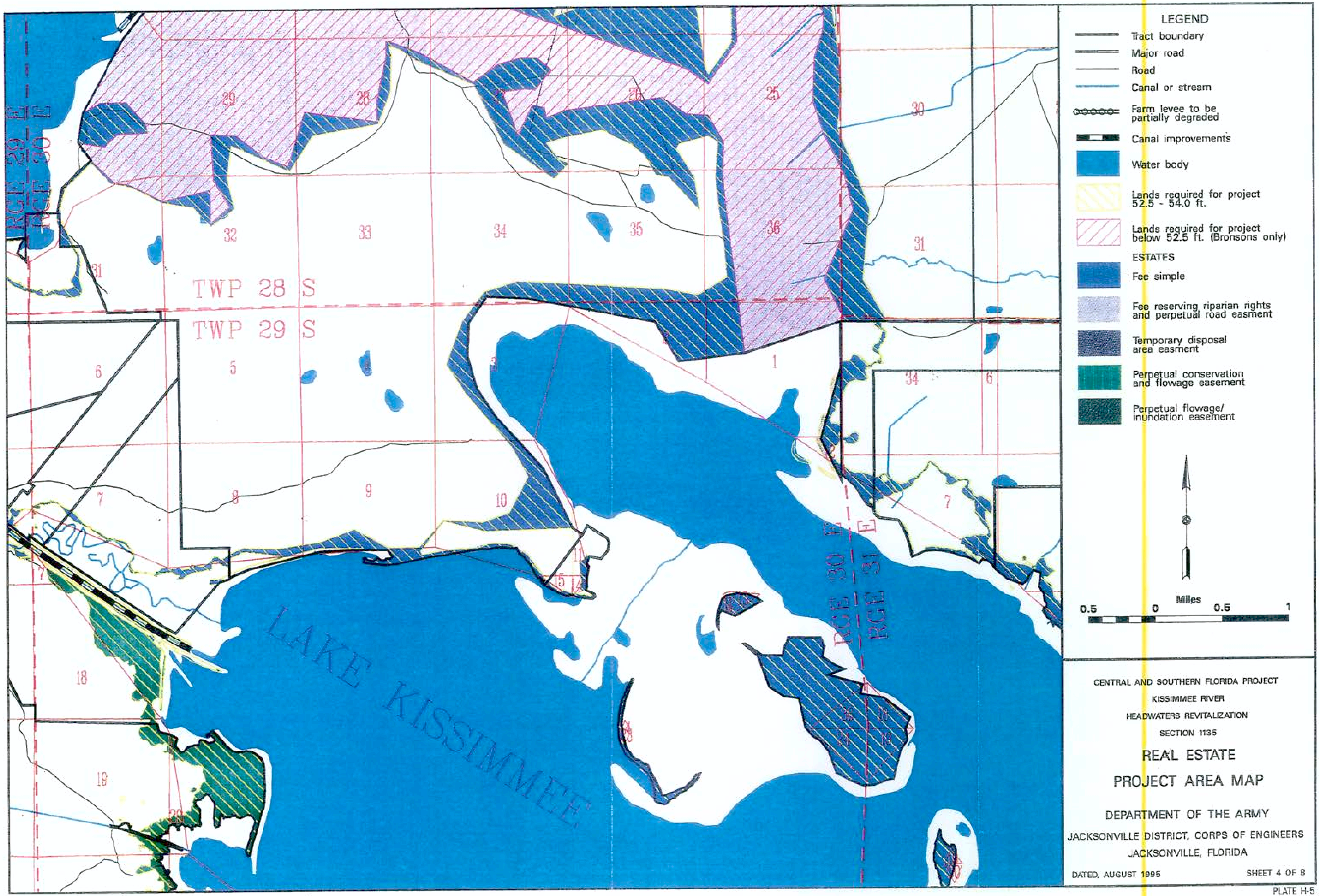
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

SHEET 3 OF 8

PLATE H-4

AML:/HOME/MATZ/KISSIMMEE/kissim_upper_basin_plots



CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

REAL ESTATE
PROJECT AREA MAP

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

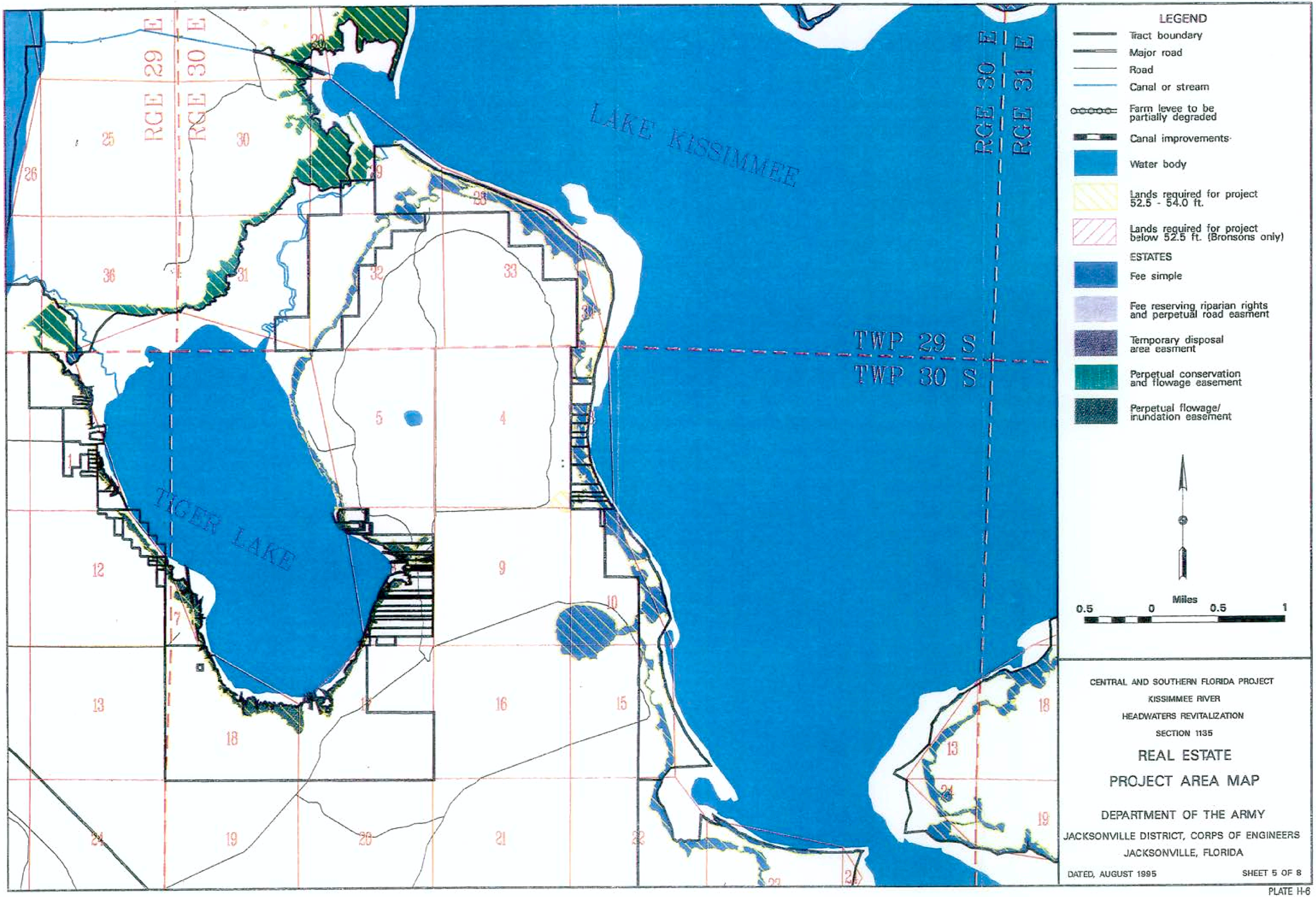
DATED, AUGUST 1995

SHEET 4 OF 8

PLATE H-5

AML:/HOME/MATZ/KISSIMMEE/kissim_upper_basin_plots

AML/HOME/MATZ/KISSIMMEE/kissim_upper_basin_plots



CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER

HEADWATERS REVITALIZATION

SECTION 1135

REAL ESTATE
PROJECT AREA MAP

DEPARTMENT OF THE ARMY

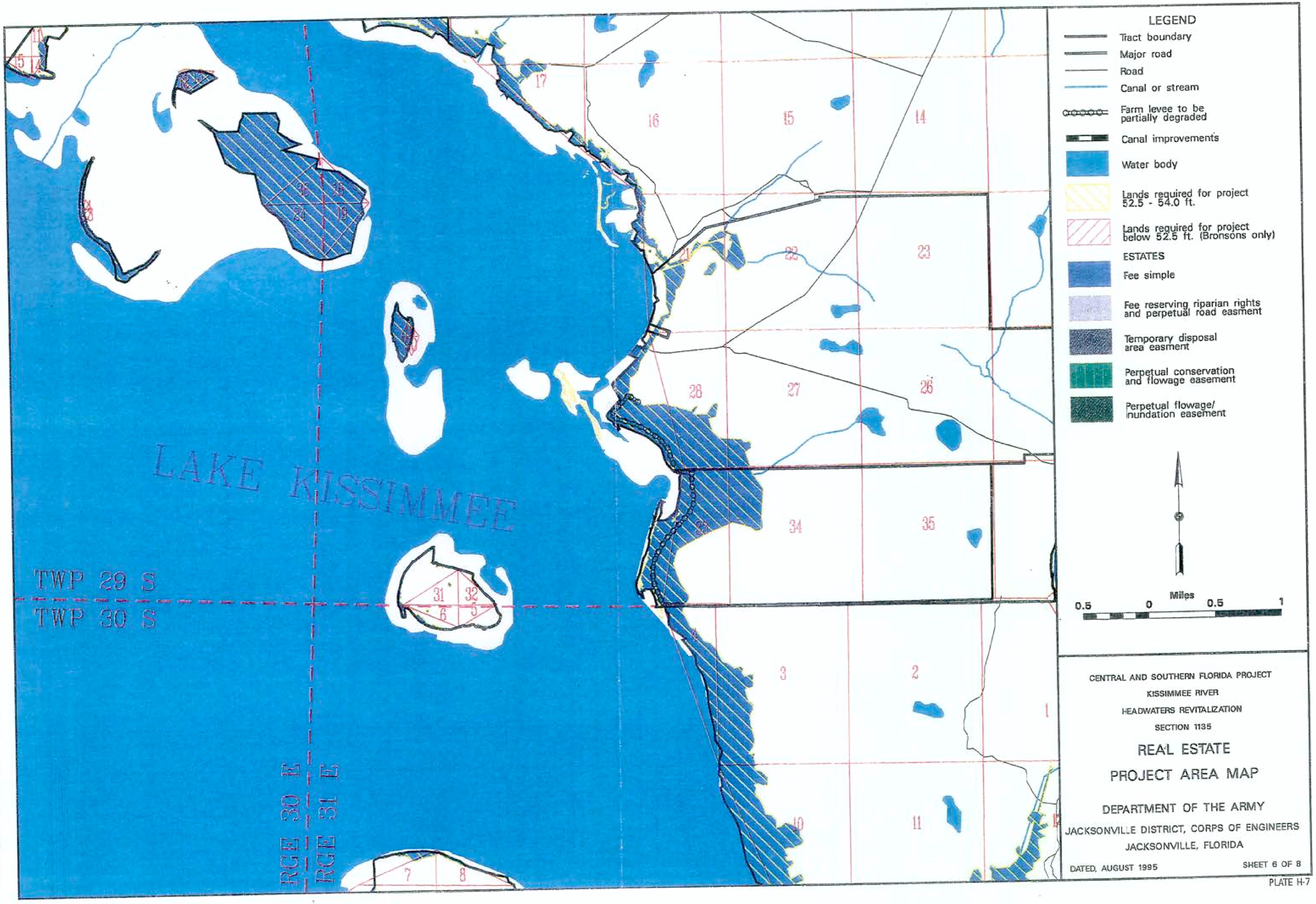
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

