

REPORT ON PROGRESS OF HYDROLOGIC,
WATER QUALITY AND LAND USE STUDIES
IN THE KISSIMMEE RIVER WATERSHED
AND LAKE OKEECHOBEE

BY

CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL DISTRICT

APRIL, 1974

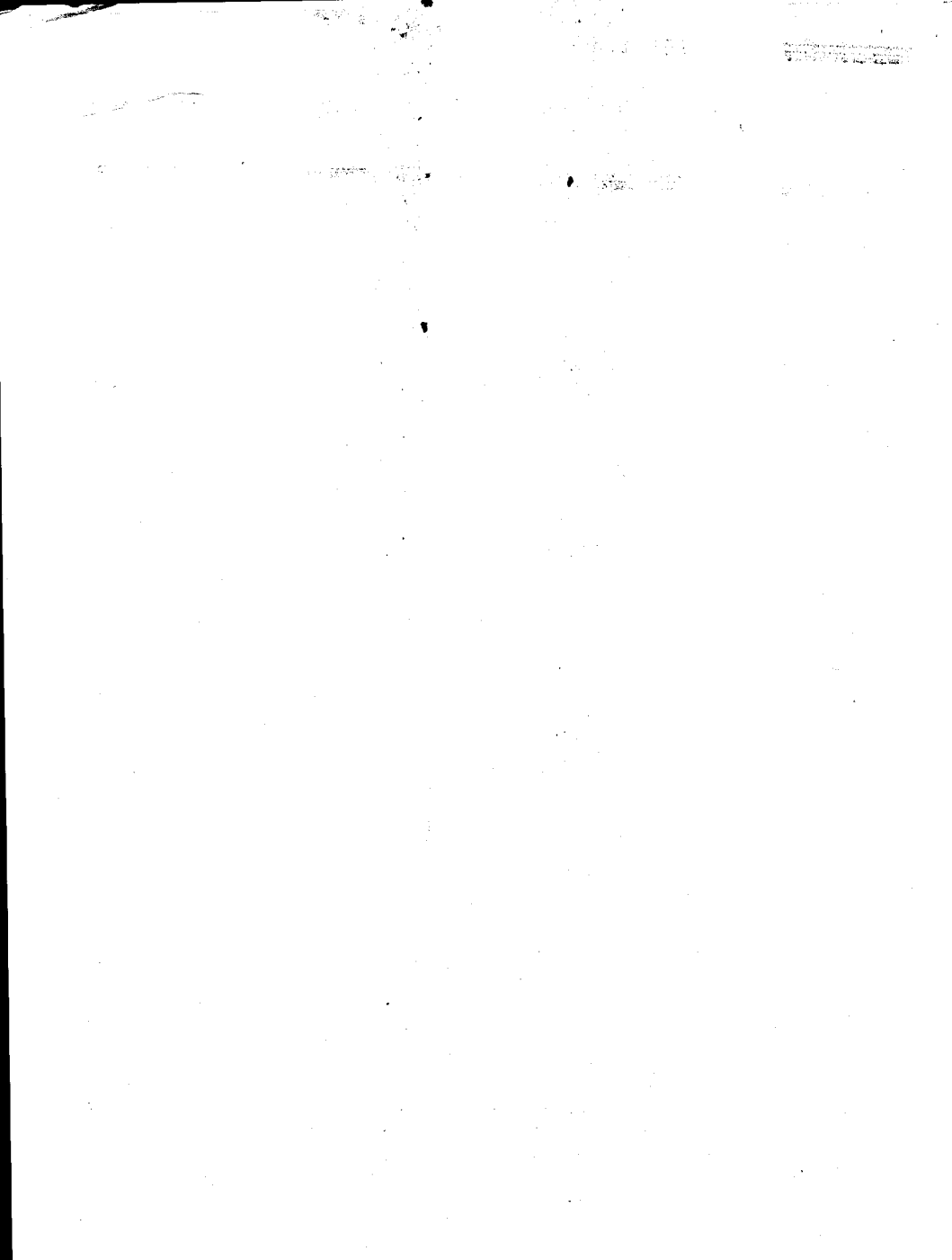


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ABSTRACT

The Central and Southern Florida Flood Control District initiated water quality and related environmental studies in the Lake Okeechobee-Kissimmee Valley area in early 1969. In succeeding years the study effort has been intensified in order to gain a more complete understanding of the physical and man-induced relationships which now exist, and to develop a capability for predicting the environmental impacts of alternative land and water management plans for the region.

At present the District has underway a series of inter-related hydrologic, water quality, biologic and land use programs. A portion of these are being funded through use of District ad valorem tax funds; the remainder are being supported through funds made available by the "Special Project to Prevent the Eutrophication of Lake Okeechobee." These programs include biological inventories, hydrologic data collection, land use mapping, system modelling, water quality monitoring, nutrient budget determinations, nutrient loading studies, and marsh nutrient assimilation investigations, among others.

Prior to the 1973-74 fiscal year the District expended an estimated \$156,900 on these studies. These expenditures were matched by \$136,300 expenditure by the U. S. Geological Survey.

In the 1973-74 fiscal year, to date, the cost of District-funded programs is an estimated \$305,000 and the cost of Special Project funded programs is an estimated \$115,600; for a total of \$420,600.

The study programs described in this report are designed to continue during the 1974-75 fiscal year, except for those contract items which will be completed this fiscal year. The District staff intends to recommend to its Governing Board the continuation in fiscal year 1974-75 of those present programs funded by the District at approximately the same level of effort as during the current fiscal year. No major change in program direction is contemplated.

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PURPOSE

The purpose of this report is to describe the several study programs in which the District is involved in the Kissimmee-Lake Okeechobee area, and to present information concerning the present status of those programs and planned future work.

