C-111
GENERAL REEVALUATION REPORT
Appendix D
Design and Cost Estimates

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Design and Cost Estimates

A. INTRODUCTION

1. General. This Appendix presents a discussion of applicable design considerations and construction methods utilized to establish a basis for the construction cost estimate. A discussion of the general requirements for real estate and operation and maintenance is also included.

B. DESIGN AND CONSTRUCTION

2. General. The recommended plan (Alternative 6A) would include the construction of two new north/south levees (L-31W Tieback & S-332D Tieback), four 300 cfs pumping stations, twenty-four 36-inch CMP culverts with stoplog risers, an emergency spillway across L-31W Tieback, and a new spreader canal with a 50 cfs pumping station. All pumps would be diesel operated. A detailed discussion of the recommended plan is presented in the main report.

3. Levees and Canals.

a. Levee 31W Tieback. This new north-south levee would be constructed roughly parallel to existing L-31N beginning at L-31W near S-175 and extending northward approximately 9.25 miles to higher ground in the Rocky Glades area in the vicinity of S-332B. The levee would be constructed with material obtained from the degrading of the C-111 disposal mounds along the southern portion of the project. The levee crown width would be 15 feet with 1 vertical on 3 horizontal side slopes. Twenty-four 36-inch diameter CMP culverts with stoplog risers would be placed in the levee at approximate 1000-foot intervals. An emergency spillway would also be constructed in the tieback to prevent overtopping of the levee. The spillway would be 300 feet in length and bank protection would be provided along the downstream face.

b. S-332D Tieback. This new north-south levee also would be constructed parallel to and about one-half mile west of L-31N. The southern half of the levee would tie into the new pumping station S-332D which is located just west of S-174. It would then proceed north and tie into higher ground in the Rocky Glades area a little north and one-half mile west of the junction of C-102 and L-31N borrow canal. The levee would be constructed with material obtained from the degrading of the C-111 disposal mounds with additional material obtained, as required, from excavation of a discontinuous borrow canal along the east side of the levee alinement. The levee crown width would be 15 feet with 1 vertical on 3 horizontal side slopes.

c. Levee 31W Borrow Canal. The borrow canal along the portion of the existing L-

31W between S-332 and the alinement for the new L-31W Tieback Levee would be filled by degrading the adjacent levee.

d. Discharge (Getaway) Canals at S-332A, S-332B, and S-332C. A concrete-lined discharge canal would be constructed at each structure site extending approximately one-half mile west from the structure at the L-31N borrow canal. The excavated material would be placed along both sides of the canal and graded to create a berm of sufficient elevation to satisfy the hydraulic design requirements and to provide access for maintenance.

e. Discharge (Getaway) Canal at S-332D. The existing L-31W borrow canal would be lined with concrete for a distance of approximately one-half mile west from the structure at the L-31N borrow canal. The excavated material would be placed along both sides of the canal and graded to create a berm of sufficient elevation to satisfy the hydraulic design requirements and to provide access for maintenance.

f. C-111 Connector Canal. A connector canal approximately 4500 feet in length would be constructed between C-111 and the L-31W borrow canal at S-175. The excavated material would be sidecast along one side of the canal and graded to provide access for maintenance.

g. Eastern Spreader Canal (C-111N). A canal would be constructed from the intersection of C-111 and C-111E and extend eastward to Canal 109. The excavated material would be sidecast along the north side of the canal and graded to provide access for maintenance. A canal extension between C-109 and U.S. Highway 1 is also included in the cost estimate as a separate item.

h. Canal 109 and Canal 110 Plugs. Nine plugs would be constructed in C-109 and ten plugs would be constructed in C-110 to help provide sheet flow from west to east along the C-111N alignment. Material for construction of the plugs would be obtained from the adjacent disposal mounds.

4. Pumping Stations.

a. Structural Design. At the structure sites, parking and turn-around areas would be provided on the north and south sides of the structure with a reinforced concrete service bridge spanning the structure. The proposed service bridge over the pumping station would provide access for service and fuel vehicles. An alternative access route going over the pump discharge pipes will be investigated during the preparation of the FDM. A service door at the north end of the superstructure would provide access for permitting installation and maintenance removal of the machinery and equipment. Office and toilet facilities for operating personnel would be provided at Structures 332A, 332B, 332C and 332D. The upstream wingwalls would be steel sheet pile walls capped with steel channels. In areas where the sheet piling cannot be driven due to hard rock, the bottom of the walls would be supported by tremie concrete placed in trench. Anchor walls to the steel tie rods would

provide the top support for the walls. The downstream wingwalls would be reinforced concrete inverted "T" walls. A concrete apron and endsill would be provided on the downstream side of the structure. The superstructure would consist of concrete frames and concrete block curtain walls. Windows, lights, doors, and forced-air fans would be installed to provide adequate lighting and ventilation. The roof would slope to insure positive drainage. The superstructure would house the pumps, pump drive, distribution panel, station crane, office and toilet. At each pumping station flapgates would be installed at the end of each pump tube to prevent backflow through the tubes. Pump Stations S-332A, S-332B and S-332C would discharge water into concrete-lined canals extending westerly from L-31N Borrow Canal. Pump Stations S-332D would discharge water the existing L-31W borrow canal.

b. Analysis of Structures. This section includes the design criteria and describes the structural design and stability analysis required for the structures in the project. In general, the design of each structurally significant feature is described in the following text.

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

(2) Design Criteria.

Reinforced Concrete. Design of structural concrete is governed by EM 1110-2-2104, "Strength Design for Reinforced Concrete Hydraulic Structures". Unless stated otherwise, the concrete compressive strength will be 3,000 psi at 28 days. Reinforcing steel would be grade 60 with a yield stress of 60,000 psi.

Structural Steel. Design of structural steel members would be governed by EM 1110-2-2101, "Working Stresses for Structural Design" and by the specifications and code of the American Institute of Steel Construction. Structural steel required for this project will be ASTM A36.