SHEET 5 OF 8

PLATE H-6



CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

REAL ESTATE
PROJECT AREA MAP

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, AUGUST 1995
SHEET 6 OF 8

PLATE H-7

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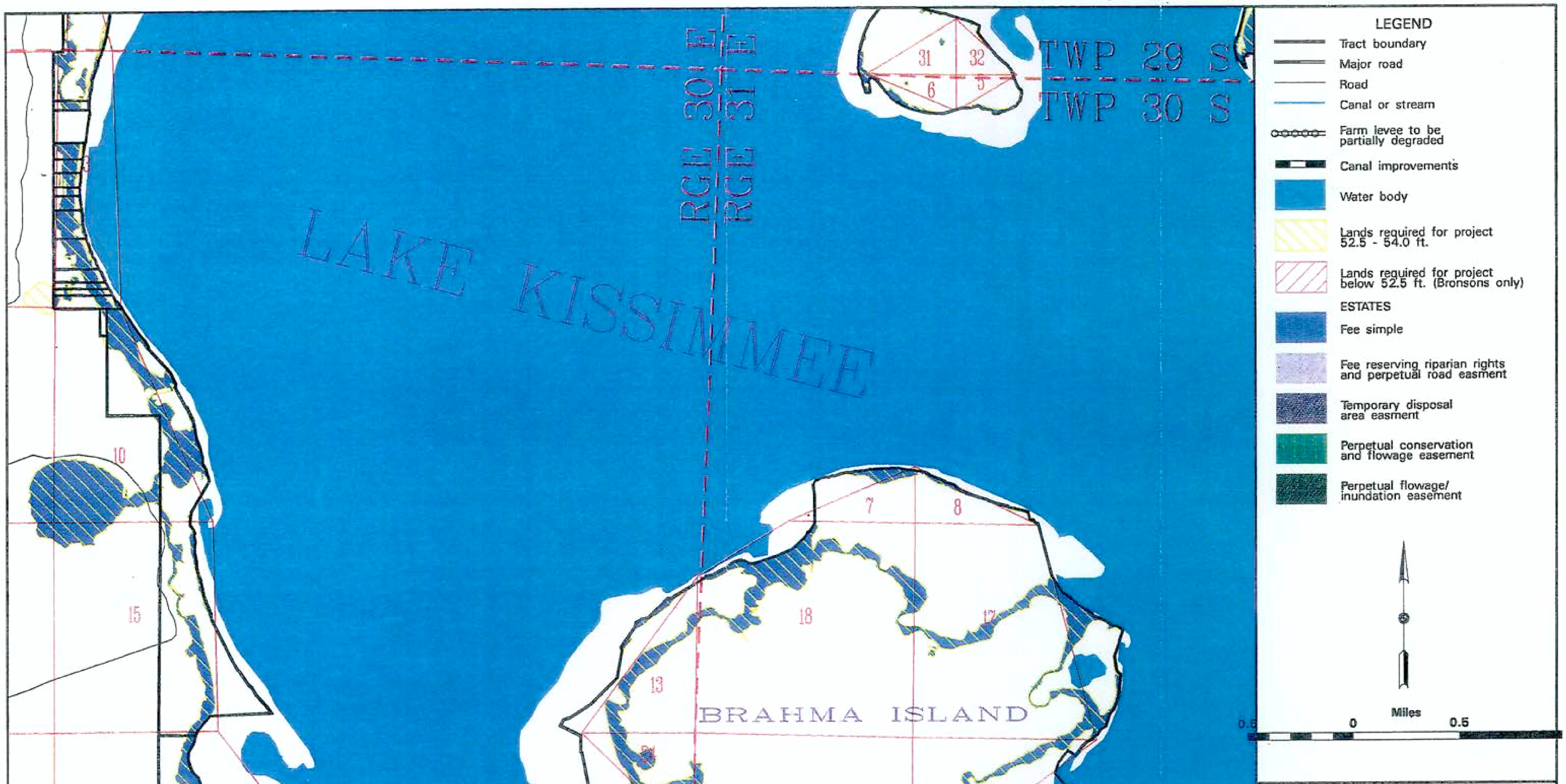


CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

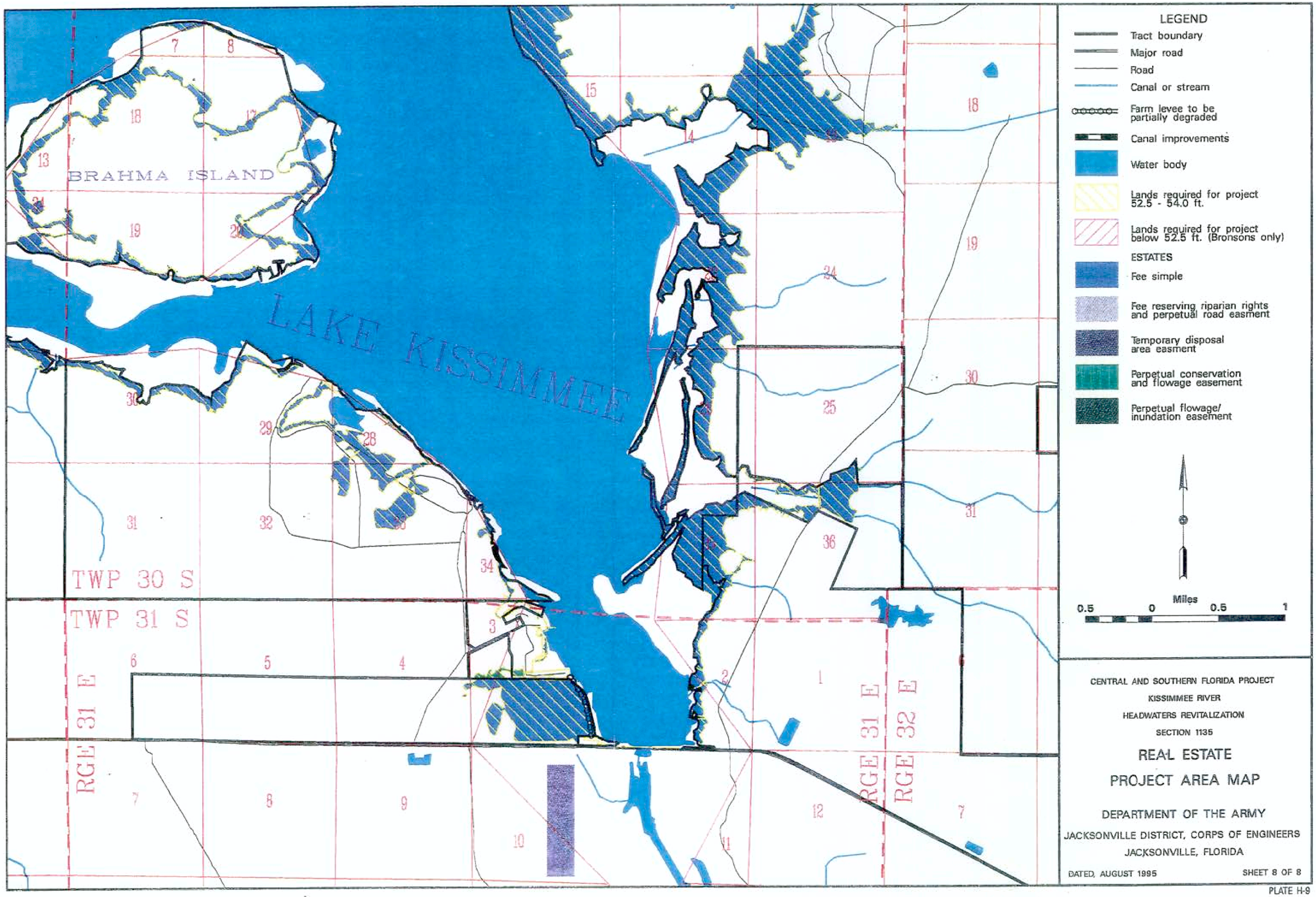
REAL ESTATE
PROJECT AREA MAP

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, AUGUST 1995 SHEET 7 OF 8

PLATE H-8

AML:/HOME/MATZ/KISSIMMEE/kissim_upper_basin_plots



CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

REAL ESTATE
PROJECT AREA MAP

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

SHEET 8 OF 8

PLATE H-9

AML:/HOME/MATZ/KISSIMMEE/kissim_upper_basin_plots

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX I

KISSIMMEE RIVER, FLORIDA
PROJECT COOPERATION AGREEMENT

PROJECT COOPERATION AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY
AND
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
FOR CONSTRUCTION OF THE
KISSIMMEE RIVER, FLORIDA, PROJECT

THIS AGREEMENT is entered into this 22 day of March, 1994, by and between the DEPARTMENT OF THE ARMY (hereinafter the "Government"), acting by and through the Assistant Secretary of the Army (Civil Works), and the SOUTH FLORIDA WATER MANAGEMENT DISTRICT (hereinafter the "Local Sponsor"), acting by and through its Governing Board.

WITNESSETH, THAT:

WHEREAS, construction of the Kissimmee River Restoration Project and the Kissimmee River Headwaters Revitalization Project were authorized by Section 101(8) of the Water Resources Development Act of 1992 and by Section 46 of the Water Resources Development Act of 1988, respectively, and have been subsequently combined into the single project called the Kissimmee River, Florida, Project, located in south-central Florida and bordered by Lake Okeechobee to the South and approaching the City of Orlando to the North;

WHEREAS, the Government and the Local Sponsor desire to enter into a Project Cooperation Agreement for construction of the Kissimmee River, Florida Project (hereinafter the "Project" and defined in Article I.a. of this Agreement);

WHEREAS, the Conference Report, House Report 103-305, which accompanied the Fiscal Year 1994 Appropriations Act (Public Law 103-126) provided guidance to execute a single Project Cooperation Agreement for this Project in advance of a Report being completed and approved for the Kissimmee Headwaters Revitalization Project;

WHEREAS, Section 101 of the Water Resources Development Act of 1992, Public Law 102-580, specifies the cost-sharing requirements applicable to the Project;

WHEREAS, Section 221 of the Flood Control Act of 1970, Public Law 91-611, as amended, provides that the construction of any water resources project by the Secretary of the Army shall not be commenced until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project;

WHEREAS, the Government and the Local Sponsor have the legal authority and capability to perform as hereinafter set forth and intend to cooperate in the cost-sharing and financing of the construction of the Project in accordance with the terms of this Agreement.

NOW, THEREFORE, the Government and the Local Sponsor agree as follows:

ARTICLE I - DEFINITIONS AND GENERAL PROVISIONS

For purposes of this Agreement:

a. The term "Project" shall mean the construction of the Kissimmee River Restoration which includes approximately 22 miles of contiguous backfilling of the middle portion of the channelized Kissimmee River as generally described in the Report of the Chief of Engineers, dated March 17, 1992 and approved by Secretary of the Army, on April 3, 1992 and construction of the Headwaters Revitalization Project as generally described in a report to be prepared and approved by the Chief of Engineers. Not included within this definition are the partial filling of Pools A & B, the weir modifications in Pool B and the backfilling in Pool E.

b. The term "total project costs" shall mean all costs incurred by the Local Sponsor and the Government directly related to construction of the Project. Such costs shall include, but not necessarily be limited to: all continuing planning and engineering costs incurred after October 1, 1985; all advanced engineering and design costs; all preconstruction engineering and design costs; engineering and design costs during construction; actual construction costs, including the costs of constructing, relocating or modifying existing railroad bridges and approaches thereto; supervision and administration costs; costs of contract dispute settlements or awards; the value of lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and the value of relocations, as may be required for the construction, operation, and maintenance of the Project; and the cost of investigations to identify the existence of hazardous substances as identified in Article XVIII.a.; but shall not include any costs for operation, maintenance, repair, replacement, or rehabilitation or increased costs for betterments.

c. The term "period of construction" shall mean the time from the advertisement of the first construction contract to the time the Government certifies in writing to the Local Sponsor that construction of the Project is complete. The Government shall furnish to the Local Sponsor copies of the Government's Written Notice of Acceptance of Completed Work furnished to the contractor(s) for all contracts for the Project.

d. The term "highway" shall mean any highway, thoroughfare, roadway, street, or other public road or way.

e. The term "relocations" shall mean the preparation of plans and specifications for, and the accomplishment of all, alterations, modifications, lowering or raising in place, and/or new construction related to, but not limited to, existing: railroads (excluding existing railroad bridges and approaches thereto), highways, and other bridges, pipelines, public utilities (such as municipal water and sanitary sewer lines, telephone lines, and storm drains), aerial utilities, cemeteries, and other facilities, structures, and improvements determined by the Government to be necessary for the construction, operation and maintenance of the Project.

f. The term "fiscal year" shall mean one fiscal year of the Government. The Government fiscal year begins on October 1 and ends on September 30.

g. The term "functional portion of the Project" shall mean a completed portion of the Project as determined by the Government in writing to be suitable for tender to the Local Sponsor to operate and maintain in advance of completion of the entire Project. To be suitable for tender, the Government, in consultation with the Local Sponsor, must determine that the completed portion of the Project can function independently and for a useful purpose, although the balance of the Project is not complete.

h. The term "betterment" shall mean the design and construction of a Project feature accomplished on behalf of, or at the request of, the Local Sponsor in accordance with standards which exceed the standards which the Government would otherwise apply for accomplishing the design and construction of the Project.

i. The term "in-kind services" shall mean Project engineering and design services that the Local Sponsor has performed or may perform at the request of the Government.

ARTICLE II - OBLIGATIONS OF THE GOVERNMENT AND LOCAL SPONSOR

a. The Government, subject to receiving funds appropriated by the Congress of the United States and using funds provided by the Local Sponsor, shall expeditiously construct the Project (including construction, modification, or relocation of existing railroad bridges and approaches thereto), applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The Local Sponsor shall be afforded the opportunity to review and comment on all contracts, including relevant plans and specifications, prior to the issuance of invitations for bids. The Government shall not issue the solicitation for the first construction contract until the Local Sponsor has confirmed in writing its willingness to proceed with the Project. To the extent possible, the Local Sponsor thereafter also will be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. In those cases where providing notice to the Local Sponsor of the required contract modifications or change orders is not possible prior to issuance of Notice to Proceed, such notification will be provided after the fact at the earliest date possible. The Government will, in good faith, consider the comments of the Local Sponsor, but award of contracts, modifications or change orders, and performance of all work on the Project (whether the work is performed under contract or by Government personnel), shall be exclusively within the control of the Government.

b. After the Government determines, in consultation with the Local Sponsor, that the Project or a functional portion of the Project is complete, and notifies the Local Sponsor in writing of such determination, the Government shall turn the Project or functional portion of the Project over to the Local Sponsor, which shall accept the Project or functional portion of the Project and be solely responsible for operating, maintaining, repairing, replacing, and rehabilitating the Project or functional portion of the Project in accordance with Article VIII hereof.

c. The Local Sponsor shall contribute 50 percent of total project costs in accordance with the provisions of this paragraph.

1. As further specified in Article III hereof, the Local Sponsor shall provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated disposal areas, and perform all relocations determined by the Government to be necessary for construction, operation, and maintenance of the Project.

2. The Government has determined that the Local Sponsor shall receive credit for the following in-kind services completed or initiated prior to the execution of this Agreement:

(a) 2-D model development
(b) Chandler Slough Backwater Study
(c) Dissolved oxygen model development
(d) Rights-of-entry for PED field work
(e) The test fill permit
(f) Residential impact evaluation

Furthermore, the Government may request the Local Sponsor to provide some or all of the following in-kind services and grant credit therefor:

(a) Seven Mile and Pine Island Sloughs Backwater Study
(b) Remaining Tributary Backwater Studies
(c) SFWMD staff modeling support for UKISS and 2-D model utilization
(d) SFWMD staff support for Upper Basin Study
(e) SFWMD staff support for the restoration evaluation component in accordance with the feasibility report

The affording of such credit shall be subject to an inspection as appropriate by the Government to verify that the work was accomplished in a satisfactory manner and is suitable for inclusion in the Project. The actual amount of credit shall be subject to an audit to determine reasonableness, allocability, and allowability of costs in accordance with Article XI.