Portions of the work described herein were initiated by the District in the period between January, 1969 and November, 1972. In November, 1972, the District Board held a public hearing concerning the Kissimmee Valley area. Its findings and recommendations were presented to the Governor and Cabinet on December 12, 1972. These recommendations were:

- "1. A program should be immediately initiated to correct existing pollution sources in the Kissimmee Basin. Adequate restrictions should be placed on any new facilities which will discharge into the waters of the basin.
- "2. A program should be initiated to plan and control all land and water use activities in the basin. Particular emphasis should be given to treatment of agricultural and urban runoff, sewage effluent, and industrial discharges. Acceleration of land and water use planning and control within the State plan is mandatory.
- "3. It is essential to implement the first two (2) recommendations above, before or concurrent with, further restoration of the Kissimmee marshes, beyond that recommended by the Flood Control District staff. A study should be initiated to determine if additional restoration will be needed and to what extent. In this connection, it is recommended that an inter-disciplinary team be established to assist in making such determinations. In conjunction with the study, and as a part of it, there should be an extensive monitoring program of water quality in the Kissimmee Basin and Lake Okeechobee to determine the effectiveness of pollution control at the source and land and water use regulations.

"4. Because of the presently divided responsibility for water quantity and quality and land use planning, among several agencies and subdivisions of government, it is recommended that authority in the Kissimmee basin for these necessary elements of land and water management be given administratively, if possible, and legislatively, if necessary, to the Flood Control District. This is the best means of accomplishing the overall task of land and water planning management in the Kissimmee basin.

"5. If the task of land and water management in the basin is to be accomplished properly, it will be necessary to confer upon the District the power of eminent domain with sufficient latitude to fulfill the objectives of the program. Furthermore, it appears that Chapter 72-317, Laws of Florida (The Environmental Land and Water Management Act of 1972), will have to be strengthened to confer the power of eminent domain where it may be necessary to acquire lands in areas of critical State concern."

As a result of those recommendations, the first three of which were adopted by the Governor and Cabinet and the last two referred to the Division of State Planning, the major effort of the District described in this report was initiated.

The main body of the report is organized under two major headings:

1. Studies undertaken by the Flood Control District, funded by District ad valorem taxes; and
2. Studies undertaken by the Flood Control District under the "Special Project to Prevent the Eutrophication of Lake Okeechobee", funded by Legislative appropriation.

Appendix A is a brief summary of physical and historical information on Lake Okeechobee and the Kissimmee Valley. Also included in Appendix A is background information on actions which have led to the intensive investigations now underway in the study area. Appendix B is a summary of costs incurred to date. Appendix C is a bibliography.

DISTRICT FUNDED STUDIES

LAKE OKEECHOBEE: (See Figure 1)

For the 1968-1969 fiscal year, the District Governing Board authorized, and budgeted for, a study of the enrichment aspects of Lake Okeechobee to be included in the District's on-going cooperative program with the U. S. Geological Survey. This study was initiated in January, 1969, and was terminated with the publication of a U.S. Geological Survey open-file report in September, 1971. The report, by B.F. Joyner, is entitled "Appraisal of Chemical and Biological Conditions of Lake Okeechobee."

With the expansion of the District's environmental staff (biologists, botanists, environmental engineers and water chemists), and the development of a water chemistry laboratory it was decided that the District would carry forward, and expand on, the initial preliminary work done in cooperation with the U. S. Geological Survey. The need was seen to be one of developing an understanding of how the present Lake Okeechobee system functions; what are the natural and man-made processes which are at work and how do they interact? From this understanding predictions can hopefully be made concerning responses of the system to future stresses and to the reduction of existing stresses. The District's programs are geared to this need.

In general terms the studies are being carried forward in four disciplinary areas:

1. Hydrology
2. Biology
3. Water Chemistry
4. Systems

1. Hydrology

- a. Water Budget: The historic and present inflow-outflow regime of the Lake is being determined. Past data at all surface inflow and outflow points is being assembled for computer application and current data is being collected.

Evaporation and meteorological data is being assembled, and current data is being collected. Additional meteorological stations in the Lake are being installed in the current fiscal year.

- b. Circulation: During the present fiscal year instrumentation for determining the direction and velocity of major circulation patterns in the Lake has been tested. Nine such devices, providing a film record of current direction and velocity, will be installed in the present year; data collection to begin in approximately two months.

Dye studies to qualitatively track the movement of water in the Lake will be initiated in two selected areas next fiscal year. One area will be along the south rim, where surface runoff from the Ag Area is being discharged. The other is along the west shore to gage Lake-littoral zone (marsh) water interchange.

- c. Streamflow: The HEC streamflow generator program has been adapted to the Lake Okeechobee area and to the District's in-house computer system. This will be used to develop surface water inflows to the Lake under varying land and water use conditions, when predictive work under these programs is initiated.

Available land use and associated water use projections will be examined for validity during the current fiscal year. Adjustments and modifications will be made as necessary. This will be used in the streamflow generation model.

The streamflow generator will be tested and ready for predictive runs by October 1, 1974.

2. Biology:

- a. Littoral Zone: The marsh vegetation studies, along the west shore of the Lake and in the Chancey Bay area on the northeast shore, were initiated in July, 1972. Three vegetative transects have been established. Along these transects detailed plant community data (obtained from 2512 stations) has been documented. These have been related to ground elevations and an emergent vegetation map of some 127 square miles of littoral zone is being prepared; about 100 square miles of mapping is now complete.

During the next fiscal year similar documentation will be carried forward for submerged vegetation in the Lake. Also density and biomass values will be established for the major plant species. Finally, soils analyses will be made at selected locations along the transects to determine the relationships, if any, between soil characteristics and plant communities.

- b. Limnetic Zone: This work was initiated in early 1973. Monthly primary productivity measurements are being made at four sites. Qualitative and quantitative analyses of phytoplankton populations are conducted at monthly intervals at eight sites on the Lake and at one in C-38 below S-65E. Similar analyses of zooplankton populations are being conducted quarterly at the four primary productivity sites. Finally, qualitative and quantitative analyses of benthic invertebrate populations are being conducted quarterly at the nine phytoplankton stations.