Stability Analysis. Stability analyses would be performed in accordance with ETL 1110-2-256, "Sliding Stability Analyses for Concrete Structures". Overturning analyses would be based on criteria in EM 1110-2-2502, "Retaining and Flood Walls". Flotation analyses would be performed in accordance with ETL 1110-2-307, "Floatation Stability Criteria for Concrete Hydraulic Structures".

c. Mechanical and Electrical Design - S-332A, B, C, and D.

(1) General. The proposed pump stations S-332A, B, C, and D would be located on the existing L-31N borrow canal as shown on the recommended plan plate included in Appendix A to this report. Each pump station would have a 300 cfs capacity and house four 75 cfs pumping units. These pump stations will pump water from L-31N borrow

canal into Everglades National Park. Each pump station would have four pumping bays each containing an identical axial-flow type vertical-shaft pump. Power to the pumps would be provided by diesel engines through right angle gear drives. Hydraulic design data for each pump station is provided in Appendix A to this report.

(2) Pump Design. Each of the four pumps in these pump stations shall be 36-inch pumps providing 75 cfs (33,525 gpm) at a total hydraulic head ranging from about 9 to 11 feet. The pumps shall be capable of pumping water at the maximum expected pool-to-pool elevations as follows: S-332A - 8.3 feet; S-332B - 7.3 feet; S-332C - 6.8 feet; S-332D - 6.3 feet. The pumps are expected to run at less than 500 rpm with an efficiency of about 80%. The diesel engines that power the pumps should be no larger than 150 hp. The pump station shall be designed in accordance with Hydraulic Institute Standards, EM1110-2-3105 (Mechanical/Electrical Design of Pumping Stations), and Guide Specification CW-15160 (Vertical Pumps: Axial-Flow and Mixed-Flow Impeller-Type). The design requirements for formed suction intake at the pumps shall be evaluated during preparation of the Feature Design Memorandum and shall be based upon the channel intake design.

(3) Station Equipment. The pump station will include various support items including the following:

a. Hoisting system for maintenance or repair of the pumps.
b. Diesel fuel storage system. Each pump station shall have two 12,000-gallon diesel fuel storage tanks. The 24,000-gallon total is based upon the capacity needed to operate all four pumps 24 hours a day at 8 gallons of fuel per hour per pump for 30 days.
c. Non-potable water system for general cleaning of the pump station.
d. Stilling well containing float switches to be used for pump operations.
e. Ventilation system to provide fresh air in the pump bays, generator room, office, and toilet room.
f. Toilet facility with a water closet and a lavatory.

(4) Electrical Requirements. The local power company, Florida Power and Light Company (FPL), would provide a 120/240 volt, single phase, 60 hertz, three wire, 100 amp service to each pump station. Pump stations will be equipped with small 15 KW engine-generator set for emergency power in case of failure of the commercial service. A manual transfer switch will be provided to transfer power to the emergency system.

(5) Power Distribution. A distribution panel will be provided with circuit breakers for station equipment, lighting, and controls. All wiring shall conform to guide specifications CE 1404.04 (CW 16120). Interior and exterior lighting, grounding and detail electrical design shall be in accordance with the National Electrical Code.

d. Mechanical and Electrical Design - S-332E.

(1) General. Pump station S-332E will be located at the junction of the C-111 and C-111E canals as shown on the recommended plan plate included in Appendix A. The pumping station will have a capacity of 50 cfs. It would pump water from the C-111 canal into a spreader canal (C-111N) which will spread water into the area north of the eastern panhandle of the Everglades National Park. The pump station would have one pumping bay containing an axial-flow type vertical-shaft pump. Power to the pump would be provided by a diesel engine through a right angle gear drive. The hydraulic design data for the pump station is provided in Appendix A.

(2) Pump Design. This pump station will include a single pump with a capacity of 50 cfs (22,350 gpm). The pump shall be a 30-inch pump providing the required flow at a total hydraulic head of about 6 feet. The pump shall be capable of pumping water at the maximum expected pool-to-pool elevation of 3 feet. The pump is expected to run at about 500 rpm with an efficiency of about 80%. The diesel engine that powers the pump should be no larger than 75 hp. The pump station shall be designed in accordance with Hydraulic Institute Standards, EM1110-2-3105 (Mechanical/ Electrical Design of Pumping Stations), and Guide Specification CW-15160 (Vertical Pumps: Axial-Flow and Mixed-Flow Impeller-Type). The design requirements for formed suction intake at the pump shall be evaluated during preparation of the Feature Design Memorandum and shall be based upon the channel intake design.

(3) Station Equipment. The pump station will include various support items including the following:

a. Diesel fuel storage system. The pump station shall have one 5,000-gallon diesel fuel storage tank. The 5,000-gallon total is based upon the capacity needed to operate the pump 24 hours a day at 6 gallons of fuel per hour for 30 days.
b. Stilling well containing float switches to be used for pump operations.
c. Ventilation system to provide fresh air in the pump bay and generator room.

(4) Electrical Requirement. The local power company, Florida Power and Light Company (FPL), would provide a 120/240 volt, single phase, 60 hertz, three wire, 100 amp service to the pump station. The pump station will be equipped with small 10 KW engine-generator set for emergency power in case of failure of the commercial service. A manual transfer switch will be provided to transfer power to the emergency system.

(5) Power Distribution. A distribution panel will be provided with circuit breakers for station equipment, lighting, and controls. All wiring shall conform to guide

specifications CE 1404.04 (CW 16120). Interior and exterior lighting, grounding and detail electrical design shall be in accordance with the National Electrical Code.

e. Construction Access. Access during construction and for operation and maintenance would be from State Road 9336 (Highway 27) along the existing Levee 31(W), across Structure 175, thence along the south and western side of Levee 31(W) borrow canal to Structure 332, a distance of about 2.3 miles, thence along the new Levee 31(W) Tieback to L-31N and the proposed Pumping Stations S-332A, S-332B, S-332C, and S-332D.