3. If the value of the contributions provided under paragraphs c.1. and c.2. of this Article is less than 50 percent of total projects costs, the Local Sponsor shall provide, during the period of construction, additional cash contributions in the amount necessary to make the Local Sponsor's contribution equal to 50 percent of total project costs.

4. If the value of the contributions provided under paragraphs c.1. and c.2. of this Article exceed 50 percent of the total project costs, the Government shall, subject to the availability of funds, reimburse the Local Sponsor for that portion of the value of lands, easements, rights-of-way, and dredged or excavated material disposal areas, and relocations and in-kind services provided by the Local Sponsor in accordance with paragraph c.2., which exceed 50 percent of the total project cost. Alternately, and at the sole discretion of the Government, the Government may at no cost to the Local Sponsor provide any remaining lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas required for the construction operation, and maintenance of the Project in excess of 50 percent of the total project costs.

d. The Local Sponsor may request the Government to acquire lands, easements, or rights-of-way, or perform relocations on behalf of the Local Sponsor. Such services as the Government may elect to provide, shall be performed in accordance with terms or conditions of separate agreements and all such work shall be paid for by the Local Sponsor in advance of the Government incurring any financial obligation therefor, in accordance with Article VI.

e. The Local Sponsor may request the Government to accomplish betterments. The Local Sponsor will be solely responsible for any increase in costs resulting from the betterments and all such increased costs will be paid by the Local Sponsor in advance of the Government incurring any financial obligation therefor, in accordance with Article VI.

f. No Federal funds may be used to meet the Local Sponsor's share of total project costs under this Agreement unless the expenditure of such funds is expressly authorized by statute as verified in writing by the Federal granting agency.

g. The Local Sponsor agrees to participate in and comply with applicable Federal flood plain management and flood insurance programs.

h. The Local Sponsor shall publicize flood plain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the Project.

ARTICLE III - LANDS, RELOCATIONS, AND PUBLIC LAW 91-646

a. The Government shall provide, in coordination with the Local Sponsor, a written description of the anticipated real estate requirements for the Project. Thereafter, the Local Sponsor shall furnish all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, as may be determined by the Government in that description, or in any subsequent description coordinated with the Local Sponsor, to be necessary for the construction, operation and maintenance of the Project, and shall furnish to the Government evidence supporting the Local Sponsor's legal authority to grant rights-of-entry to such lands. The necessary lands, easements, and rights-of-way for the Project may be provided incrementally for each construction contract. All lands, easements, and rights-of-way determined by the Government to be necessary for work to be performed under a construction contract must be furnished prior to the advertisement of that construction contract.

b. The Local Sponsor shall provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the Project.

c. The Government shall provide, in coordination with the Local Sponsor, a written description of the anticipated relocation requirements for the Project. Thereafter, the Local Sponsor shall accomplish or arrange for the accomplishment of all relocations, as may be determined by the Government in that description, or in any subsequent description coordinated with the Local Sponsor, to be necessary for the construction, operation and maintenance of the Project. The necessary relocations for the Project may be provided incrementally for each construction contract. All relocations determined by the Government to be necessary for work to be performed under a construction contract must be furnished prior to the advertisement of that construction contract.

d. The Local Sponsor shall comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the Project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

ARTICLE IV - VALUE OF LANDS AND RELOCATIONS

a. The Local Sponsor shall not receive any credit for lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, previously provided as an item of cooperation for another Federal project nor shall the value thereof be included in total project costs. The value of the lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, to be included in total project costs and credited towards the Local Sponsor's share of total project costs shall be determined in accordance with the following procedures:

1. If the lands, easements, or rights-of-way are owned by the Local Sponsor as of the date this Agreement is signed by both parties, the credit shall be the fair market value of the interest at the time this Agreement is signed by both parties or, in exceptional circumstances, upon request of the Local Sponsor and in the sole discretion of the Assistant Secretary of the Army for Civil Works, the actual purchase price paid by the Local Sponsor. The fair market value, if used, shall be determined by an appraisal, to be obtained by the Local Sponsor, which has been prepared by a qualified appraiser who is acceptable to both the Local Sponsor and the Government. The appraisal shall be reviewed and approved by the Local Sponsor and the Government.

2. If the lands, easements, or rights-of-way are acquired by the Local Sponsor after the date this Agreement is signed by both parties, the credit shall be the fair market value of the interest at the time such interest is acquired. The fair market value shall be determined as specified in Article IV.a.1. of this Agreement. If the Local Sponsor pays an amount in excess of the approved appraised fair market value, the Local Sponsor may be entitled to a credit for the actual purchase price paid provided that the purchase price is approved by the Government in writing.

3. If the Local Sponsor acquires more lands, easements, or rights-of-way than the Government determines are necessary for construction, operation, and maintenance of the Project, then only the value of such portions of those acquisitions as have been determined by the Government to be necessary for the construction, operation, and maintenance of the Project shall be included in total project costs and credited towards the Local Sponsor's share.

4. Credit for lands, easements, and rights-of-way acquired through eminent domain proceedings occurring after the date of this Agreement will be based on court awards for the real property interests taken, or on stipulated settlements or portions of stipulated settlements that have received written Government approval. The fair market value for the purposes of filing an eminent domain proceeding in court shall be based on an appraisal prepared and approved as specified in Article IV a.1. of this Agreement.

5. Credit for lands, easements, or rights-of-way acquired by the Local Sponsor within a five-year period preceding the date this Agreement is signed by both parties, or at any time after this Agreement is signed by both parties, will also include the reasonable documented incidental costs of acquiring the interest, e.g., closing and title costs, appraisal costs, survey costs, attorney's fees, plat maps, and mapping costs, as well as the actual amounts expended for payment of any Public Law 91-646 relocation assistance benefits provided in accordance with the obligations under this Agreement.

b. The value of relocations which will be included in total project costs and credited towards the Local Sponsor's share of total project costs shall be determined by the Government as set forth below:

1. Highways and Highway Bridges: Only that portion of the cost as would be necessary to construct substitute bridges and highways to the design standard that the State of Florida would use in constructing a new bridge or highway under similar conditions of geography and traffic loads.

2. Utilities and Facilities, Structures and Improvements (including railroads): Actual relocation costs, less depreciation, less salvage value, plus the cost of removal, less the increased cost of betterments. New materials shall not be used in any alteration or relocation if materials of value and usability equal to those in the existing facility are available or can be obtained as salvage from the existing facility or otherwise, unless the provision of new material is more economical. If, despite the availability of used material, new material is used, where the use of such new material represents an additional cost, such cost will not be included in total project costs, nor credited toward the Local Sponsor's share.

ARTICLE V - CONSTRUCTION PHASING AND MANAGEMENT

a. To provide for consistent and effective communication, the Local Sponsor and the Government shall, prior to the advertisement of the first construction contract, appoint representatives to coordinate on all facets of Project development, including Project design, scheduling, plans, specifications, real estate requirements, award of contracts, contract modifications and change orders, contract costs, claims, and other related matters.

b. These representatives shall generally oversee the Project construction and shall be identified as the Project Coordination Team. They shall meet regularly during the period of construction and will be informed of all changes in total project costs. The Project Coordination Team shall make recommendations concerning construction as it deems are warranted to the Government, including suggestions to avoid potential sources of dispute.

c. The Government shall, in good faith, consider the recommendations of the Project Coordination Team on all matters relating to construction and anticipated requirements for operation, maintenance, repair, replacement and rehabilitation of the Project. The Government, having the legal authority and responsibility for construction of the Project, has discretion to accept, reject, or modify the recommendations of such representatives.

ARTICLE VI - METHOD OF PAYMENT

a. The Local Sponsor shall provide, during the period of construction, the cash payments required under Article II of this Agreement. Total project costs are currently estimated to be $511,098,000 and the Local Sponsor's share of total project costs is currently estimated to be $255,496,000. In order to meet the Local Sponsor's share, the Local Sponsor must provide a cash contribution currently estimated to be $65,895,000. The dollar amounts set forth in this Article are based upon the Government's best estimates which reflect projections of costs, price level changes, and anticipated inflation. Such costs estimates are subject to adjustments based upon cost actually incurred and are not to be construed as the total financial responsibilities of the Government and the Local Sponsor.

b. The Local Sponsor shall provide the Local Sponsor's required cash contribution during the period of construction in accordance with the following provisions:

1. For purposes of budget planning, the Government shall notify the Local Sponsor by March 15 of each year of the estimated funds that will be required from the Local Sponsor to

meet the Local Sponsor's share of total project costs for the upcoming fiscal year.

2. No later than 120 calendar days prior to the award of the first construction contract, the Government shall notify the Local Sponsor of the Local Sponsor's share of the total project costs required for the first fiscal year of construction, including the Local Sponsor's share of costs attributable to the Project incurred prior to the initiation of construction. No later than 60 calendar days thereafter, the Local Sponsor shall verify to the satisfaction of the Government that the Local Sponsor has deposited the requisite amount in an escrow or other account acceptable to the Government, with interest accruing to the Local Sponsor.

3. For the second and subsequent fiscal years of Project construction, the Government shall, no later than 60 calendar days prior to the beginning of the fiscal year, notify the Local Sponsor of the Local Sponsor's share of total project costs for that fiscal year. No later than October 1, or the first business day of the fiscal year, the Local Sponsor shall make the necessary funds available to the Government through the funding mechanism specified in Article VI.b.2. of this Agreement.

4. As construction of the Project proceeds, the Government shall on a regular basis each year, adjust the amounts required to be provided under this paragraph to reflect actual costs to date. If at any time during the period of construction the Government determines that additional funds will be needed from the Local Sponsor, the Government shall so notify the Local Sponsor, and the Local Sponsor, no later than 60 calendar days from receipt of such notice, shall make the necessary funds available through the funding mechanism specified in Article VI.b.2. of this Agreement.

c. The Government will draw on the escrow or other account provided by the Local Sponsor such sums as the Government deems necessary to cover contractual and in-house fiscal obligations attributable to the Project as they are incurred, as well as Project costs incurred by the Government prior to the initiation of construction.

d. During the period of construction, the Government shall provide quarterly financial reports on the status of total project cost and the status of contributions made by the Local Sponsor. Upon completion of the Project and resolution of all relevant contract claims and appeals, the Government shall compute the total project costs and tender to the Local Sponsor a final accounting of the Local Sponsor's share of total project costs.

1. In the event the total contribution by the Local Sponsor is less than the Local Sponsor's required share of total project costs, the Local Sponsor shall, no later than 90 calendar

days after receipt of written notice, make a cash payment to the Government of whatever sum is required to meet the Local Sponsor's required share of the total project costs.

2. In the event the total contribution by the Local Sponsor is more than the Local Sponsor's required share of total project costs, the Government shall, no later than 90 calendar days after the final accounting is complete, subject to the availability of funds, return the excess to the Local Sponsor. In the event existing funds are not available to repay the Local Sponsor for excess contributions provided, the Government shall seek such appropriations as are necessary to repay the Local Sponsor for excess contributions provided.

ARTICLE VII - DISPUTES

Before any party to this Agreement may bring suit in any court concerning an issue relating to this Agreement, such party must first seek in good faith to resolve the issue through negotiation or other forms of nonbinding alternative dispute resolution mutually acceptable to the parties.

ARTICLE VIII - OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION (OMRR&R)

a. After the Government has determined that construction of the Project or functional portion of the Project is complete and provided the Local Sponsor with written notice of such determination, the Local Sponsor shall operate, maintain, repair, replace, and rehabilitate the completed Project, or functional portion of the Project, at no cost to the Government, in accordance with applicable Federal and State laws as provided in Article XII and specific directions prescribed by the Government in an OMRR&R Manual and any subsequent amendments thereto.

b. The Local Sponsor hereby gives the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the Local Sponsor owns or controls for access to the Project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the Project. If an inspection shows that the Local Sponsor for any reason is failing to fulfill the Local Sponsor's obligations under this Agreement without receiving prior written approval from the Government, the Government will send a written notice to the Local Sponsor. If, after 30 calendar days from receipt of notice, the Local Sponsor continues to fail to perform, then the Government shall have the right to enter, at reasonable times and in a reasonable manner, upon lands the Local Sponsor owns or controls for access to the Project for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the Project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Government shall operate to relieve the Local Sponsor of responsibility to meet the Local Sponsor obligations as set forth in this Agreement, or to preclude the Government from pursuing any other remedy at law or equity to assure faithful performance pursuant to this Agreement.

ARTICLE IX - RELEASE OF CLAIMS

The Local Sponsor shall hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the Project and any Project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

ARTICLE X - MAINTENANCE OF RECORDS

Within 60 days of the date of this Agreement, the Government and the Local Sponsor shall develop procedures for keeping books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to this Agreement to the extent and in such detail as will properly reflect total project -costs. The Government and the Local Sponsor shall maintain such books, records, documents, and other evidence in accordance with these procedures and for a minimum of three years after completion of construction of the Project and resolution of all relevant claims arising therefrom, and shall make available at their offices at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the parties to this Agreement.

ARTICLE XI - GOVERNMENT AUDIT

The Government may conduct audits of the Local Sponsor's records for the Project to ascertain the allowability, reasonableness, and allocability of the Local Sponsor's costs for inclusion as credit against the Local Sponsor's share of total project costs. Any such Government audits shall be conducted in accordance with Government Auditing Standards and the cost principles in OMB Circular No. A-87 and other applicable cost principles and regulations.

ARTICLE XII - FEDERAL AND STATE LAWS

In the exercise of the Local Sponsor's rights and obligations hereunder, the Local Sponsor agrees to comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulations 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

ARTICLE XIII - RELATIONSHIP OF PARTIES

The Government and the Local Sponsor act in an independent capacity in the performance of their respective functions under this Agreement, and neither is to be considered the officer, agent, or employee of the other.