A preliminary report on the sampling and analyses to date is presently in preparation.

In the next fiscal year the above described work will be continued. In addition a vertebrate sampling program will be initiated to determine the nutrient assimilation characteristics of these populations.

3. Water Chemistry:

- a. Nutrient Budget: Data collection for nutrient and dissolved solids budgets was started in April, 1973. Wet season samples were collected weekly, and bi-weekly during the dry season. Samples are being collected at all inflow points to the Lake. Rain water samples are being collected and analyzed.

A cooperative undertaking has been developed in this activity with the Corps of Engineers, and since January, 1974, the Corps has been collecting and analyzing most of the samples necessary for the budget studies.

- b. Monitoring: Water quality monitoring within the body of the Lake was started by the District in October, 1972, at nine stations. Field measurements of pH, temperature, dissolved oxygen and conductivity are made at top and bottom locations. Water samples for lab analysis are also being collected at these sites. Under the cooperative effort with the Corps of Engineers the District, in February 1974, was able to increase the sampling frequency to bi-weekly.

The water quality data from these stations is being related to the information being collected under the previously described limnetic zone biological studies.

This work will be continued in the next, and succeeding, fiscal years.

- c. Littoral Zone: Since February, 1973, water samples and field measurements of pH, temperature and conductivity have been taken along the three vegetation transect lines described previously. Bi-monthly samples have been collected and are analyzed for nutrients and major ions.

The sampling schedule will be shortly changed to a monthly frequency on two transects, and this schedule will be followed in the next fiscal year.

- d. Sediments: During the current year a soils laboratory was equipped and personnel recruited. Methods for sampling were evaluated.

During the next fiscal year sediment cores will be obtained and analyzed. An attempt will be made to determine depositional history and rates of deposition.

Studies will be conducted concerning the chemistry of the sediment-water interface in terms of the binding of nutrients (phosphorous) to the sediments and/or the re-cycling of nutrients from the sediments into the body of the Lake.

- e. Agricultural Runoff: In April, 1973, the District initiated a cooperative study with the U. S. Sugar Company to obtain water quality and hydrologic data from two types of agricultural operations in the agricultural area south of Lake Okeechobee. One area is pasture on sand lands and the other sugar cane on muck lands. Water quality and hydrologic data has been collected on these two tracts of land, together with data on total loading entering the Lake from the primary receiving canals.

This program will be evaluated next month and quite probably expanded to include a truck crop operation next fiscal year.

4. Systems:

- a. Budgets: This is the least complex type of system being analyzed. This is a simple input-output model, dealing with sources and sinks. Water is the transport mechanism for pollutants. Water inputs and outputs to the Lake have been determined, as described earlier. These together with the water quality data described in the water chemistry section are now being used to develop, seasonally and annually, total amounts of various constituents entering, leaving and remaining in the Lake.

The streamflow generator will be used during the next fiscal year to predict similar water and nutrient budgets for the Lake under a variety of conditions of land use, water use and Lake regulation.

- b. Receiving Water Model: A receiving water model, developed by Drs. Heaney and Huber at the University of Florida for Conservation Area No. 3, is being adapted for Lake Okeechobee and for the District's EDP facilities. It is hoped that this model can be used to provide some predictive capability for the movement of water within the body of the Lake in response to inflows, outflows, wind stresses and other factors affecting circulation.

This model will be ready for testing early next fiscal year once sufficient field data on circulation, wind velocities and direction have been collected and assembled.

- c. Littoral System: Emergent marsh data and hydrologic data (Lake stage) have been matched to the extent that a preliminary model of the plant community-Lake stage relationship has been determined. This system, in terms of the single parameter of Lake stage, has been described and a preliminary predictive capability has been developed.

Additional work will be done next year, as described earlier, in terms of soils chemistry, marsh-Lake interchange of water, and extended water quality sampling. These additional parameters will enable the marsh system to be more completely described. This will permit a more sophisticated model of this system to be developed giving a firmer capability for predicting changes in the make-up, location, and effect of the marsh system with changes in Lake hydrology.

- d. Limnetic System: Available water quality, phytoplankton and productivity data is currently being analyzed for relationships. Circulation data collection has not yet started, but soon will be. Sediment-water interface exchange data will not be obtained until next year. All of these factors, plus others, are involved in the limnetic zone system.

Once sufficient data is obtained in all of these areas it will be analyzed to determine whether or not any systematic relationship appears to exist and is describable. If this proves to be the case, an attempt will be made to develop a mathematical model describing this system. Such work will not start until near the end of the next fiscal year.

KISSIMMEE VALLEY: (See Figure 2, Lower Valley and Figure 3, Upper Valley)

The studies being undertaken in the Kissimmee Valley with District funds can be most conveniently described and reported on under the following major headings:

1. Nutrient Loading - Lower Valley
2. Nutrient Assimilation - Lower Valley
3. Marsh Vegetation - Lower Valley
4. Water Quality Inventory - Upper Valley
5. Hydrologic - Economic

Some of these studies, initiated by the District as District programs have been expanded in scope under the "Special Project", funded by Legislative appropriation. These are identified below by an asterisk.

*1. Nutrient Loading (L.V.): In 1971 the District initiated a cooperative program with the U.S. Geological Survey for the collection and analysis of nutrient and other water quality data upstream and downstream of the S-65 structures. Data collection under this program stopped in June, 1973. The report will be completed by the U.S. Geological Survey in the current fiscal year.

In July, 1973, the District picked up the data collection program and expanded it to include sampling sites in mid-reach. Data collection in the river ox-bows was also started.

Early in 1974 eleven major inflow sites to C-38 were selected and water quality sampling was initiated. Instrumentation for flow measurements suitable for these locations was developed and tested. These will shortly be installed and data collection will start.

Instrumentation has been installed to obtain rainfall and groundwater level data in these tributary areas.

In these major tributary areas land use and land drainage has been mapped. Information on cultural practices is being obtained.