C. CONSTRUCTION PROCEDURE

5. General. The material removed from the western half of Canal 111, Section 1 between approximately station 220+00 and station 425+00 would be used to construct the new Levee 31(W) Tieback and construct the plugs in Canal 109 and Canal 110. Excess material would be placed along the north side of Canal 111 between U.S. Highway 1 and Structure 18C.

6. Construction Method. Material would be excavated by clamshell, hydraulic excavator, or similar types of equipment. Material would either be sidecast to construct a berm for access and maintenance or be truck hauled to designated for levee construction or disposal. Standard earth moving equipment would be used to construct the levees and shape the disposal mounds. Interlocking portable barges would be used to bridge Canal 111 and provide equipment access to the mounds along the south side of the canal.

D. QUANTITY AND COST ESTIMATES

7. General. The summary of the estimate for the first cost of construction of the recommended plan, including quantities, unit costs, contingencies, and reasons for contingencies is presented in Table D-1.

8. Quantity Estimates. Quantities of excavation and fill for this project were calculated based on available survey data taken from existing design memoranda and USGS Quadrangle Maps. Detailed site surveys, cross sections, and geotechnical information would be required prior to preparation of contract plans and specifications.

9. Cost Estimates. Since this project is similar to the Modified Water Deliveries Project, the cost data developed for that project was used for the Canal 111 construction cost estimate.

E. OPERATION AND MAINTENANCE

10. General. The project sponsor would be responsible for operation and maintenance of the improvements and features presented in this report upon completion of construction. The contractor would be responsible for all maintenance required during the construction

contract. Operation and maintenance of the project facilities would be performed in accordance with the instructions prepared and incorporated into the current "Operation and Maintenance Manual" which would be furnished to the project sponsor.

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INTRODUCTION

Purpose and Objectives - The purpose of this appendix is to evaluate the effects of alternative plans for the proposed water resources project in the C-111 basin. Information provided in this section includes the following:

a. A description of the study area.
b. The identification of the key economic activities in the study area and the determination of the extent and location of present land use and resource development in the area.
c. The discussion of impacts upon existing land use due to Hurricane Andrew and the development of a proposed future land use pattern in response to Hurricane Andrew.
d. The analysis of the effects of the proposed plan modifications to the existing water control system.

Description of the Study Area - The portion of the C-111 study area selected for economic studies includes the Taylor Slough basin, the Canal 111 basin and Levee 31 West. This area covers approximately 42,700 acres in southeastern Dade County. Generally, the study area lies west of U.S. 1, north and east of the Everglades National Park, and extends from SW 168th street (Grossman Drive) on the north side south to S-197. The Taylor Slough basin includes the area from S-331 at Grossman Drive south almost to Canal 103 at Southwest 264th Street. The Canal 111 basin and Levee 31 West extends further south past Structure 177, south west of Florida City. Existing land uses are primarily agricultural in the northern and central portion of the basin, with moderately urbanized areas near Florida City and Homestead. Ground level contours range from 1 to 10 feet NGVD with most of the active agricultural and urban land use on terrain 5 feet above NGVD. The southern-most portion of the basin at the 3.5-foot NGVD contour line is characterized by abandoned farmland and natural wetlands sloping gradually to Florida Bay.

Physical Characteristics of the Study area - Existing land use in the C-111 economic study area is predominately agricultural. In 1986, an estimated 36,700 acres were utilized for fruit tree groves, row and field crops and nurseries. There are two types of soil in the study area: limestone rockland, which accounts for most of the agricultural acreage, and marl soils. The rockland area extends roughly from U.S. 1 west to the Everglades Park boundary and from Tamiami Trail north of Grossman Drive, to Florida City and SR. 27 leading to the Everglades Park, on the south. Marl "East Glade" land generally lies east of U.S. 1 to the mangroves and south of Miami to the end of the mainland. This soil type is also found in the southern portion of the study area at elevations ranging from 0 to 4 feet above sea level.

Limestone rock is a relatively soft rock until it is exposed to the air. Many solution holes extend below the surface and act as storage places for water. Solution holes vary in diameter from a few inches to many feet, and may be 10-12

feet or more, in depth. Rockland is prepared for tree or vegetable crops by heavy tractors and scarifying equipment to "chisel" or "plow" this soil. Some 200 varieties of subtropical and tropical fruits are grown on the well-drained limestone rock soils of Dade County.

Marl is a dense, calcareous sedimentary soil deposited by water flowing from the northwest to the ocean. Since percolation for this soil type is slow, ditches and pumps are used to move excess water flows from marl areas to the ocean. Salt water control structures at canal outlets halt inward flow of sea water during periods when fresh water flow is inadequate to prevent salt water intrusion. Like rockland soils, marl soil areas are low in organic matter and require periodic applications of nutrient fertilizers such as nitrogen, phosphorous, and potash. Since most vegetable farming is done during the late fall and dry winter season, these crops can be grown on either rockland or low elevation marl soil areas. Potatoes and seed corn are major crops grown on marl land.

Problem Statement - Since initial project construction in the 1960's, damage susceptibility has increased due to the increased value of crops and agricultural encroachment which has taken place in the floodplain. Agricultural encroachment has occurred since the system has been operated at lower water levels than originally authorized. Two forms of encroachment are evident. First, highly damage susceptible vegetable crops can be grown year around rather than just in the dry winter months. Second, the amount of fruit tree crops and general horticultural activity have increased in the flood plain. Since these trees have longer root zones than other field crops, they are more susceptible to high water tables and to flooding.