ARTICLE XIV - OFFICIALS NOT TO BENEFIT

No member of, or delegate to, the Congress, or resident commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom.

ARTICLE XV - COVENANT AGAINST CONTINGENT FEES

The Local Sponsor warrants that no person or selling agency has been employed or retained to solicit or secure this Agreement upon agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the Local Sponsor for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this Agreement without liability, or, in the Government's discretion, to add to the Agreement or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE XVI - TERMINATION OR SUSPENSION

a. If at any time the Local Sponsor fails to fulfill its obligations under this Agreement, the Assistant Secretary of the Army (Civil Works) shall terminate this Agreement or suspend future work under this Agreement, unless the Assistant Secretary of the Army (Civil Works) determines that continuation of work on the Project is in the interest of the United States or is necessary in order to satisfy agreements with any other non-Federal interests in connection with the Project. Any delinquent payment shall be charged interest at a rate, to be determined by the Secretary of the Treasury, equal to 150 per centum of the average bond equivalent rate of the 13-week Treasury bills auctioned immediately prior to the date on which such payment became delinquent, or auctioned immediately prior to the beginning of each additional 3-month period if the period of delinquency exceeds 3 months.

b. If the Government fails to receive annual appropriations in amounts sufficient to meet Project expenditures for the then-current or upcoming fiscal year, the Government shall so notify the Local Sponsor. After 60 calendar days either party may elect without penalty to terminate this Agreement pursuant to this Article or to defer future performance hereunder; however, deferral of future performance under this Agreement shall not affect existing obligations or relieve the parties of liability for any obligation previously incurred. In the event that either party elects to terminate this Agreement pursuant to this Article or Article XVIII.c. of this Agreement, both parties shall conclude their activities relating to the Project and proceed to a final accounting in accordance with Article VI. of this Agreement. In the event that either party elects to defer future performance under this Agreement pursuant to this Article, such deferral shall remain in effect until such time as the Government receives sufficient appropriations or until either the Government or the Local Sponsor elects to terminate this Agreement.

ARTICLE XVII - OBLIGATIONS OF FUTURE APPROPRIATIONS

This Agreement does not obligate future appropriations by the South Florida Water Management District. The Local Sponsor will use its best efforts to obtain adequate funding and seek sufficient appropriations in subsequent fiscal years.

ARTICLE XVIII - HAZARDOUS SUBSTANCES

a. After execution of this Agreement and upon direction by the Government, the Local Sponsor shall perform, or cause to be performed, such investigations for hazardous substances as are determined necessary by the Government or the Local Sponsor to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, on lands necessary for Project construction, operation, and maintenance. All actual costs incurred by the Local Sponsor which are properly allowable and allocable to performance of any such investigations for hazardous substances shall be included in total project costs and cost shared as a construction cost.

b. In the event it is discovered through an investigation for hazardous substances or other means that any lands, easements, rights-of-way, or disposal areas to be acquired or provided for the Project contain any hazardous substances regulated under CERCLA, the Local Sponsor and the Government shall provide prompt notice to each other, and the Local Sponsor shall not proceed with the acquisition of lands, easements, rights-of-way, or disposal areas until mutually agreed.

c. The Government and the Local Sponsor shall determine whether to initiate construction of the Project, or if already in construction, to continue with construction of the Project, or to terminate construction of the Project for the convenience of the

Government in any case where hazardous substances regulated under CERCLA are found to exist on any lands necessary for the Project. Should the Government and the Local Sponsor determine to proceed or continue with construction after considering any liability that may arise under CERCLA, the Local Sponsor shall be responsible, as between the Government and the Local Sponsor, for any and all necessary clean up and response costs, to include the costs of any studies and investigations necessary to determine an appropriate response to the contamination. Such costs shall not be considered a part of total project costs as defined in this Agreement. In the event the Local Sponsor fails to provide any funds necessary to pay for clean up and response costs or to otherwise discharge the Local Sponsor's responsibilities under this paragraph upon direction by the Government, the Government may either terminate or suspend work on the Project or proceed with further work as provided in Article XVI of this Agreement.

d. The Local Sponsor and the Government shall consult with each other under Article V of this Agreement to assure that responsible parties bear any necessary clean up and response costs as defined in CERCLA. Any decision made pursuant to Article XVIII.c. of this Agreement shall not relieve any party from any liability that may arise under CERCLA.

e. As between the Government and the Local Sponsor, the Local Sponsor shall be considered the operator of the Project for purposes of CERCLA liability. To the maximum extent practicable, the Local Sponsor shall operate, maintain, repair, replace and rehabilitate the Project in a manner that will not cause liability to arise under CERCLA.

ARTICLE XIX - NOTICES

a. All notices, requests, demands, and other communications required or permitted to be given under this Agreement shall be deemed to have been duly given if in writing and delivered personally, given by prepaid telegram, or mailed by first-class (postage pre-paid), registered, or certified mail, as follows:

If to the Local Sponsor:

Executive Director
South Florida Water Management
District
Post Office Box 24680
West Palm Beach, Florida 33416-4680

If to the Government:

District Engineer
U.S. Army Engineer District
Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232-0019

b. A party may change the address to which such communications are to be directed by giving written notice to the other party in the manner provided in this Article.

c. Any notice, request, demand, or other communication made pursuant to this Article shall be deemed to have been received by the addressee at such time as it is either personally delivered or seven calendar days after it is mailed, as the case may be.

ARTICLE XX - CONFIDENTIALITY

To the extent permitted by the laws governing each party, the parties agree to maintain the confidentiality of exchanged information when requested to do so by the providing party.

ARTICLE XXI - SECTION 902 PROJECT COST LIMITS

The Local Sponsor has reviewed the provisions set forth in Section 902 of P.L. 99-662, as amended, and understands that Section 902 establishes the maximum total project cost. For purposes of this Agreement, the Section 902 cost limit is $572,565,000 as calculated on December 15, 1993. This amount is calculated using procedures set forth in Appendix P of ER 1105-2-100. It shall be adjusted to allow for appropriate increases for inflation and changes in total project costs as provided in Section 902. Should this cost maximum be reached, no additional funds may be expended on the Project until additional authority is obtained from Congress.

ARTICLE XXII - CONTINGENCY OF PERFORMANCE

Performance by either party under this Agreement and any entitlement owing to either party under this Agreement is contingent upon completion of a report by the Chief of Engineers on the Headwaters Revitalization Project that is approved by the Assistant Secretary of the Army (Civil Works).

IN WITNESS WHEREOF, the parties hereto have executed this Agreement.

THE DEPARTMENT OF THE ARMY

John H Zirschky

BY: JOHN H. ZIRSCHKY
Acting Assistant Secretary
of the Army (Civil Works)

DATE: March 22, 1994

SOUTH FLORIDA WATER
MANAGEMENT DISTRICT

Thomas K MacVicar
for

BY: TILFORD C. CREEL
Executive Director

DATE: March 22, 1994

Legal Form Approved
SFWMD Office of Counsel
By Abner Cooper Date 3/18/94

CERTIFICATE OF AUTHORITY

I, Barbara Markham, do hereby certify that I am the principal legal officer of the South Florida Water Management District, that the South Florida Water Management District is a legally constituted public body with full authority and legal capability to perform the terms of the Agreement between the Department of the Army and the South Florida Water Management District in connection with the Project, and to pay damages, if necessary, in the event of the failure to perform, in accordance with Section 221 of Public Law 91-611, that Thomas MacVicar, in executing this Agreement on behalf of the Executive Director of the South Florida Water Management District, has acted within his statutory authority and is fully empowered to execute this Agreement and bind the South Florida Water Management District to the terms thereof.

IN WITNESS WHEREOF, I have made and executed this certification this 22nd day of March, 1994.

Barbara Markham
General Counsel for the South
Florida Water Management District

CERTIFICATION REGARDING LOBBYING

The undersigned certifies, to the best of his or her knowledge and belief that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

DATE: March 22, 1994

Thomas K. MacVicar
Tilford C. Creel
Executive Director
South Florida Water
Management District

CERTIFICATION OF LEGAL REVIEW

The draft Project Cooperation Agreement for the Kissimmee River, Florida Project has been fully reviewed by the Office of Counsel, USAED Jacksonville and is legally sufficient.

Assistant District Counsel

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX J

NAVIGATION IMPACT STUDY

UPPER KISSIMMEE REVITALIZATION BOATING IMPACTS NAVIGATION STUDY

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF CONTENTS (Cont'd)

LIST OF FIGURES

UPPER KISSIMMEE REVITALIZATION BOATING IMPACTS

HISTORY

Early problems on the Kissimmee River were a result of natural droughts in the area that would halt waterborne transportation from 4 to 8 months of the year. Growing steamer traffic on that river in the late 1800s provided cargo and passengers to the region. Reported commerce at that time had a total value of about $151,000. The river port of Kissimmee secured the service of two passenger lines with the potential of a third one in 1902. The growing traffic on the river provided the support necessary to justify a Federal navigation project. The Rivers and Harbors of 13 June 1902 authorized the Federal navigation project in the upper Kissimmee basin. That project provided for a channel 3 feet deep over a bottom width of 30 feet at ordinary low stage.

Waterborne movement of goods and passengers has since declined in this region. Better rail and highway service have replaced cargo movements by water. The navigation features of the project are now part of a more extensive flood control project that came later and provided a broader and deeper waterway. Current usage of those waters is in the form of recreational boating. A 1994 Florida Game and Freshwater Fish Commission Creel Report indicates that recreational boaters contribute over $ 8,510,000 a year (excluding boat/trailer expenditures) to the economy of the upper Kissimmee basin.

PROBLEM AREA IDENTIFICATION

Potential problems areas are most likely to occur at extreme high water above 53.0 feet national geodetic vertical datum (NGVD) and extreme low water below 48.5 feet NGVD. The extreme high water condition is the top elevation of the lowest boat ramps in the impacted area. The extreme low water condition comes from interview information obtained during field work. Those two conditions are most likely in the summer and winter months, respectively. The analysis focuses on boat usage in those months to assess the most likely impact to boating on the lakes.

COUNTY BOAT REGISTRATION DATA

Osceola and Polk Counties are in the study area. Vessel registration for 1995 shows 6,370 and 24,905 recreational vessels in Osceola and Polk Counties, respectively. Those two counties have over 660 commercial vessel registrations. Recreational boat registrations from those counties are by class of boat. The class, length, and number of boats most prevalent in those counties are in table 1.

TABLE 1
Boat Registration

	Recreational Boat	
Class	Length	Number
A-1	under 12 feet	4,041
A-2	12-15 feet 11 inches	13,792
1	16-25 feet 11 inches	11,914
2	26-39 feet 11 inches	374
3	40-64 feet 11 inches	55
4-5	65 and more	2

CURRENT BOAT RAMP USAGE AND CONDITIONS

A field investigation of boating in the area occurred in December 1995 to survey boating facilities as well as boat use. Site visits covered about 40 known public and private boat ramps and marinas in the affected area to determine conditions and usage. The investigation included a weekend to more accurately determine boat use. A count of trailers provided an estimate of usage at each boat ramp. Roughly, that count indicated ramp usage at about 380 boats a day during the weekend in the upper Kissimmee. An estimate of weekday usage is about 40 percent of the usage on the weekend or about 150 boats a day. That estimate is from visual observation and knowledgeable area sources.

Discussions with boaters at the ramp sites provided other information. An estimate of vessel size at the ramps from the field data is in table 2 according to registration class. Boater origin from license plate information on the trailers and discussions with boat owners indicated about 95 boats from the approximate 380 boats a day during the weekend were from out of state. Time spent in using boats from interview data indicated an averaged about 6.1 hours a day on the lakes. Based on the estimated average people per boat from field data, the combined usage is about 18 user hours per boat day. The season of preferred usage is the winter. Boaters also provided information as to their anticipated usage with higher and lower lake regulation stages during the year for comparison with existing usage. Boaters indicated no significant change in their boat usage as other alternatives are abundant in the area.

TABLE 2
Ramp Boats by Class

Class	Boat length	Percentage at ramp boats
A-1	under 12 feet	3
A-2	12-15 feet 11 inches	20
1	16-25 feet 11 inches	74
2	26-39 feet 11 inches	3
3-5	40-64 feet 11 inches	0

Access ramp conditions were visually noted as to water levels in relation to the ends of the ramps. Two ramps appeared to be a potential problem with high water. Discussions with county engineers confirmed the estimated conditions from visual observations.

NAVIGABLE CONDITIONS AND PROBLEMS

The Florida Game and Fresh Water Fish Commission (FG&FWFC) officials provided assistance during field work in determining existing conditions. A visit to each public ramp by water enabled an assessment of channel depths. Rough depth checks of other channels, canals, and navigational routes indicated available water based on the lake stage at that time. The results of those rough measurements compared favorably with more accurate survey data obtained in 1986.

Four waterway areas, identified during recent field work as public access routes, had sufficient shoaling to constrict navigation at a lake stage of 49.8 feet. Two of those shoaled areas are on a main waterway route in Lake Cypress. Lake Hatchineha has one shoaled area on a main waterway route. The fourth area is Tiger Creek which drains Tiger Lake into Lake Kissimmee. Water depth in the creek at an elevation of 48.5 NGVD is an estimated 1.0 feet.

Based on a preliminary assessment of overall water depths in the lakes, the main waterways in the lakes have about 1.5 feet or more of usable depth at a stage of 48 feet NGVD. An elevation of

48.5 feet NGVD enables a depth of about 2.0 feet which is about the minimum for most small outboard traffic to operate. Depths less than that begin to cause boating problems.

Hydrilla is a major navigational problem on two lakes and a minor problem on Lake Kissimmee. Lakes Cypress and Hatchineha have hydrilla that affects boating on about 70 to 80 percent of the lakes' surfaces. The only vessels that have no problems are airboats in those lakes. Boats with propellers in the water have difficulty with navigation through the hydrilla which can foul props and block water intakes. That water plant can be found in nearly all depths of water in the lakes.