The work done by the U.S. Geological Survey gave a general indication of the amounts and patterns of nutrient loads entering C-38 by structure reach between Lakes Kissimmee and Okeechobee. The District's expanded work is designed to more closely identify the sources, causes, nature, volumes and variability of pollutant loadings by establishing the relationships between water quality, streamflow, drainage practices, land use, intensity of land use, and land use practices. These relationships must first be established and described in order to determine the regulatory measures, if any, which will prove the most effective.

The data collection indicated will continue through the next fiscal year, and analysis of the data for the purpose of identifying relationships will be started.

2. Nutrient Assimilation (L.V.): A test area for this program is being constructed in a diked-off portion of the former flood-plain immediately upstream of S-65B. The site preparation work consists of the construction of new dikes, re-building of existing dikes, and installation of pumps and flow control structures. The test area will be ready for operation in approximately two months.

Detailed water and nutrient budget studies under various overland flow regimes will be conducted. The program includes collection of soil samples for nutrient analysis and collection of samples of several types of vegetation for tissue analysis of nutrients and for biomass estimation. Flows will be carefully regulated and monitored in order to permit residence time of water in contact with the marsh to be calculated.

The purpose of this study is to determine the nutrient up-take characteristics of the natural flood-plain when subjected to a simulated natural flow regime and possible alternative flow regimes. A preliminary water transport model for the original river-flood plain system has been developed. This model relates water-marsh contact time to depth of water flow, and relates the proportion of total flow which was in contact with the marsh to depth of flow. The data from the marsh nutrient uptake studies will be used in this transport model, or a further refined version of that model, to evaluate the effectiveness of the former, or a restored, flood-plain as a nutrient assimilation mechanism.

One portion of the test area will also be used to obtain values for the friction factor used in calculation of flow rates. These values will be used in the transport model.

The studies in this test area will extend over a period of at least two years.

3. Marsh Vegetation (L.V.): These studies were initiated by the District in 1971. The initial work involved a vegetation inventory and extensive sampling of fish populations and productivity. The result of this initial inventory work was a program for the experimental fluctuation of water levels in the impoundment pool upstream of S-65B.

Over a two-year period this pool was subjected to a drawdown of water elevations for a 60-day period in each year. Associated with each drawdown was the application of certain vegetation control techniques, such as burning, use of herbicides and mechanical clearing. A report on the results of this program was published last month. The work to date indicates that a viable marsh environment can be restored by fluctuating water levels.

Work with experimental fluctuations, both raising and lowering, will be continued during the current fiscal year and next year. This work will be extended to the impoundment pool above S-65C, the largest and deepest in the system. The objective here will be to arrive at a management program for the impoundment pools which has the prospect of restoring an optimum marsh environment consistent with other objectives.

Associated with this is the program for acquisition of additional flood-plain lands upstream of Structures S-65B through S-65E.

4. Inventory (U.V.): Water quality sampling was initiated by the District in July, 1973, at a total of 23 sites in Lakes East Tohopekaliga, Tohopekaliga, Cypress, Hatchineha and Kissimmee. This sampling will be continued during the next fiscal year, and will be extended to the major lakes of the chain upstream of Lakes East Tohopekaliga and Cypress. In addition, phytoplankton and primary productivity sampling will be initiated in these same lakes.

Associated with this work is the review and evaluation of current lake regulation schedules from the environmental viewpoint. This environmental evaluation will be completed during the current fiscal year.

In the period 1970-1972 the District cooperated with the U. S. Geological Survey in a water quality program in Lake Tohopekaliga in connection with the experimental drawdown of that lake.

*5. Hydrologic-Economic: In 1969 the District initiated the development of a watershed model for application to the Kissimmee Valley system. This model is capable of simulating streamflows from rainfall input data. Improvements to this model to enhance its capabilities are currently underway. Associated with this a statistical analysis of rainfall was performed in order to synthesize and estimate rainfall data for the Kissimmee Basin.

A water allocation model based on economic benefits was developed and applied to the Kissimmee River Basin. This work was accomplished through a research grant from the Florida Water Resources Research Center (Office of Water Resources Research) in cooperation with University of Florida personnel.

"SPECIAL PROJECT" STUDIES

A study design for the "Special Project" was prepared by the Division of State Planning. After a meeting on June 20, 1973, of the 17 agencies included for participation in the original design only the Department of Pollution Control and the District expressed interest in active participation.

A task group of the DSP, DPC and FCD was formed, specific agency tasks were assigned, and on December 12, 1973, interagency agreements were executed. Of the \$650,000 legislative appropriation for this program, the District share is \$205,000.

The tasks assigned to, and accepted by, the District are listed below. Those which are an expansion of programs initiated by the District with District tax funds are marked with an asterisk.

- #1. Baseline Land Use
- #2. Identification of Land Use Factors
3. Shingle Creek Flood Plain
4. River Basin Planning Model
- *5. Hydrologic Data Collection
- *6. Rainfall/Runoff Relationships
- *7. Kissimmee Watershed Model

1. & 2. Land Use and Land Use Factors: A portion of this work was basically described under the heading "Nutrient Loading", on page 10 of this report. Special Project funding permitted the expansion of this work in connection with that District program.

Special Project funding also permitted the extension of this same work into the Upper Kissimmee Valley. Land use mapping and the identification of land use factors in the Upper Valley as well as in the Lower Valley is being used in connection with the development of a River Basin Planning Model, to be described below.

In connection with that program the District has delivered mylar overlays of the following information: planning unit boundaries, general soils classification, existing land use and land cover, and pre-project (1960) land use and land cover. Extensive regional mapping has been accomplished for geology, soils and topography.

3. Shingle Creek Flood Plain: This sub-watershed, tributary to Lake Tohopekaliga and extending into the Orlando city limits, is one which is receiving tremendous developmental pressure. Two counties, Orange and Osceola, are involved.