Project Alternatives - All project alternatives are designed to provide increased flood protection when compared to the existing project operated at authorized levels in the economic study area and provide varying degrees of environmental restoration in the basin below this area. Eight alternatives have been selected for study. Each of the alternatives basically provide similar hydrologic and hydraulic responses, therefore, only one major economic investigation has been conducted. However, slight differences in flood damage effects for plans are noted since some of the plans require different quantities of land purchases in the Frog Pond area which is located in the south-west portion of the area. The effect of land purchases is to remove crop acreage from production and therefore reduce flood damage prevention benefits.

Risk Analysis - All plans include a flood control component which should approximately restore the authorized 10 year level of protection. The remaining features in Plans 1 through 6A achieve differing degrees of environmental restoration. Since the level of protection has not been changed from the authorized level, no risk evaluation has been performed for this study. In addition, the primary benefit category of inundation reduction is agriculture. Currently, there in no guidance or model available for this type of analysis and the compressed study schedule does not allow time for model development.

ANALYSIS OF ECONOMIC IMPACTS

Types of Impacts - The major impact being examined in this economic analysis is the variations in flood durations which adversely affect various types of active agricultural acreage in the study area. Specifically, water tolerances of Dade County crops (vegetables, tropical fruit trees, and nursery stock) in floodprone areas are measured using expected flood durations from varying flood frequency situations to determine crop damages. These damages are generally measured by the loss in operating and fixed costs sustained by growers even if they are covered by crop insurance. Damages are computed for various frequency flood events and converted to an average annual basis. Tree crops and nurseries are susceptible to damage at any time during the year. Damage to seasonal crops is adjusted using the cumulative percentage of production costs invested during any given month in the growing season and the percent chance of monthly occurrence of a damaging flood event.

The evaluation of flood damage impacts has been conducted at two separate points in time. The first evaluation consists of an analysis of plan impacts on land use development physically existing in the study area in the base year 2001. The second evaluation was an analysis of the impacts on land use development in the year 2006. Differences in damage susceptibility are solely due to assumptions concerning differing stages of maturity of new fruit trees expected to be planted after Hurricane Andrew. Other changes in land use are not expected after the year 2006. Project life impacts are amortized and discounted during the fifty year period and converted to an average annual equivalent.

Flood damage susceptibility is measured without and with proposed alternatives. The differences represent the inundation reduction benefits of the proposed project. A more detailed explanation of the procedures used in the determination of these damage estimates is presented in a later section.

1986 Land Use - In the 1970's and 80's, there had been increased agricultural and urban development in the Homestead - Florida City area. The pace of cropland development in the northern portions of the C-111 basin had been especially rapid. While total agricultural acreage had increased, there had been a relatively more extensive development of tropical fruit groves and ornamental horticulture than in seasonal vegetable row crops. As a result, land values have increased as well as the potential damages that may occur from periodic flooding. There was and is now approximately 42,700 acres of land within the economic study area boundaries of which approximately 36,800 acres or 86 percent are utilized for agricultural purposes. Tropical fruit groves and nurseries in 1986 covered approximately 13,600 acres. Vegetable tracts, field crops, and fallow areas account for the remaining acreage. Some 5,900 acres of nonagricultural land were comprised of residential tracts, recreational areas, marginal wetlands, and undeveloped open land. Study area land use acreages are displayed in table 1.

Existing (1993) Land Use - The original tabulation of land use acreage in the C-111 basin was conducted in 1986. Since that time Hurricane Andrew has impacted all of South Florida with greatest concentration in the Homestead and Florida City area. Interviews with representatives of the Institute for Food and Agricultural Sciences, and the Dade County Extension Service have indicated that

the agricultural area is recovering quickly after the event. None of the fruit growers have left the area after Hurricane Andrew and no additional acreage since Hurricane Andrew is currently fallow due to the storm. Also, no reductions in vegetable crop production per acre have been recorded. Approximately, sixty percent of the property used for vegetable crops is rental property and many of the areas were used for burning debris immediately following the storm.

Since Hurricane Andrew was a wind-driven rather than a rain-driven storm, tree crops were severely affected in the study area. The Florida Agricultural Statistics Service in Orlando has reported for all of Dade County that there has been a 34 percent decrease of avocado acreage in the Dade County area from 8,987 acres in 1990 to 5,965 acres in 1993. Limes were down over 70% from the 6,071 acres reported in Dade in 1990 and mangos had decreased over 40 percent to 1,398 acres. It can be assumed that a significant portion of this decrease is due to Hurricane Andrew. In the study area portion of C-111, productive fruit tree crop acreage has decreased, particularly east of L-31N. It is believed that many of the remaining trees east of L-31N and L-31W may not survive. West of L-31N, much of the fruit tree acreage is either unaffected or has been replanted. Productive acreage west of L-31N is considered to be incompatible with optimum stage regulation authorized by the original flood control project. Plan alternatives which worsen conditions over optimum stage levels in this area include the purchase of these lands as a project component. Therefore flood damage effects to this land use are not considered.

The 1993 land use condition was prepared using detailed crop information provided by the firm of Larsen and Associates[1] as a guide. Other sources utilized included 1990 land use Cad-drawings provided by the Dade County Planning Department recorded before Hurricane Andrew at approximately land use classification LUDA Level II, and 1992 aerial photographs from the REDI (Real Estate Information Service) located in Ft. Lauderdale. In addition, two field investigations were conducted solely to locate fruit groves that were destroyed by Hurricane Andrew and to generally update field crop land use information in the study area. Agencies contacted include the Dade County Extension Service, the Agricultural Stabilization and Conservation Service (USDA), the Dade County Tax Assessor's Office, the Department of Environmental Management, and the Metropolitan Dade County Planning Department.

Updated land use information was collected, however, the specific location of downed fruit groves due to Hurricane Andrew was not determined. Therefore, percentages of downed fruit trees for Dade County reported by the Florida Agricultural Statistics Service in Orlando are used in this study. These percentages have been proportionally distributed among all the fruit tree acreage in the study area. After the storm, downed groves were replanted mainly in mixed vegetables. This interim decision allows immediate income production while landowners decide whether or not to replant fruit trees. The 1993 land use condition has been constructed to display the appropriate acreage of downed fruit trees in the mixed vegetable land use classification.