Inspection of navigation markers provided data on their height above water and their surrounding water depths. That information enables an assessment on the susceptibility to extreme low or high waters. Depths at low waters can cause vessel grounding if not sufficient for navigation in the marked channel. Extreme high waters could put a marker or a portion of one under water. A preliminary inspection of navigational markers indicated no significant impact would occur to existing markers considering current conditions. Figure 1 shows the condition of a marker on the waterway and is typical of other markers.

AREA DATA COORDINATION

Meetings with county, water management district, and state officials concerning initial findings. The Osceola County officials helped confirm initial findings. The South Florida Water Management District Kissimmee Field Office corroborated data retrieved concerning navigational markers. None seem to pose a potential problem with respect to the proposed lake levels on the upper Kissimmee River.

State officials from the FG&FWFC confirmed a wealth of anecdotal knowledge concerning the location of impediments to navigation with high water at boat ramps. Their annual survey information on fishing effort is current on Lake Kissimmee and indicates the approximate numbers of people fishing on that lake. Current information on Lakes Cypress and Hatchineha was not available. However, a survey in 1985 indicated those lakes had a smaller amount of fishing effort than Lake Kissimmee. That survey indicated the effort in Lake Cypress was about 25 percent of that in Lake Kissimmee. Lake Hatchineha had about 59 percent of the Lake Kissimmee effort. The hydrilla weed in those lakes at that time was not as great a problem as the current situation making those lakes almost unusable except to airboats.

Table 3 provides a preliminary estimate of boating use in the lakes. FG&FWFC observations in the area and their surveys on fishing efforts were primary considerations in obtaining those estimates. Observations during data collection indicated most boats had an estimated two people fishing. The count excludes non-fishing boat usage for other recreational purposes. Their records do not distinguish between commercial and recreational fishing effort. Using the estimated value of two people per boat, current survey numbers were adjusted to show boating use on Lake Kissimmee. Table 3 values for Lakes Cypress and Hatchineha are an estimated percentage of Lake Kissimmee taking into account recent observations with the severe hydrilla problem.

TABLE 3
Boats Used for Fishing

	Estimated Average Boats a Day for Fishing 1/					
	Lake Kissimmee		Lake Cypress		Lake Hatchineha	
Year	Winter	Summer	Winter	Summer	Winter	Summer
1993	944	532	47	27	142	80
1994	974	615	49	31	146	92
1995	-	664	-	33	-	100
Average	959	603	48	30	144	90

1/ Estimates for Lakes Cypress and Hatchineha are a percentage of Lake Kissimmee based on 1985 survey data and recent field observations.

The three lakes have an estimated average total for each season of about 1151 boats a day during the winter and 723 boats a day during the summer. As fishing is a primary activity on the lakes, most of the estimated boat use is already in table 3. Other recreational usage does occur to increase these totals.

Considering the hydrilla problem in Lakes Cypress and Hatchineha, other recreational boating activities in them is probably very small to none. Excluding those lakes from consideration leaves Lake Kissimmee as the primary area for those activities. An increase in boating related to other recreational activities can possibly increase the boats a day another 10 to 20 percent. However, that usage probably involves a shorter day of about 3 hours verses 6 hours for fishing. Increasing the average boats a day in use on Lake Kissimmee by about 15 percent and accounting for the shorter usage period, the equivalent boats for other recreational activities are about 72 and 45 boats a day during the winter and summer, respectively. Estimated total average usage is about 1220 and 650 boats a day for the winter and summer seasons, respectively

LOW WATER IMPACTS

Figures 2, 3, and 4 show stage duration curves for the proposed and observed lake level schedules for each lake from 0 to 100 percent of the time. The ordinary high and low water (OHW and OLW) reference datums are on these figures. The low water end of figures 2, 3, and 4 from 80 to 100 percent of the time are on figures 5, 6, and 7 for an enlarged view of that portion. Field interview information indicates the problems at low water start at about elevation 48.5 feet NGVD under current conditions.

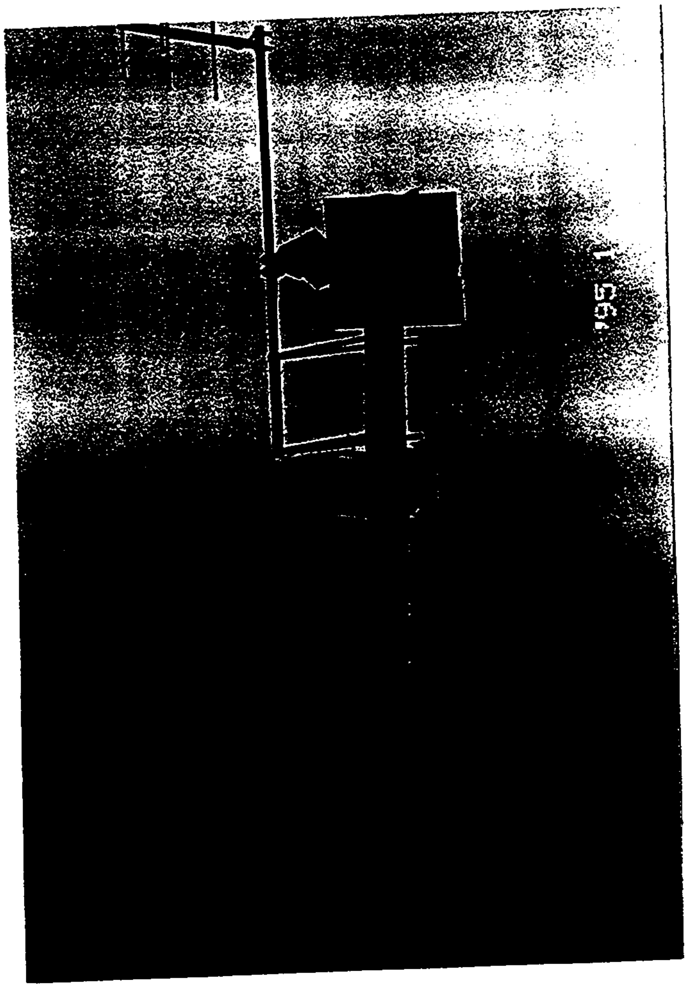
The proposed schedules drop no lower than the 48 feet NGVD stage level which is higher than the observed schedules as shown for each lake on figures 5, 6, and 7. The observed schedule at a lake stage of 48.5 feet NGVD is below the proposed schedule on all three lakes. The proposed schedule offers less of a duration restriction at that low water stage and below than the observed schedule. The proposed schedule, therefore, results in less of an impact on boating use than the observed schedule at low water conditions of 48.5 feet NGVD and lower. This is especially true on Lake Kissimmee which has a more severe drawdown with the observed schedule than the proposed one. Since Lake Kissimmee has the most usage, the obvious conclusion is the proposed schedule has a significant beneficial impact to boating in the area at low water.

Two boat ramps were susceptible to low water impacts. The two ramps are both on Lake Kissimmee. Both ramps face the likelihood of descending into mud flats at water levels of 48 feet NGVD or below. The Osceola County Environmental Services Director confirmed that the county has plans to perform the required maintenance to keep those boat ramps operational during periods of low water. Since low water conditions are better with the proposed schedule than the observed, only a beneficial impact is likely.

HIGH WATER IMPACTS

High water impacts take the form of overtopping the high end of boat ramps and raising boats to higher levels in covered slips. Navigational markers as stated previously will not be adversely affected by proposed high or low waters conditions.

Figure 1



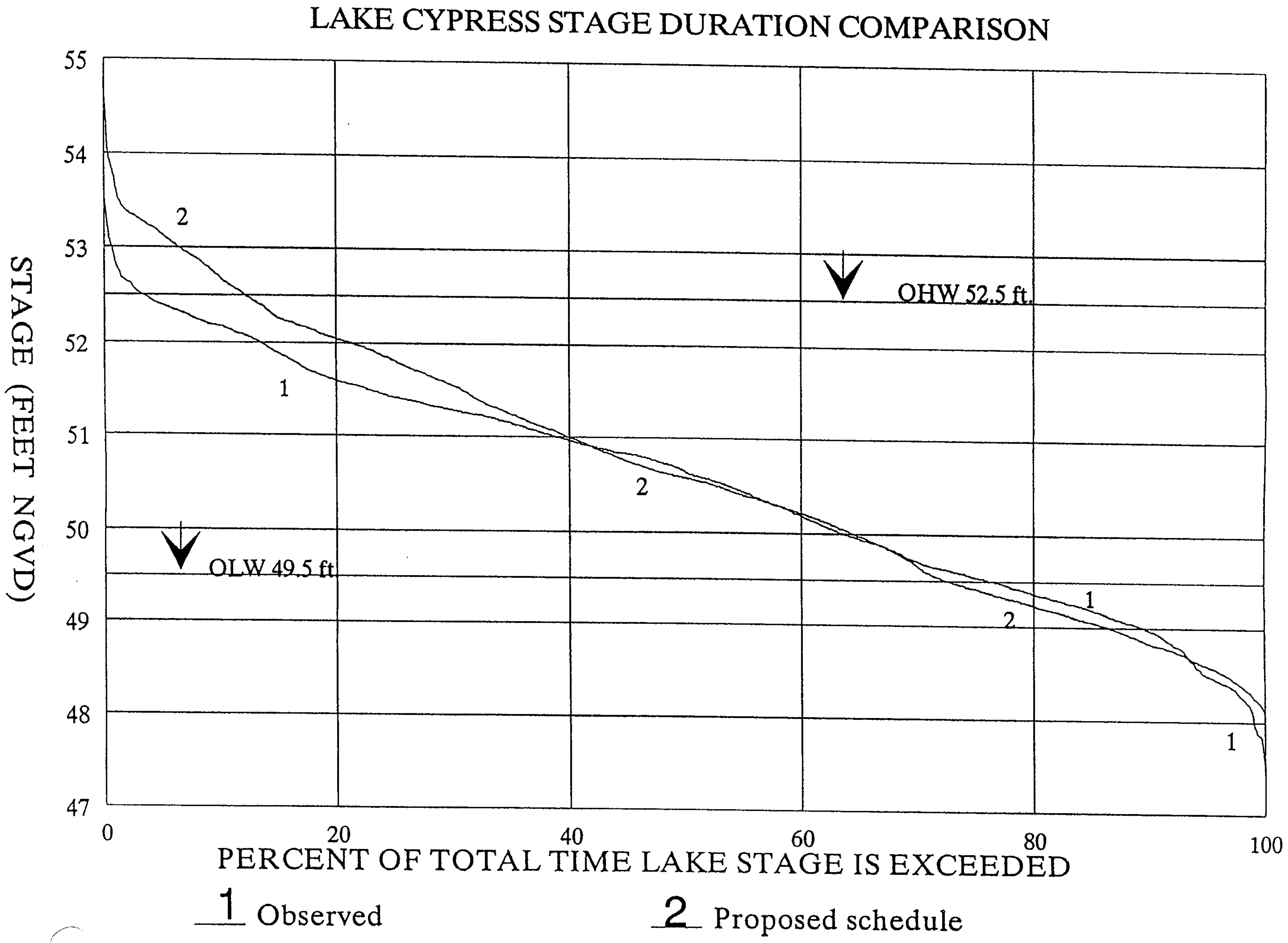

LAKE CYPRESS STAGE DURATION COMPARISON
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
0
20
40
60
80
100
PERCENT OF TOTAL TIME LAKE STAGE IS EXCEEDED
OHW 52.5 ft.
OLW 49.5 ft
1
2
1 Observed
2 Proposed schedule