The District entered into a contract with Orange County for the determination of the hydrologic impact of existing and committed land use on the Shingle Creek flood plain. An engineering report is to be prepared which will include maps of the areas flooded under selected storms of varying degrees of intensity. The extent and nature of the flooding hazard in this area will thus be delineated and a basis will be available for development of a land and water management plan for the watershed.

Work is on schedule and will be completed during the current fiscal year (June 1, 1974).

4. River Basin Planning Model: The District executed a contract with Drs. J.P.Heaney and W. C. Huber, University of Florida for a project entitled "Environmental Resources Management Studies in the Kissimmee River Basin." The project is in two phases; Phase I to be completed in June, 1974, and Phase II approximately nine months later. Special Project funds have been committed only for Phase I.

Phase I will present an environmental inventory and an economic and hydrologic assessment of management alternatives. The alternatives being considered were selected by the District, in consultation with the investigators. The alternatives are combinations of physical and land system configurations as applied to the Kissimmee Valley, and are listed below:

Physical System

- (a) Existing Kissimmee River, as of 1973.
- (b) Dechannelization of the Kissimmee River.
- (c) Physical separation of C-30 and flood plain

Land System

- (a) Existing land use, as of 1973 (existing land use and environmental controls).
- (b) Restrictive land use controls.
- (c) On-the-land water quality control

Phase II would involve an in-depth evaluation of the more promising alternatives identified in Phase I, and examine questions of equity, ecological and water quality parameters.

This work is presently on schedule.

5. Hydrologic Data Collection: This work has been described under the heading "Nutrient Loading" on page 10 of this report. Special Project funding has permitted the number of gaging sites to be expanded and has permitted the installation of additional instrumentation for groundwater level and rainfall data collection.

6. and 7. Hydrologic Relationships: The work originally done by the District in this area of activity has been described under the heading "Hydrologic-Economic", on page 13 of this report. Special Project funding has permitted the acceleration of work on refinements and improvements to existing models of the hydrologic system.

With Special Project funding the District has also entered into a contract with Dr. T. Waite and Mr. P. C. Rosendahl of the Environmental Engineering Department, University of Miami. This is a water quality model study of the Kissimmee Valley in which, on a dynamic basis, a working model will be developed interfacing the hydrology and water quality aspects of the watershed. The resultant hydrology-water quality interfaced model will hopefully offer a means for evaluating management alternatives.

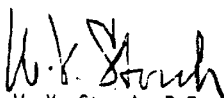
SUMMARY

Overall progress on the Lake Okeechobee-Kissimmee Valley study project has been generally satisfactory. Delays have been experienced in the programs for sediment sampling and circulation studies in Lake Okeechobee due to the necessity to devise, test and procure instrumentation suited to the special

conditions in the area. On the other hand progress has been excellent in the various water quality data collection programs, the several vegetative Inventory and analysis programs both in the Lake and the Kissimmee Valley, and in system model development.

At this point, ten months into the intensive work initiated this fiscal year, the District staff is of the opinion that no major change in program direction is required. The program elements identified and described in this report are all still believed to be necessary parts of the total project package. At this stage the District staff is not prepared to recommend that effort on any element should be curtailed, or that new program elements should be added to the package.

Accordingly, the District staff's recommendation to the Governing Board, as presented in the form of a budget request for fiscal year 1974-75, will be for the continuation of those present programs supported by District funds at approximately the same level of effort as in the current fiscal year.