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[1] Larsen and Associates is a consulting environmental engineering firm located in Miami, Florida.

Future Land Use (General) - Projections of future land use in the study area would indicate some growth in agricultural acreage and in residential areas. Tracts utilized for tropical fruit groves, Cuban vegetables, specifically guava and papaya, and ornamental horticulture are expected to replace some acreage used for traditional vegetables such as tomatoes, beans, corn, and squash. Market price is excellent for these commodities, production practices are improving and new methods have been developed to make these crops more disease resistent. South Florida Lime production should not be significantly affected by the increased importation of Mexican limes as a result of the North American Free Trade Agreement. Although, 95% of U.S. limes are produced in South Florida, Mexican limes currently have no rigid standards for production or export and are inferior in quality and durability.

Open rockland soil areas bordered by C-111, L-31W, and SR. 27 will continue to be utilized for nontropical row crops, particularly tomatoes. Urban development around Homestead and Florida City should show controlled growth of low to low-medium density residential areas with an upper limit of 13 dwelling units per acre. New residential development should include single family homes, townhouses, or small apartments after recovery from Hurricane Andrew. Future residential, commercial and industrial land use is not projected to significantly affect existing agricultural land in the study area. Unless environmental restrictions change this land use from agriculture to wetland, no further change is expected throughout the project life.

Base Condition (2001) and 2006 Land Use - The 2001 land use condition reflects damage susceptibility at the beginning of the project life. The major differences between the 1993 and 2001 land uses will be the replanting of fruit trees. Two effects are expected to occur with replanting. First, the mixed vegetables currently being grown in the groves will disappear. Second, the new fruit trees will begin to experience damage susceptibility to flood events.

At present, an exact estimate of the acreage of fruit trees that will be replanted is unknown. Most of the fruit crop acreage affected by Hurricane Andrew has been replanted west of the levee. East of the levee, discussions with the Dade County Extension Office and the United States Department of Agriculture (USDA) indicate that 50% to 100% of the trees will be replanted. This analysis assumes that by 1996, 50% of the downed fruit tree acreage will be replanted. During the (1993-1996) time frame when all re-planting is estimated to be completed, there will be no damage susceptibility to this acreage. Major fruit trees expected to be replanted in the basin include lychee, limes, avocadoes, mangos, papaya, carambola, longan, and guava. Major fruit crops which are especially flood damage susceptible include; limes, avocadoes, mangos, and papaya. Generally, fruit trees require 4-5 years before bearing fruit, and 8-12 years to achieve full production. Therefore after 5 years at the beginning of the project life in 2001, it is assumed all new trees will be mature, however, no fruit will currently be produced. Flood damage assessment in this time period will be assessed using the full value of the tree but no damage is claimed for fruit losses. At the end of 10 years in the year 2006, it is assumed all fruit trees will be fully mature and fruit production has returned to normal. Flood damage susceptibility now will affect fruit as well as trees. Flood damage susceptibility is expected to remain the same from the years 2006-2051. Study area land use acreages expected in the year 2001 are displayed in table 2.

Frog Pond Land Use - It is not rational to expect growers to plant areas in the Frog Pond where the topography would be below normal operating stages. Optimum operating stages at authorized levels at S-332 and the surrounding area are expected to be approximately 3.75ft. msl. on the average for the without project condition. Plan alternatives would not significantly change this elevation. Although seasonal regulation schedules will not be formulated in this report, it is assumed given the environmental nature of the formulation that maximum flexibility will be required in maintaining high water levels for the express purpose of producing the highest quality environmental wetlands. At these levels, entry via State Road 9336 will be possible which should allow entry of heavy equipment and allow the rock-plowing necessary for the preparation of all land above 4.25 feet. It is assumed all productive land at or below 4.25 feet msl. will not be able to be used in a productive capacity in the Frog Pond or in the area below the Frog Pond adjacent (west) of C-111. The current land use grown in the area is predominately tomatoes.

Analysis Methodology

General Methodology - Flood damage analysis for the C-111 study area is focused primarily on agriculture production. For the flood damage evaluation, six different flood frequencies were used with durations ranging from no flooding to 25 or more days. The frequencies of these floods are the Standard Project Flood (SPF which is estimated to be equalled or exceeded once every 250 years), 100-year, 50-year, 25-year, 10-year, and the 2-year. Elevation-duration relationships were constructed for each one square mile cell. The adjusted topographic elevation for each parcel of land use was retrieved, flood durations were computed and flood damages were estimated. To determine flood damages for varying flooding frequencies, it was necessary to obtain specific land use data, measure the extent of flooded acreage by crop type and flood duration, and apply per acre damage estimates for each crop to plot frequency-damage curves and calculate average annual damages. This procedure is discussed in detail in the following paragraphs.

Land Use and Topography - Land use data was compiled for the 2001 and 2006 land use conditions as discussed earlier and was sub-divided into one square mile grid cells. Topographic information was recorded using USGS quadrangle sheets with 5 foot contour intervals using one foot interpolation. Limited topographic coverage was available from the Everglades Drainage District in 1939. These maps provided 1/2 foot contour intervals in the south portion of the basin. In addition, topographic coverage of the Frog Pond was provided for the South Dade Land Corporation by Ghioto and Associates in 1988. Inside each square mile cell, acreages were recorded by land use classification and topographic elevation. For agricultural land use, acreage totals were reduced by 10% to allow for infrastructure (road, canal, and levee areas) and again by approximately 4% to account for fallow agricultural land inside each ownership.