Figure 2

LAKE HATCHINEHA STAGE DURATION COMPARISON

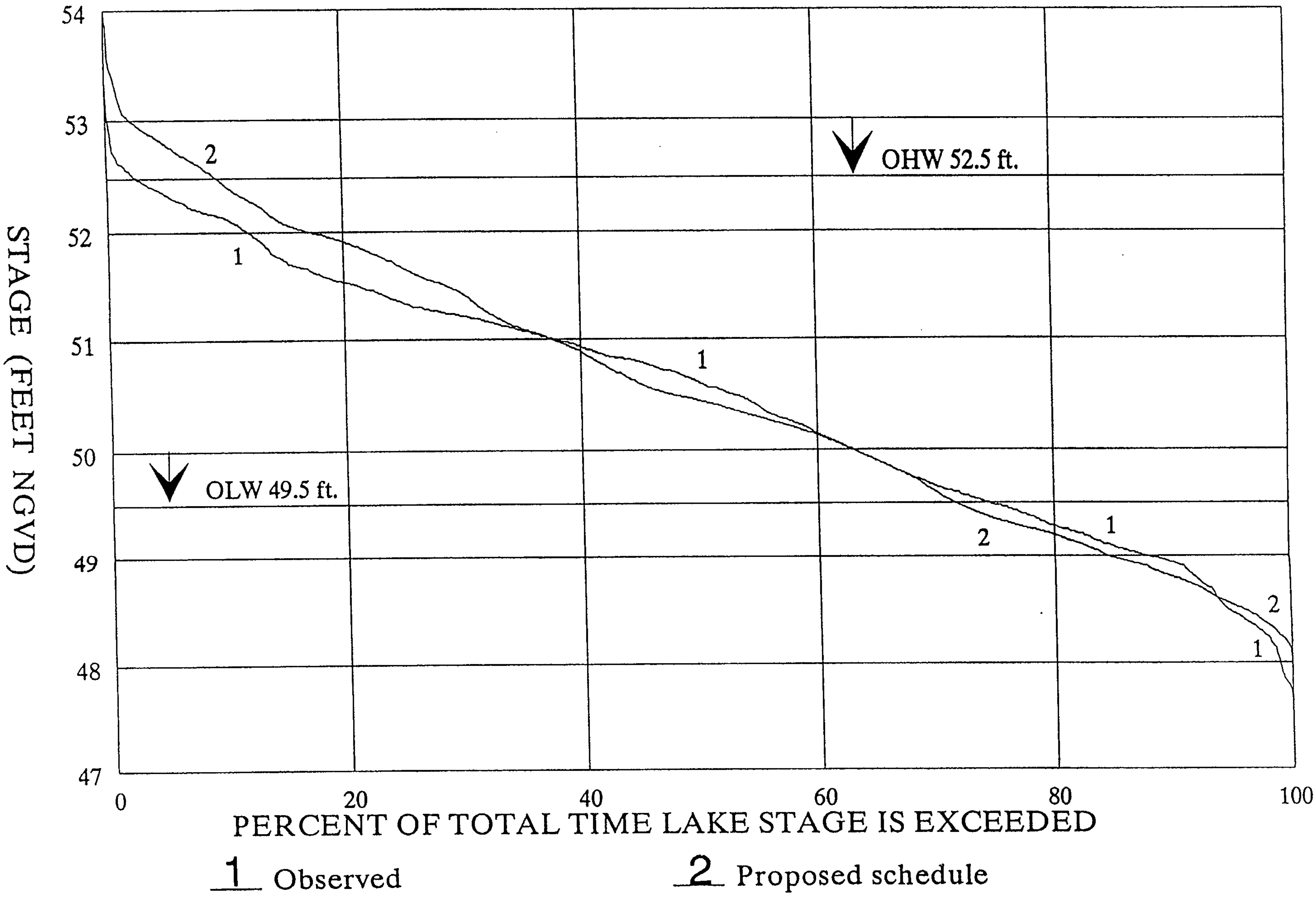


Figure 3

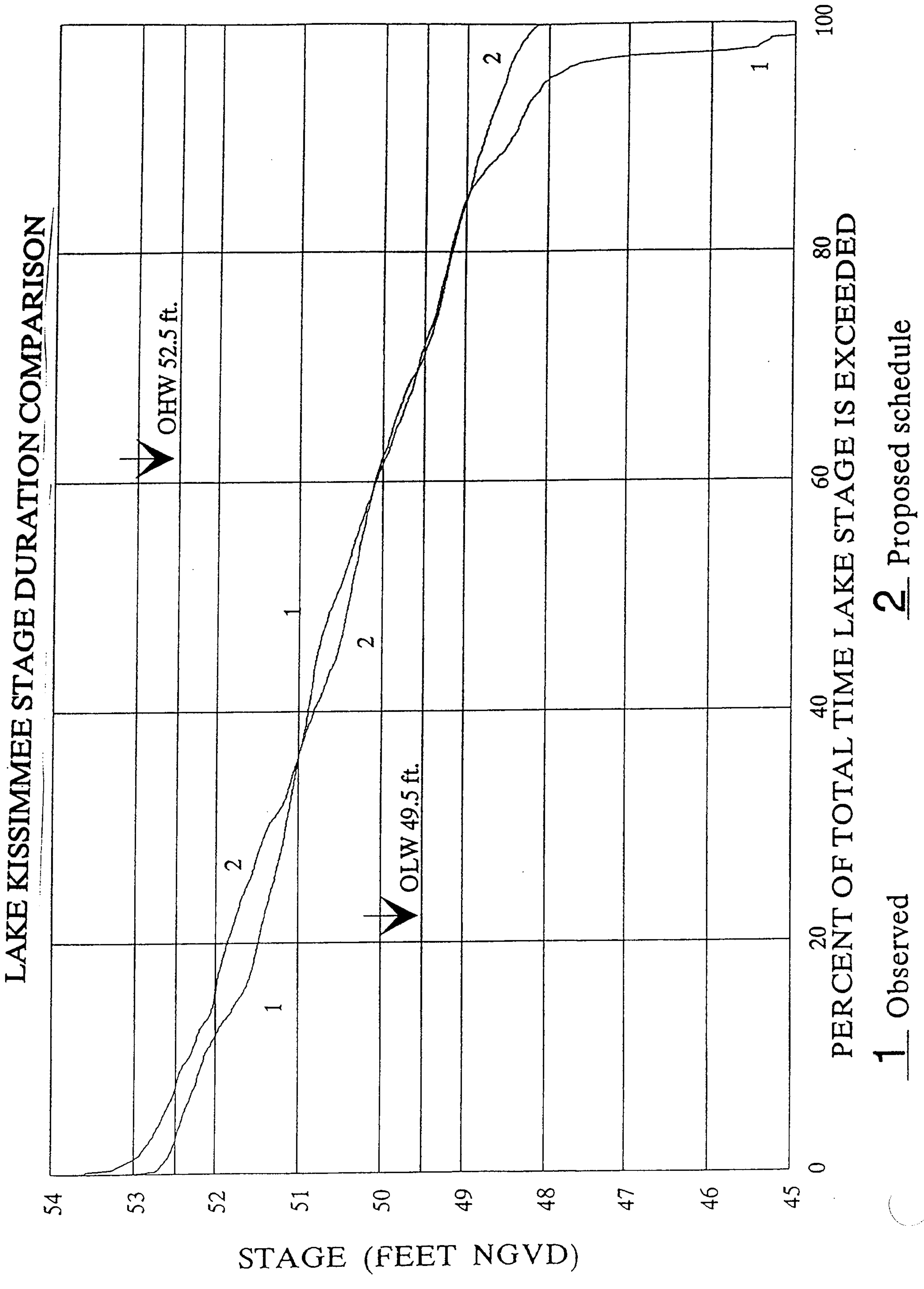
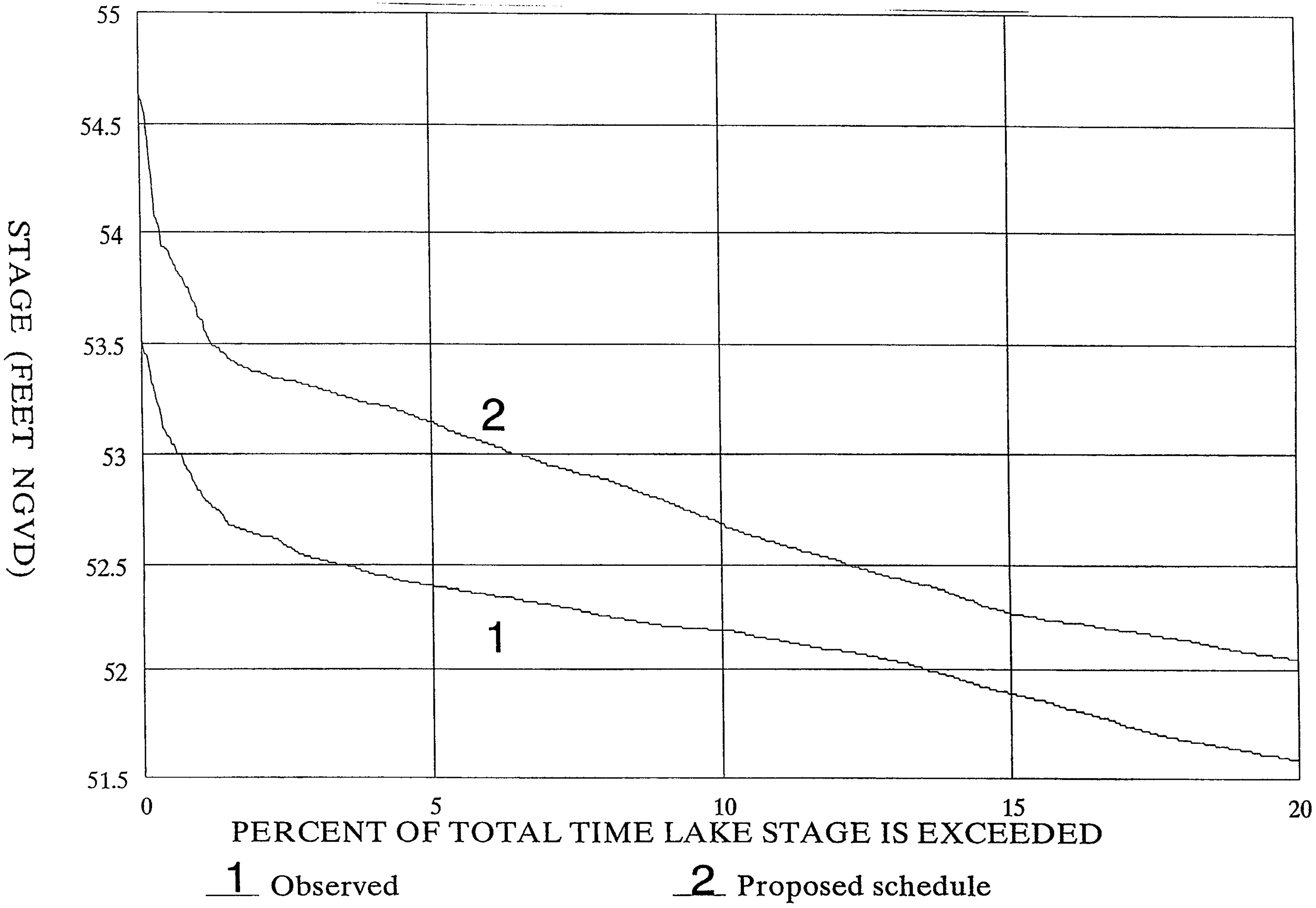
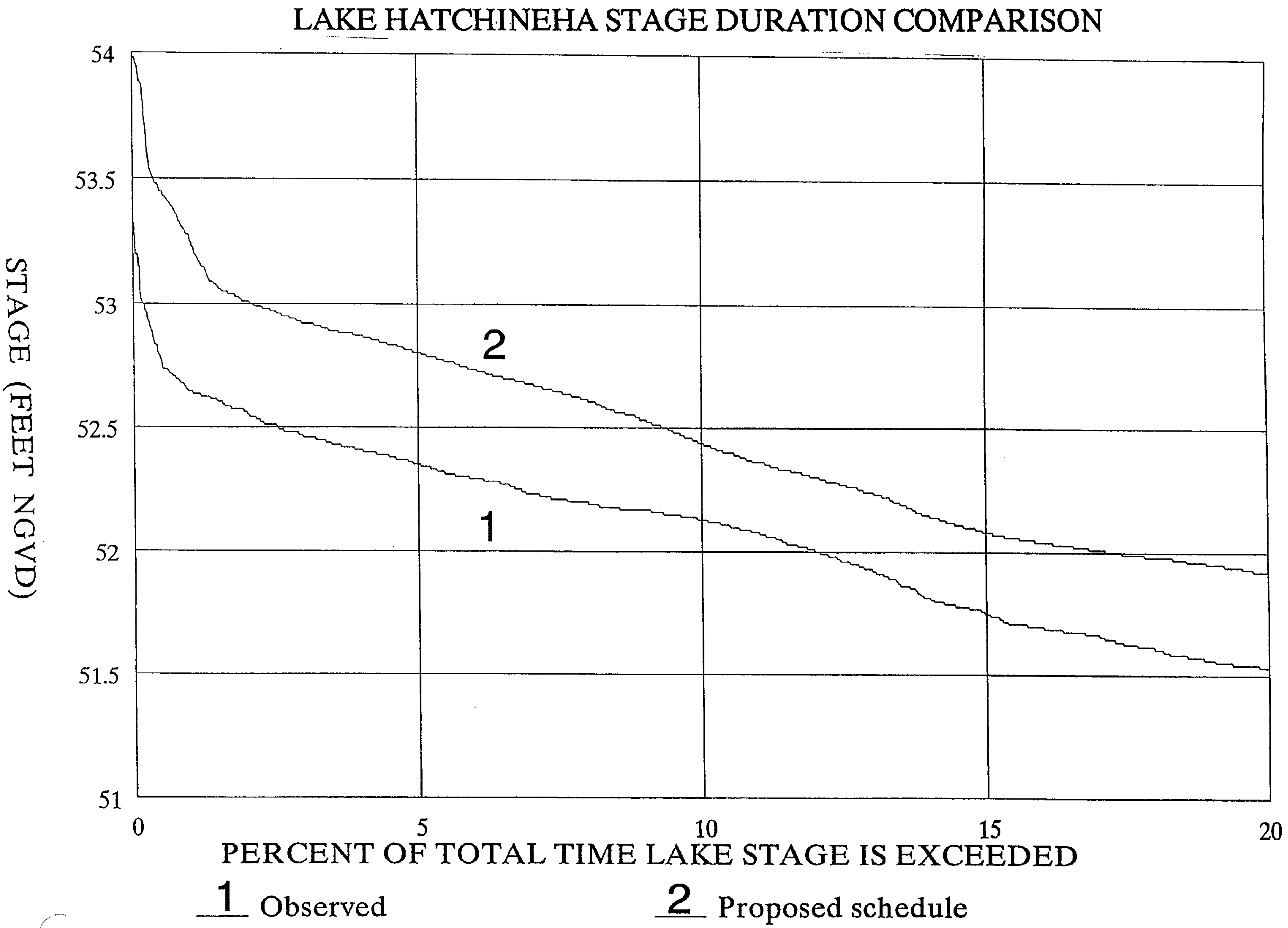

LAKE KISSIMMEE STAGE DURATION COMPARISON
STAGE (FEET NGVD)
54
53
52
51
50
49
48
47
46
45
PERCENT OF TOTAL TIME LAKE STAGE IS EXCEEDED
0
20
40
60
80
100
OHW 52.5 ft.
OLW 49.5 ft.
1
2
1 Observed
2 Proposed schedule