W. V. Storch, P.E., Director
Resource Planning Department
April 11, 1974

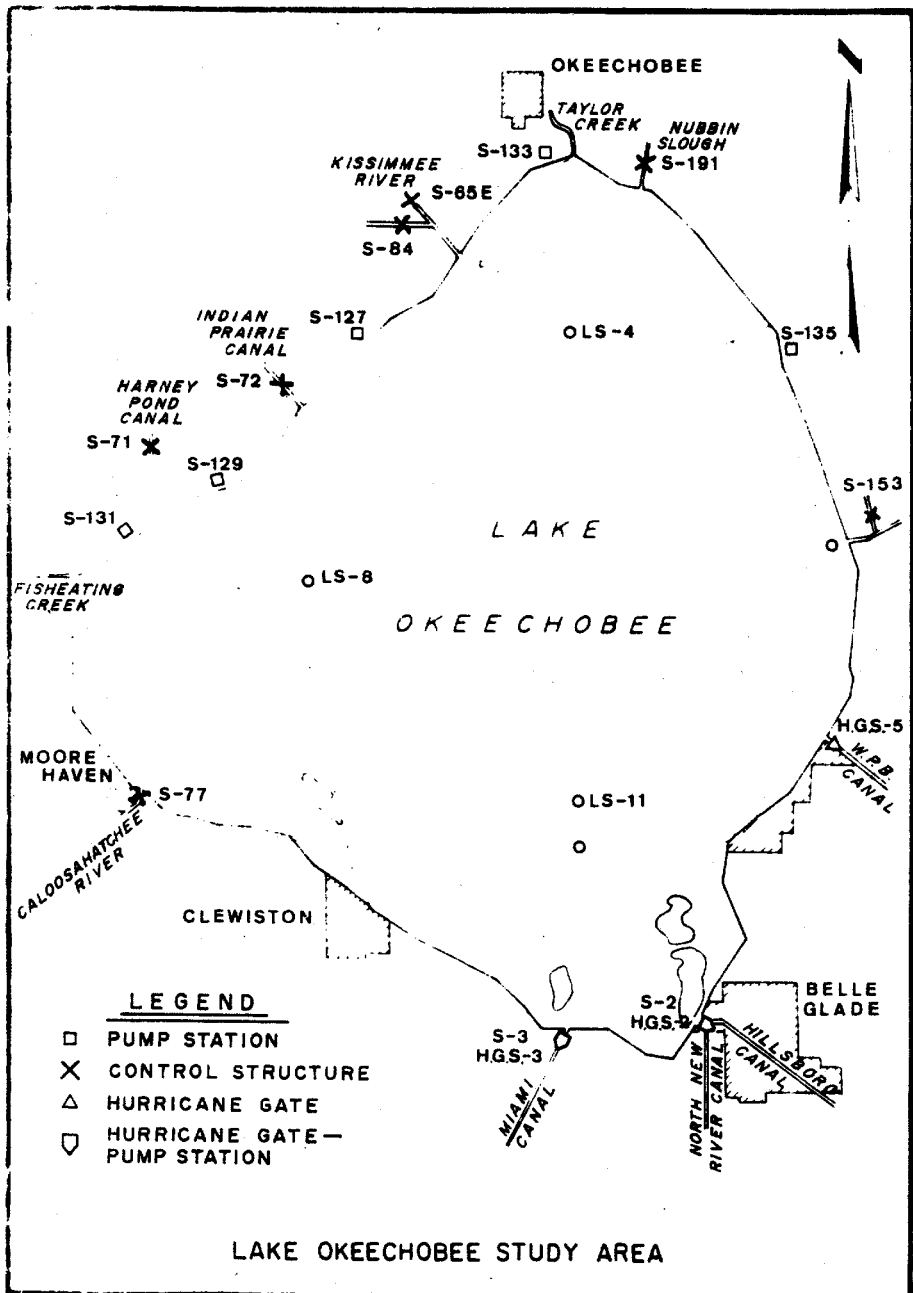
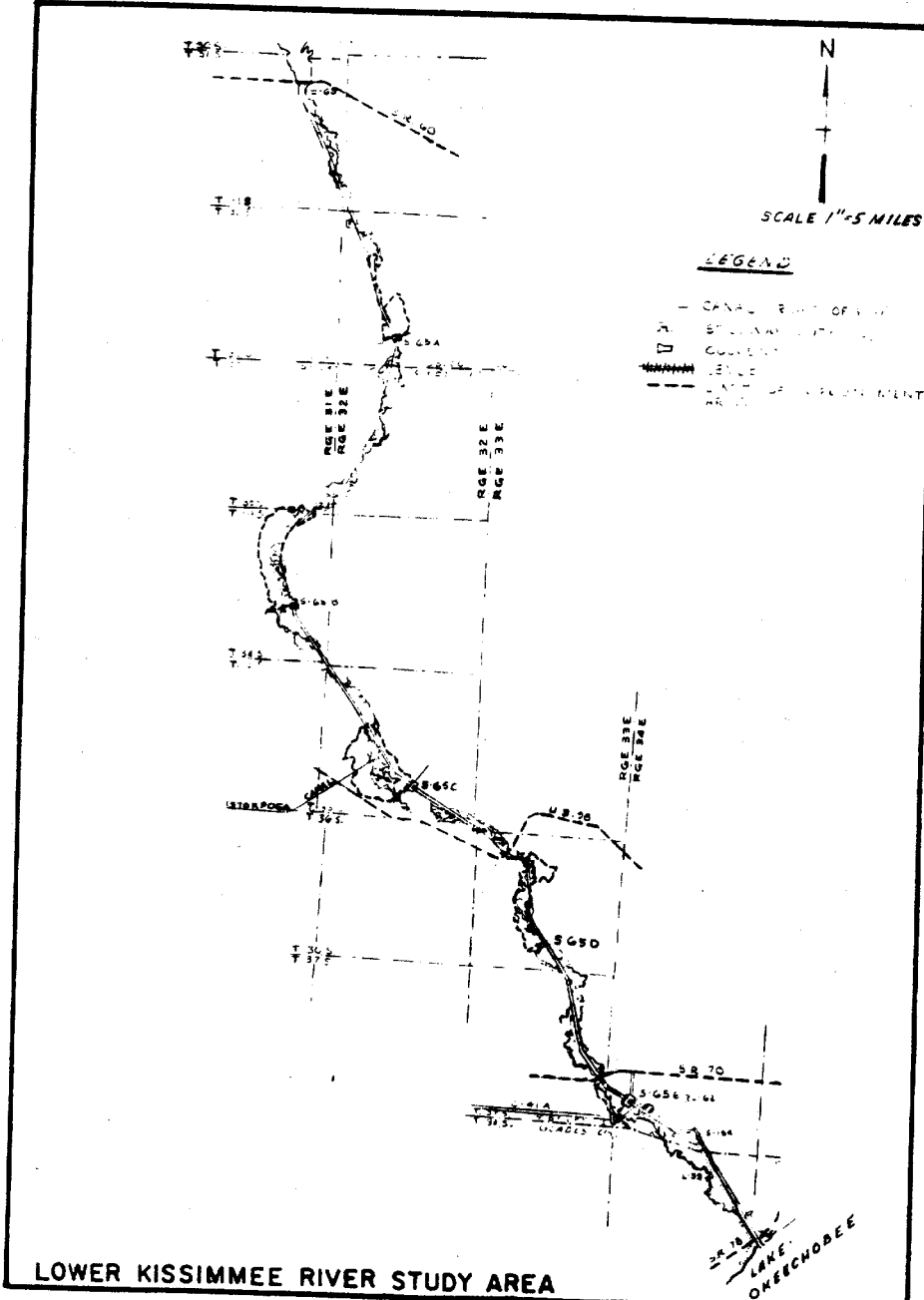
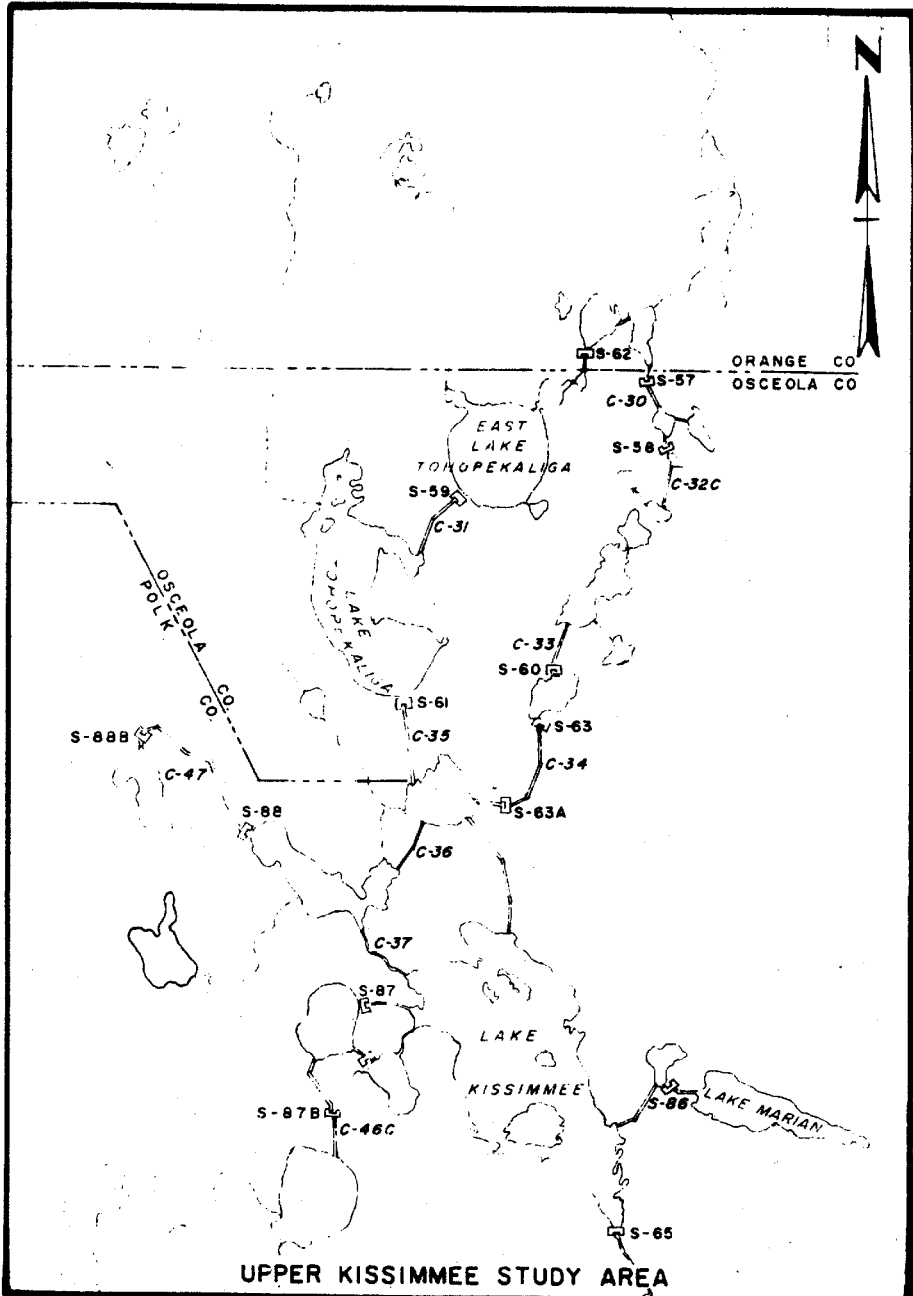