General Agricultural Damage Susceptibility

Root Zone Depth - For agricultural land use, it is assumed damage susceptibility begins when water reaches the bottom of the root zone. Therefore, it is necessary to know the depth of root zones and water tolerances for individual tree and row crops in the rockland and marl soils of the study area. Vegetable crops have root depths of 6 to 12 inches. A root length of 8 inches has been selected for this study. Root zones for fruit trees are deeper than row crops, generally ranging from 12 to 30 inches deep. A root length of 18 inches has been selected for limes, avocados, and mangos and a 12 inch root length has been selected for papaya. Root depths for field nursery plants vary from 2 feet to 4 feet. A 2 foot root depth is used in this analysis. For all other nursery classifications, it is assumed all plants are in containers and the containers are at ground level. It is also assumed that all plants in containers and not elevated incur damage during a flood.

Bedding Heights - It is assumed all vegetable crops are planted on beds. The average bed height is estimated to be 6 inches. Fruit trees are planted on beds and bed heights range from 12 to 30 inches. An average compacted height of 16 to 18 inches is considered reasonable and a 17 inch bedding elevation is used for all fruit trees in this analysis. For lack of better information, all field nursery plants in this analysis will also use a 17 inch bedding elevation. Root zone damage susceptibility is computed by adding the bedding height to the topographic elevation and subtracting the root zone depth for the appropriate vegetable crop or fruit tree. For example, all vegetable crop damage susceptibility will begin when floodwaters are 2 inches below the recorded topographic elevation. Detailed agricultural land use classifications, root depths and average bedding heights are displayed in table 3. Fruit crop damage susceptibility will vary depending upon root depth as shown in table 4.

Vegetable and Fruit Crops Damage Susceptibility

Production Costs per Acre - A conservative estimate of the value of vegetables in the ground can be approximated by using operating costs, fixed costs, and land rental values to produce the crop. Operating costs include seeds or transplants, fertilizers and pesticides, labor, interest, and machinery expenses. Fixed costs include land rents, depreciation, licenses, and insurance. Excluded from loss estimates are harvesting and marketing costs and any share of net returns to the grower which are derived from total receipts less total costs. Vegetable Summaries provided by the Institute for Food and Agricultural Sciences for the South Dade area and Everglades Agricultural area provide fixed cost, operating costs, and land rent estimates for most vegetable crops in the C-111 basin. This information is utilized to compute flood damage potential for these crops. Sufficient information was not available to use any normalized procedure for costs. For land use classifications 1 through 11 in table 3, the values in table 5 represent a simple 5 year average of operating costs, fixed costs and land rental information transcribed from economic information reports for

production costs produced by IFAS.[2] These values are used to compute a maximum potential loss per acre for each vegetable crop.

The Dade County Extension Service provided information concerning production costs, fixed costs and land rental for pole beans, sweet potatoes, malanga, calabaza, and yuca. Fruit crop losses include losses of production costs and tree replanting operating and fixed costs estimated for non-bearing periods when the tree is replanted. All fruit crop production cost information was provided by the Dade County Extension Service. A summary of potential fruit crop losses on a per acre basis is shown in table 6.

Duration-Damage Relationships - Losses to vegetable and fruit crops are very much dependent upon the duration of flooding in root zones. Put simply, crop damage is caused by the crops inability to breath and the associated diseases which occur due to the growth of micro-organisms when aerobic activity is replaced by anaerobic activity due to lack of oxygen and CO_2. Discussions with knowledgeable sources have indicated that damage begins immediately after water enters the root zone and continues until maximum loss occurs as shown in table 7. Expected losses during time frames between the initial flooding and total plant mortality are computed using a linear relationship. The actual period when losses will occur is also dependent upon whether or not water in the root zones is moving or stagnant during the flood and whether root zones are continuously or intermittently flooded.

As shown in table 5, vegetable crops, with the exception of potatoes, are generally lost after 12 hours of inundation. Water inundation tolerances show considerable variance for citrus and tropical fruit trees. Periods of inundation that will cause fruit loss and, if extended, cause root damage and tree loss are shown in table 7. Short water inundation tolerance periods for avocados and papaya trees make these crops highly vulnerable in flooding situations.

Horticulture - Horticulture activity in Dade County has been classified as either foliage, woody ornamentals, or field nurseries. In 1984-85 it was estimated that approximately 55% of total sales was foliage, 15% was woody ornamental, and 30% was field nurseries. In addition, 38.7% of the acreage in production was classified as foliage nurseries, 12.9% as woody ornamentals and 48.3% as field nurseries. These percentages are used as weights to determine flood damage susceptibility for these crops in the Canal 111 basin. Horticultural plants grown in the C-111 basin are shown in table 8.

A conservative measure of the loss that would occur with any flood would be the loss of production costs necessary to produce the crop. The total dollar value of horticultural crops in 1983-84 and acreage in production in the South Dade area is shown in table 9. It is estimated that the value of crops increased by approximately 20% from 83-84 to 1986.[3] The value per acre computed in 1986 is used in the current analysis to represent a conservative estimate of the total

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[2] Economic Information Reports 245, 257, 273, EI 91-2 and Circular 1064. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

[3] Estimates provided by representatives of nursery sales outlets in Homestead.

value of the crop in the ground that could be damaged with a given flood. The production costs associated with these sales have been estimated to be 89.7% for foliage nurseries, 89.5% for woody ornamentals and 81.8% for field nurseries. [4] It is assumed there would be sufficient warning time to protect some of the foliage nursery and woody ornamental plants. Protection may be as simple as providing covered shelter on site and elevating the plants a foot or two above the ground. In some cases protection may not be possible. The evaluation assumes 30% of the foliage plants and 15% of the woody ornamental plants can be protected against the flood. Duration-percent damage for each classification was estimated using empirical information gathered from local growers during the 1986 flood. A composite damage relationship for horticulture is shown in table 10.