Figure 4

LAKE CYPRESS STAGE DURATION COMPARISON





LAKE HATCHINEHA STAGE DURATION COMPARISON

Figure 6

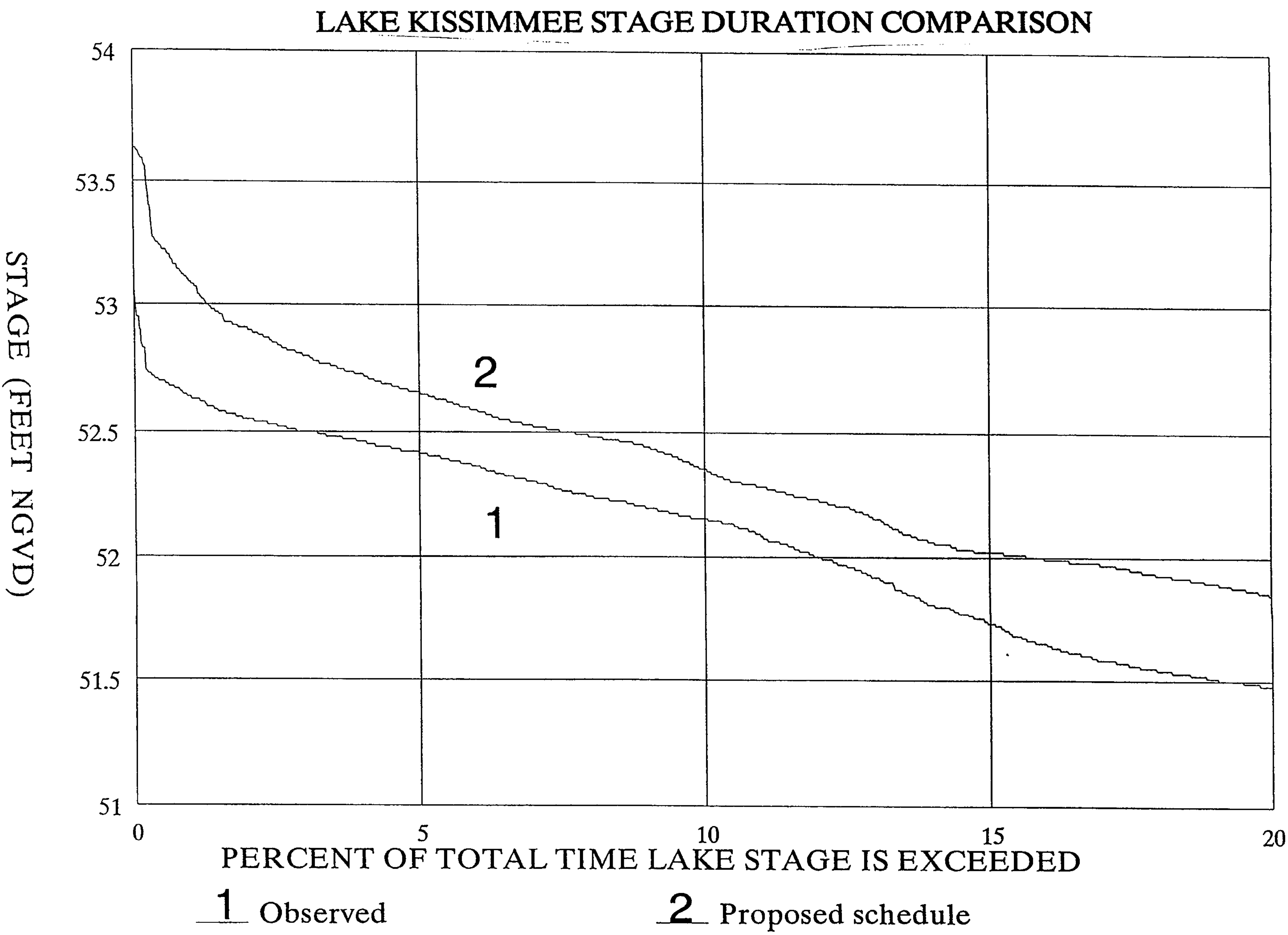

LAKE KISSIMMEE STAGE DURATION COMPARISON
STAGE (FEET NGVD)
54
53.5
53
52.5
52
51.5
51
0
5
10
15
20
PERCENT OF TOTAL TIME LAKE STAGE IS EXCEEDED
2
1
1 Observed
2 Proposed schedule

Figure 7

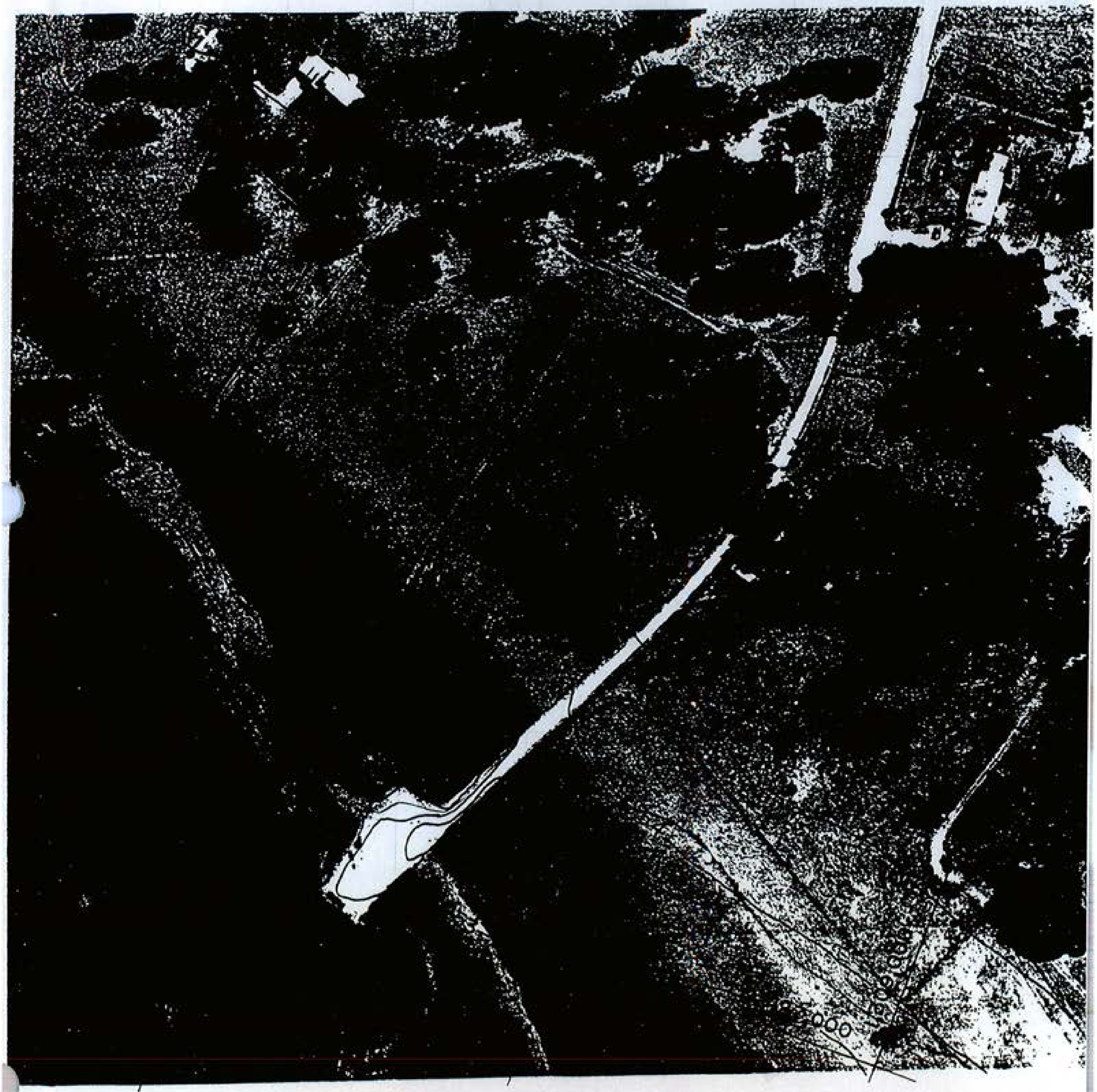
Boat Ramp Access. Two boat ramps are subject to overtopping with water levels above 53 feet NGVD. One is on Lake Kissimmee and the other is on Lake Cypress. Figure 8 is an aerial photograph of the public ramp on Lake Kissimmee and the other ramp is a commercial ramp at a marina. Figure 12 shows the general location of the sites with "P" and "N" (Overstreet's Landing) being the location of the public ramps on Lakes Cypress and Kissimmee, respectively. The triangle on figure 12 with the number "14" in it is the location of a commercial ramp (Grape Hammock) that is subject to isolation. Isolation takes place when the public paved access road leading to the commercial ramp becomes inundated.

The high water level with the observed schedules range from about 53 to 53.5 feet NGVD as shown on figures 9, 10, and 11. The proposed schedule ranges from about 53 to 54.5 feet NGVD. The high water from the proposed schedule can cover the landward ends of the concrete ramps with water which will impact their use for boat access to the lakes. The impacted public ramps on both lakes have dirt roads for access. The private commercial ramp has a paved access road. A portion of those roads nearest the lakes would also be covered with water at a lake level of 53 feet NGVD or above. The total impact with the proposed schedule and the net impact between the proposed and observed schedules is as follows for Lake Cypress and Kissimmee:

Lakes	Total Impact Days a year	Net Impact Days a year
Cypress	24	21
Kissimmee	5	5

Boat Slips. Boat slips in the water numbered about 630 around the lakes and include both private residences and marinas. Approximately 225 have a cover over them and about two-thirds of those are in marinas. Figures 13 and 14 show the types of covered boat slips in the area. About 25 covered slips on Lakes Hatchineha and Kissimmee would be affected with a proposed schedule exceeding 53.9 feet. The net duration of that impact with the proposed schedule over the observed schedule is about 2 days a year in Lake Hatchineha and 1 day a year in Lake Kissimmee between July and September. Interviews with marina operators indicate that dockage is not in high demand at that time of year. Finding other mooring alternatives for 1 or 2 days a year is a minor inconvenience which does not appear to be a significant problem.