FIGURE 1



LOWER KISSIMMEE RIVER STUDY AREA

FIGURE 2



UPPER KISSIMMEE STUDY AREA

PHYSICAL AND HISTORICAL INFORMATIONLAKE OKEECHOBEE:

Lake Okeechobee is a shallow fresh water body covering, at normal stage, approximately 730 square miles and having a maximum depth of 15.5 feet. Under natural conditions the Lake received inflow from approximately 5244 square miles of tributary area to the northeast, north and northwest. There was no positive, channel outflow from the Lake in its natural state and normally stage fluctuation was governed by direct rainfall on the Lake, tributary inflow and evaporation. During periods of high Lake stage, overflow occurred at locations on the south and southwest rim into the wide, shallow, grassy trough of the Everglades.

By 1884 an outlet to tidewater (Gulf of Mexico) was completed when the Caloosahatchee Canal was excavated between Lakes Flirt and Okeechobee. Low muck levees were built along the south and southwest shores by local interests in the early 1900's. After the 1926 and 1928 hurricanes, the Federal Government built large protective levees on the south perimeter of the Lake and on the north shore near the City of Okeechobee, and in the early 1930's the enlarged St. Lucie Canal connection to the Lake was completed.

Under the Central and Southern Florida Project some 406 square miles of tributary area was added to the Lake; this area consisting of agricultural mucklands in northwestern Palm Beach and northeastern Hendry Counties. The existing Lake levees were raised and new levees were constructed on the northeast and northwest shores. Additional firm Lake stage regulation capacity was provided by enlargement of Caloosahatchee Canal.

The purpose of that program is to increase the safe water storage capability of

the Lake. At present the upper stage for the Lake is 15.5 feet msl. When the current program is completed this elevation will be raised to 17.5 ft. This two foot increase provides the capability to conserve an additional 900,000 acre feet of water.

KISSIMMEE VALLEY:

Of the total 5,650 sq.mi. area presently tributary to Lake Okeechobee, about 2,391 sq.mi., or 42%, is in the Kissimmee River watershed. This watershed consists of what is termed the Upper Basin and the Lower Basin. The Upper Basin contains 14 major lakes and numerous smaller ones. In the natural state these lakes were not positively interconnected but, comparatively frequently, they did overflow and surplus water moved downstream by this means through the chain of lakes to the Kissimmee River.

The Lower Basin starts at the Lake Kissimmee outlet, where the Kissimmee River proper starts. The Kissimmee River is a distinct channel of substantial dimensions and, in its natural state, meandered through a marshy flood plain having an average width of about one mile. The straight line distance between Lakes Kissimmee and Okeechobee is 52 miles, whereas the meandering channel length was about 90 miles. The fall between Lakes Kissimmee and Okeechobee is about 37 feet.