Seasonal Flood Damage Potential to Field Crops - Fruit trees and horticulture crops grow and produce year around. Therefore, they are susceptible to flooding throughout the year. Field crops have specific planting, growing, and harvesting periods and are susceptible only on a seasonal basis. There are many methods of compensating for seasonal probabilities of flooding. In this evaluation annual series of flooding probabilities are adjusted to determine the percent chance of occurrence of a damaging flood in any given month. In addition, it is necessary to determine the flood damage susceptibility of vegetable crops by month during the growing and harvest seasons. Since production costs are being used to determine the loss, it was necessary to estimate the cumulative value of production costs that would be lost if the flood occurred during any given month. Due to the amount of information and calculations required, no attempt is made to determine this relationship for all vegetable crop classifications in the basin. Tomato crops are the major crop of interest. Calculated tomato crop damage under varying storm conditions ranges from approximately 64% to 91% of total full production vegetable crop damages with the larger percentages occurring for the more frequent storm events. Therefore, seasonal adjustments computed for tomatoes are used for all full production vegetable crop damage estimates.

The method used to estimate the cumulative value of production costs that would be lost during any given month required the computation of daily percentages of total production cost estimates that would be expended before harvest. A daily production scenario was developed using the following general assumptions:

a. Field interviews indicate that approximately only 20% of tomato acreage is currently double cropped for tomatoes. Therefore, only single crop production costs are used in the analysis although it is likely that more double cropping could be expected in the future. Second crops other than tomatoes are usually either squash or cucumbers. In some cases, a cover crop may be grown during the rest of the year. Damage susceptibility to these crops are slight and is not considered.

b. Total tomato acreage in the basin is planted only once per year but picked three times per year. This means a given owner may plant only 1/3

[4] Information computed from the Economic Information Report El 92-1r, "Business Analysis of Ornamental Plant Nurseries in Florida, 1990", IFAS, University of Florida, May 1992.

of his acreage at a time. The analysis assumes there are three groups of planters; early season, mid-season, and late season planters. Each group of planters plant 1/3 of their acreage at a time with an average 10 day delay between plantings. There is a 60 day interval between early season, mid-season, and late season planters. The entire season for planting, growing and harvesting will extend from mid-august to mid-april.

c. The actual growing period is approximately 85-120 days between 1 September and 31 December. There is a 60-70 day growth period for tomatoes between planting and harvesting. This evaluation assumes a 70 day growth period.

d. The analysis assumes that 2 weeks of land preparation are required before the growing season. Land preparation includes cleanup, soil treatment, insecticides, fertilizers, discing and rock-plowing. At this time, some production costs are expended. Losses can occur due to delays in planting.

e. The analysis assumes that land preparation costs are approximately 31% of total production costs. 1991-92 production costs for tomatoes are shown in table 11. The remaining costs are proportionately distributed on a daily basis to the growing period. The evaluation assumes all remaining growth of production costs are linear until the end of the growth period.

f. The analysis assumes a 14 day harvest period.

g. The analysis assumes after the growth period during harvesting, production costs decrease in a linear fashion until all production is harvested at the end of the harvest period.

h. Computed costs for each group of growers for each function are summed on a daily basis. A simple monthly average of the daily data is then computed.

Simplified sample calculations of the entire process are shown in table 12. Monthly probabilities of flooding and cumulative percentages of total production costs expended for field crops are shown in table 13.

Urban Damage Susceptibility - Urban land uses susceptible to flood damage in the basin include single family residential housing and mobiles homes. Damage to residential structures and personal property is a function of the peak stage of the flood. Damage to residential lawns, pavement, shrubs and streets is a function of the duration of the flood. A formal appraisal of structure value was not undertaken in the study area since residential damage was not the major focus of the evaluation. However, informal discussions with realtors in the area and site inspections revealed that average values for residential structures and mobile homes of $60,000 and $20,000 are reasonable. Residential development in the basin consists of single family estate homes and planned developments with densities of development at less than 1 per acre and approximately 4 to 5 per acre respectively. Mobile homes are mainly concentrated in a few mobile home parks. A density of 2 homes per acre for all single family development and 5 homes per acre for mobile homes are used in this study. First floor elevations

are approximately 1 foot for single family residential and 3 feet for mobile homes. Personal property or content value is estimated at 40% of the value of the structure. Estimates of depth-damage for single family residential and mobile homes structure and content damage were produced by the Federal Emergency Management Agency (FEMA) in 1992 for the nation. FEMA data for Florida is not used due to sample inadequacy and resulting inconsistencies in the form of the damage relationship.

Homes in the area have reasonable amounts of landscaping. To compute damages to lawns, pavement, shrubs and streets, the following assumptions are made after review of aerial photographs and a field inspection:

1. Residential lawns - Quality of lawns range from fair to good. Structural size is approximately one-third of the total lot size basin wide for all residential except for single family estates and mobile homes. Therefore, for all single family land use, lawn size is assumed to be a function of structure size and lawn size is approximately twice as large as the structure. One-half of the lawn size in a single family residence is used for mobile homes damage calculations. These damage relationships are used basin wide.

2. Residential shrubs - The number, quality, and maturity of shrubbery on residential lots was estimated using field information and photographs. Then, it was assumed that the number of shrubs on a residential lot is directly proportional to lawn size and therefore to structure size. Little shrubbery is associated with mobile homes, therefore, no shrub damage potential is evaluated for this land use classification. The single family residential damage relationship for shrubs is used basin wide.

3. Residential pavement - It is assumed that the amount of pavement required for a single family residence is fairly standard and not a function of lot and structure size. Quantities of pavement used for driveways, sidewalks and walkways were estimated from field observations. Since most mobile homes are higher density, 1/2 of the single family residence relationship is used for damage calculations. These damage relationships are used basin wide.

4. Residential streets - The linear footage of streets in a residential area is not a function of structure size. Street lengths in other low density residential areas have been measured on aerial photographs and found to approximately 140 linear feet per acre of development. The damage relationship derived from this information is adjusted by residential land use densities to produce estimates of street damage by structure. These damage relationships are used basin wide.