Figure 8



LAKE CYPRESS STAGE DURATION COMPARISON

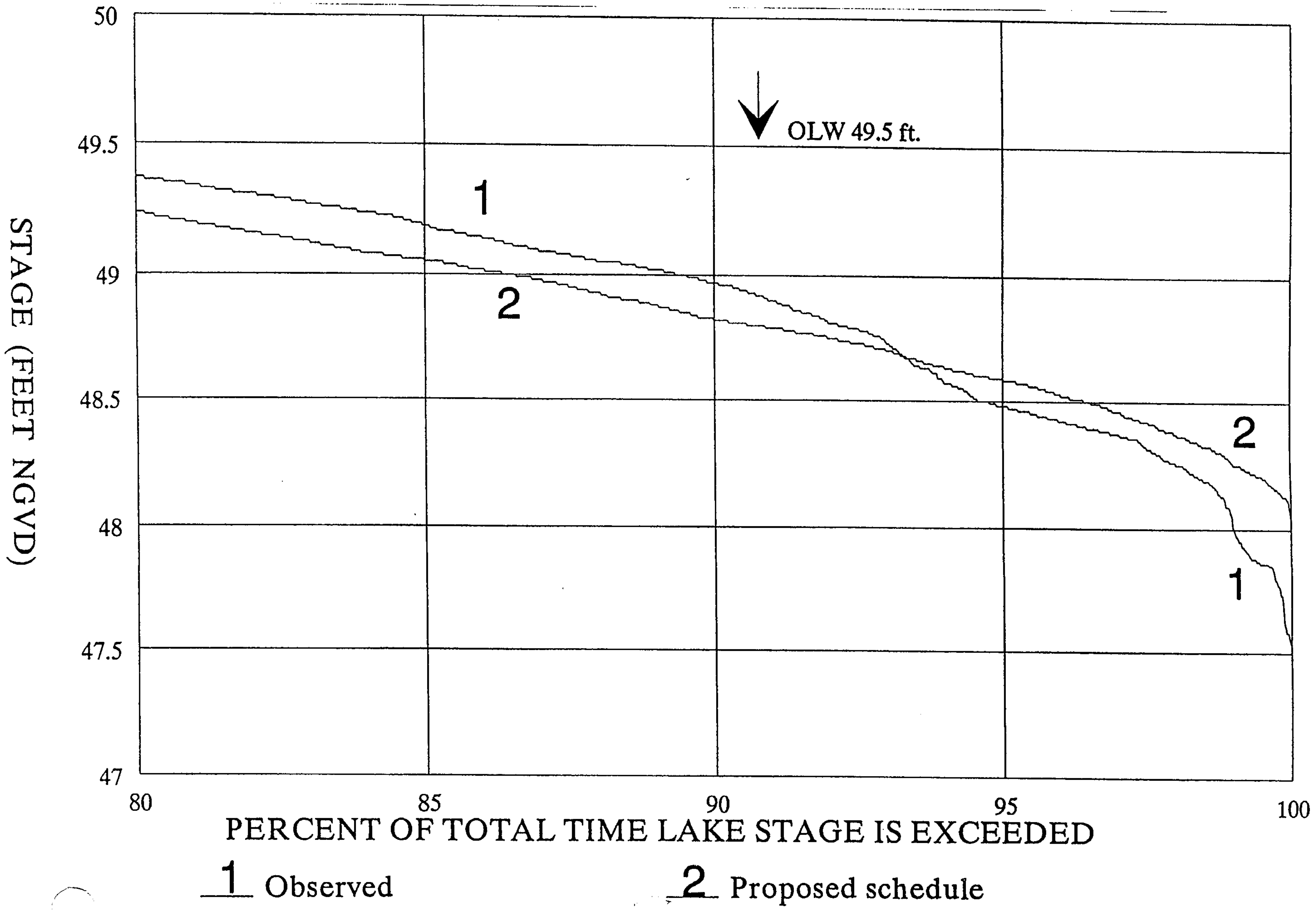


Figure 9

LAKE HATCHINEHA STAGE DURATION COMPARISON

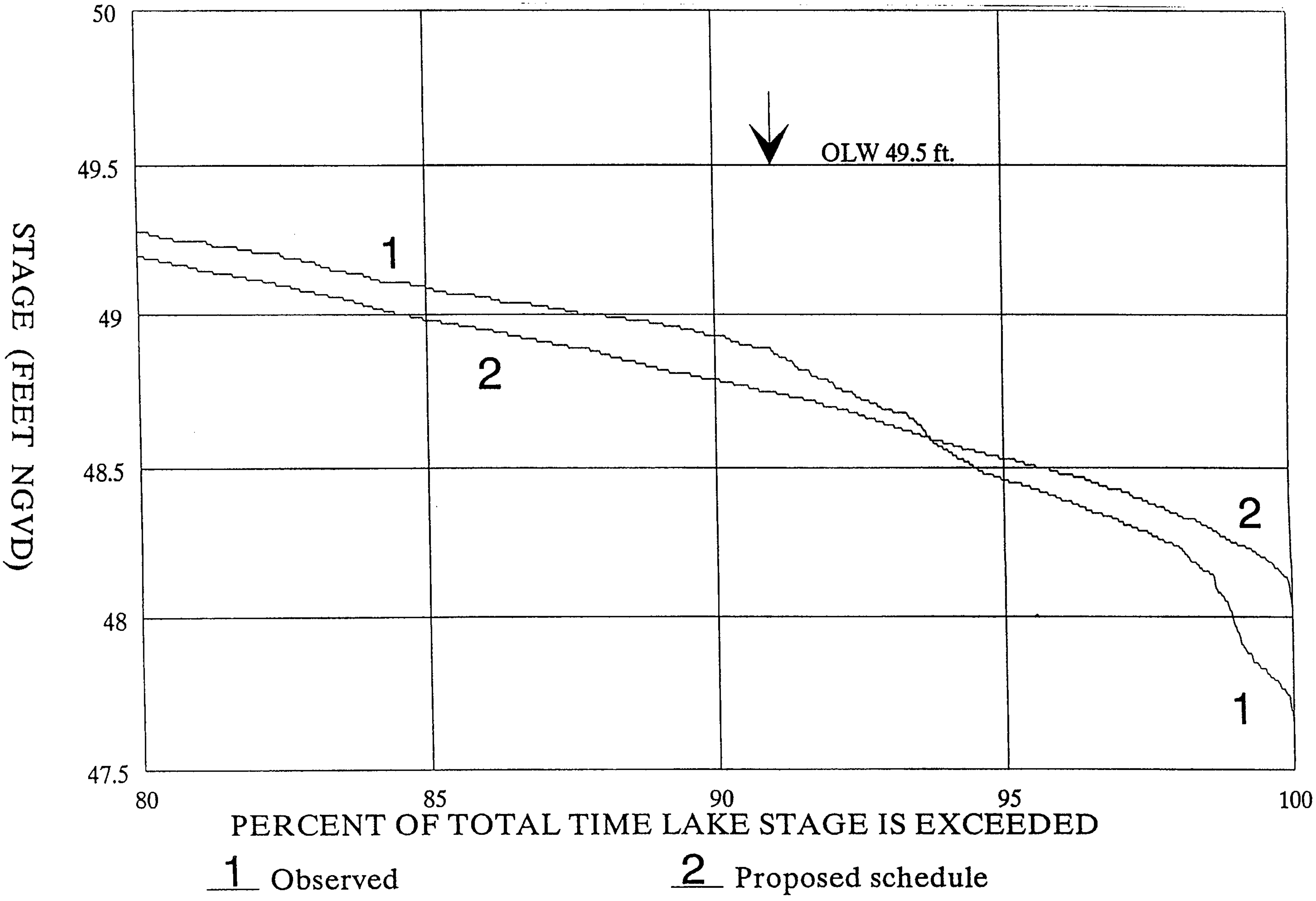


Figure 10

LAKE KISSIMMEE STAGE DURATION COMPARISON

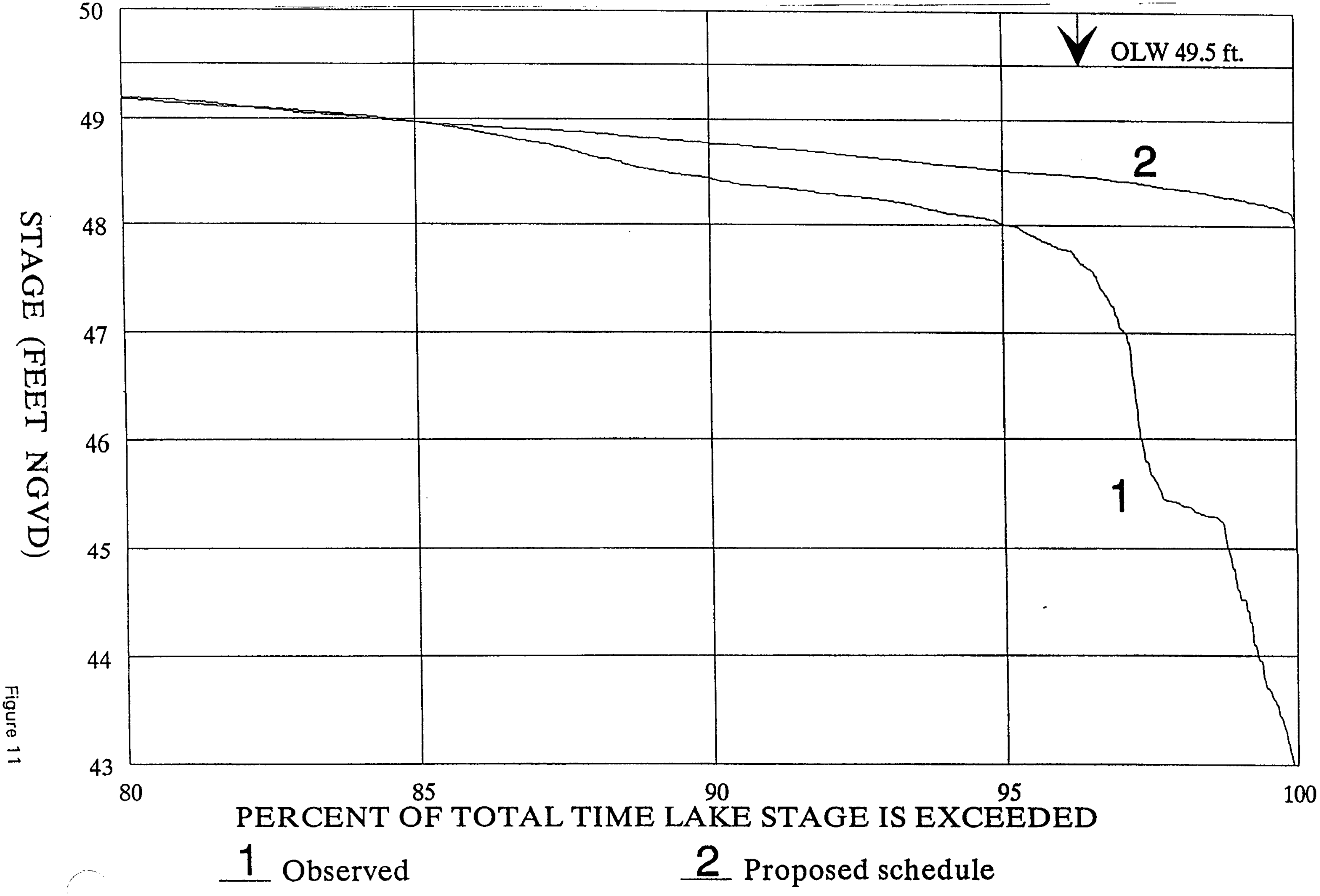
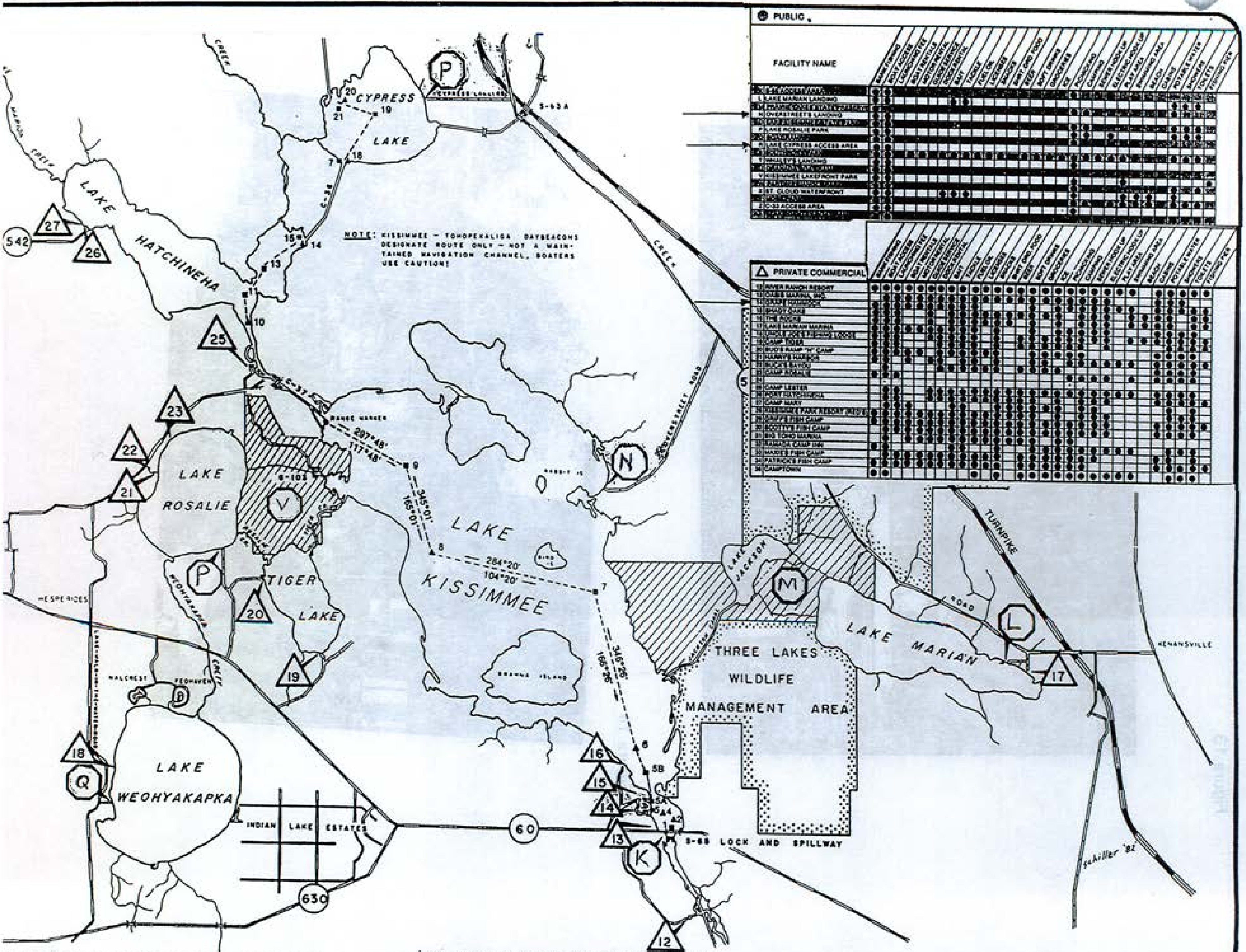


Figure 11



(SEE OTHER PAGE FOR CONTINUATION OF MAP)

Figure 13

Figure 14

Summary. Table 4 is a summary of the estimated impacts from high water on boat use in days. Table 5 is a list of alternative ramps or slips for use.

CONCLUSIONS

The proposed water elevation schedule for the upper Kissimmee basin revitalization appears to have minimal adverse impacts. Those impacts occur during extreme high water conditions above lake levels of 53 feet NGVD. The estimated net impacts of the proposed schedule over the observed schedule are discussed in the subsequent paragraphs. Low water impacts with the proposed lake schedules should be a beneficial impact to boat usage based on existing conditions in the area with no apparent adverse impacts.

Lakes Cypress and Hatchineha. The estimated impacts involve ramps and covered boat slips. Lake Cypress has a public boat ramp impacted during high water. Usable alternative boat ramps are available for access. They are within a 30 minute drive from the impacted boat ramp. High water impacts occur at lake levels exceeding 53 feet. The ramp on Lake Cypress has 21 more days of impact with the proposed schedule than with the observed schedule. About 20 covered slips in Lake Hatchineha and C-37 on figure 12 would have a total and net impact of 2 days a year with the proposed schedule. The net and total impact is the same because the observed high water schedule does not get 53.9 feet NGVD for an impact. Such an impact appears minor with the availability of alternative berthing.

Lake Kissimmee. The observed schedule for Lake Kissimmee remains at or below a level of 53 feet NGVD causing no existing impact during high lake levels. Navigational impacts to Lake Kissimmee with the proposed schedule will likely involve overtopping a public boat ramp, isolating a private commercial boat ramp, and raising water levels sufficiently to impact about five covered slips. The boat ramp impacts are possible about 5 days a year on Lake Kissimmee during high water above 53 feet NGVD. The private commercial boat ramp is likely to experience an inundation of the public access (paved road) with high water thus rendering it unusable for boating. Covered slips on the southwest side of the lake can experience less impacted duration but have alternative berthing options to minimize the problem. Duration of extreme high water impacts (water levels exceeding 53.9 feet) on slips should be roughly 1 days a year for Lake Kissimmee.

TABLE 4

HIGH WATER IMPACTS

Summary of Navigational Impacts

Location	Average boat use a day	Days impacted a year	Impacted Boat–days
Lake Cypress boat ramp	30	21	630
Overstreet's Landing boat ramp	20	5	100
Grape Hammock boat ramp	10	5	50
Port Hatch/Kiss. River Marina slips	20	2	40
Grape Hammock/Shady Oaks slips	5	1	5
TOTAL	85	34	825

TABLE 5

RAMPS AND SLIPS

Location	Distance to alternative	Alternative capacity?
Lake Cypress boat ramp	12 miles	Yes
Overstreet's Landing boat ramp	27 miles	Yes
Grape Hammock boat ramp	1 mile	Yes
Port Hatch/Kiss. River Marina slips	1 mile	Yes
Grape Hammock/Shady Oaks slips	1 mile	Yes