In the 1880's the major lakes of the Upper Basin were interconnected by means of excavated channels by Hamilton Disston. No work was done in this period in the Lower Basin other than occasional snagging to facilitate navigation.

A general plan for flood protection in the Kissimmee Basin was incorporated in the comprehensive plan for Central and Southern Florida presented to the Congress of the United States in 1948. That portion of the comprehensive plan which included the program in the Kissimmee Basin was authorized for

construction by the Congress in 1954.

The inclusion of the Kissimmee Basin in the comprehensive plan was directly pursuant to Public Law No. 534, 1947. However, earlier Congressional Acts in 1937, 1939 and 1956 had directed that studies of regulating the Kissimmee River and its tributaries be made.

The general plan for the Kissimmee Basin submitted to the Congress in 1948 contemplated:

1. Use of the major lakes as storage basins for flood control and water conservation.
2. Connecting channels between the major lakes and provision of control structures.
3. Channel and control structures in the Kissimmee River portion of the Basin.

The purpose of this plan was to relieve flooding and minimize flood damages, largely in the Upper Basin. This was to be accomplished partially by flood storage in lakes of the Upper Basin, but primarily by providing the capability to more rapidly remove surplus flood producing 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 from the maximum flood of record would result from such a plan.

The system of works now in being in the Kissimmee Basin conforms closely with the general plan outlined in the 1948 report to the Congress. The major lakes of the Upper Basin are connected by channels; in most cases channels excavated by Disston in the 1880's, but enlarged to varying degrees under the project. Nine control structures regulate water levels and flow in the lake-channel system of the Upper Basin. A channel connects Lake Kissimmee with Lake

Okeechobee. Five control structures in this channel control water elevations in the channel and regulate flows originating in both the Upper and Lower 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 with completion of structures 59, 61, and 65. Work in the Lower Basin started shortly thereafter with the lower control structure, S-65E, being completed in mid-1964. Channel excavation was completed in late 1970. It can be considered that in 1965 some degree of manmade control of flows and water levels in the Kissimmee Basin started.

BACKGROUND OF STUDY PROGRAMS

In 1967 the Corps of Engineers in response to Congressional mandate, and after four years of investigation, completed a plan for augmenting and conserving water supplies in South Florida. This plan included as one of its elements raising the Lake Okeechobee conservation pool stage to 21.5 ft. msl., thus providing capability for the storage of an additional 1.8 million acre feet of water. At the public hearings held by the Corps in late 1967 concern was expressed by environmental agencies, and in particular the Game Commission, over the impact of raising Lake levels on enrichment of Lake Okeechobee. The experience with Lake Apopka prompted this expression of concern.

The Governor's Conference on Water Management in South Florida gave further expression to this concern. One of its recommendations stated:

"Pollutants entering the Kissimmee Valley have cumulative adverse effects on water quality in the Kissimmee chain of lakes and in Lake Okeechobee. The Kissimmee lakes and marshes should be restored to their historic conditions and levels to the greatest extent possible in order to improve the quality of the water entering Lake Okeechobee. Action should

be taken to restore fish resources and wildlife habitats. Contamination by pastured livestock must be reduced. Techniques should be investigated to increase restoration of selective areas to their natural condition by use of advance waste disposal and composting materials.

"Recognizing that Lake Okeechobee is the hub of water quantity and quality in South Florida, the most important and overriding consideration should be not only to maintain the present quality of the lake but also to improve it. Specific consideration should be given to assure that all water inputs into Lake Okeechobee are of high quality."

During this period, and while excavation of the C-38 flood control channel was nearing completion, certain members of the academic community, citizen's environmental organizations, and State and Federal environmental agencies were drawing attention to the channelization of the Kissimmee River as a prime cause of hastening the environmental degradation of Lake Okeechobee. A report prepared by Dr. Arthur Marshall and his associates was presented to the Governor and Cabinet on December 12, 1972.

On November 15, 1972, the Flood Control District Governing Board held a hearing on the Kissimmee River channelization at West Palm Beach. Its findings and recommendations were also presented to the Governor and Cabinet on December 12, 1972.

The latest official expression of concern in regard to the eutrophication of Lake Okeechobee, and the impact of Kissimmee River channelization, was the action of the 1973 Legislature. This action is incorporated in Chapter 73-335, Laws of Florida, and provided funds to the Division of State Planning, Department of Administration, "to perform ecological studies, to conduct land use and ownership mapping, and to investigate improvements in monitoring and testing." This study program is identified as the "Special Project to Prevent the Eutrophication of Lake Okeechobee."

APPENDIX B

ESTIMATED EXPENDITURES TO DATE

Prior to F.Y. 1973-74

<u>Item</u>	<u>1969-70</u>	<u>1970-71</u>	<u>1971-72</u>	<u>1972-73</u>	<u>Total</u>
*U.S.G.S. Coop. Studies					
Lake Okeechobee	\$10,000	\$21,200	\$12,900	\$ 8,000	\$52,100
Kissimmee River	-	-	31,200	40,000	71,200
Lake Tohopekaliga	-	3,000	10,000	-	13,000
FCD Environmental Studies			6,000	14,600	20,600
	\$10,000	\$24,200	\$60,100	\$62,600	\$156,900

*Matched with U.S.G.S. funds.

F.Y. 1973-74 (to date)

Estimated Expenditures

<u>Item</u>	
*U.S.G.S. Coop Studies (Kiss. River)	\$ 22,000
Test Area Construction	250,000
FCD Funded Environmental Programs (Personnel, materials, equipment)	33,000
"Special Project" Program Funding	<u>115,600</u>
	Total
	\$420,600

*Matched with U.S.G.S. funds.

Total, 1969-1974 (to date)

FCD Funded	\$461,900
"Special Project" Funded	115,600
U.S.G.S. Matching Funds	<u>158,300</u>
	Total
	\$735,800

APPENDIX C

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