Inundation Reduction Analysis

Existing Damage Potential, Without-Project. (No Frog Pond Land Purchases) - For land use conditions expected in the year 2001, flood damages adjusted for

seasonal probabilities are expected to flood in excess of 31,700 acres and cause approximately $93.6 million in damage during a Standard Project Storm. A 2 year frequency storm is expected to flood in excess of 4,500 acres and cause approximately $2.3 million in damage. Floodprone areas without the project and for alternative conditions are shown in tables 14 and 15[5] and in figures E-1 and E-2.[6] Fruit tree crops incur only minimal damage susceptibility for floods at the 10 year level or less. For fruit trees, flood damages are expected to range from $51.5 million during a Standard Project Storm to $1.5 million during a 10 year storm. For these floods limes, avocados, and mangoes are affected with avocados incurring over 90% of fruit crop damage. The high damage susceptibility for avocados reflect the long time to grow a mature replacement tree after a flood and the relatively low water tolerance period for avocado root systems, which allow tree loss after 24 hours of inundation. Conversely, mangos and lime tree groves incurred less damage due to higher water tolerances. Fruit crop damage potential is shown in table 16.

Nurseries show high damage susceptibility due to several factors. Like fruit trees, root zones can be 2 to 4 feet long which makes them highly vulnerable to underground flooding. In addition, short term durations can cause total losses to foliage and woody ornamental plants since the public will not except any of these plants that are blemished or marred. Damage potential to nurseries are also shown in table 16.

Urban damage potential includes damage to urban structures, contents and lawns, pavements, shrubs, and streets. All of the damage below a 25 year event is basically flooding to lawns, pavement, shrubs, and streets caused by the duration of the event. Given most single family residences have a one foot first floor elevation, water is not expected to enter residences except for the rarer flood frequencies at the 25 year interval or greater. Mobile home flood damage is minimal since most first floor elevations are 3 feet or greater. Urban damage potential is also shown in table 16.

Vegetable crops have a high potential for damage if a large flood event occurs just prior to harvest. As discussed earlier, virtually all vegetable row

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[5] Acreage in tables 14 and 15 are cataloged as floodprone when flood elevations are above ground level. Affected field crop acreage may be less than shown depending upon the growing season of the crop and the seasonal occurrence of the flood.

[6] Notes concerning figures E-1 and E-2 are as follows:

- Floodprone area delineation represents when damage susceptibility occurs in a cell and not necessarily when flooding above ground exists and no damage susceptible land use is located.

- Topographic information is adjusted by bedding heights and root depths for fruit and vegetable crops. Damage susceptibility can occur at elevations from 2 to 7 inches underground.

- Representation of damage susceptibility indicates damage exists in a cell. It does not indicate that the entire cell is flooded nor does it represent the magnitude of flooding.

- Floodprone area delineation based upon vegetable crop damage susceptibility is dependent upon the seasonal occurrence of flooding.

- Spatial allocation of flooding for alternative conditions is similar to without project although the magnitudes of damage susceptibility are less.

crops are lost after 12 or more hours of flooding with the exception of potatoes with a 24-hour damage threshold. Tomatoes, which account for the highest production value of vegetable row crops in the study area, consistently incurred the largest dollar damages during any flood frequency. Snap beans and mixed vegetables, the leading vegetable crops in terms of acreage, ranked second in damage value during various flooding events. Seasonally unadjusted full production flood damages for vegetable crops are shown in table 17. However, an examination of table 13 indicates that if growers continue current growing practices during the winter months, flood damage susceptibility can be substantially reduced.

Seasonally adjusted damage estimates for vegetable crops are added to nursery, fruit crop and urban damage for each frequency flood. The result is total expected damage by frequency for the without project condition at the beginning of the project life (2001). These results are shown in table 18.

After total damage estimates are tabulated for each frequency flood, probability of occurrence is defined for selected floods on the basis that the flood could be equaled or exceeded in a given year. Flood frequencies and damage estimates are then combined to produce a frequency-damage curve. The frequency-damage curve is integrated to produce average annual flood damages for the 2001 without project condition. Average annual damages are expected to be $5,366,800 with no frog pond purchases, $5,157,600 with the west 1/2 of the frog pond removed from production and $4,698,600 with the entire frog pond removed from production.

Future Damage Potential, Without-Project (No Frog Pond Land Purchases). As discussed previously, the evaluation of impacts on land use development in the year 2006 was also investigated. Differences in damage susceptibility are due to assumptions concerning differing stages of maturity of new fruit trees planted after Hurricane Andrew. Fruit trees generally require 4-5 years before bearing fruit, and 8-12 years to achieve full production. Therefore if replanting is completed by 1996, after approximately 5 years at the beginning of the project life in 2001, fruit trees will be mature and ready to bear fruit. At this time, flood damage is assessed using the full value of the tree. However, no marketable fruit is produced at this point and no damage is claimed for fruit losses. At the end of 10 years in the year 2006, it is assumed all fruit trees will be fully mature and producing fruit at pre-Andrew capacity. At this time, flood damage is assessed using the full value of the fruit and tree. Flood damage susceptibility will remain the same from the years 2006-2051. Total expected damage by frequency for the without project condition for the period 2006-2051 are shown in table 19. Average annual damages for the 2006-2051 without project condition are expected to be $5,560,500 with no frog pond purchases, $5,271,800 with the west 1/2 of the frog pond removed from production and $5,008,500 with the entire frog pond removed from production.

The future annual increase in flood damages is amortized and discounted at 8%, 6% and 2 1/2% to calculate an average annual equivalent. The result of this analysis is average annual equivalent flood damages for the without project condition. Average annual equivalent damages without the project with no frog pond purchases are estimated to be $5,533,300 at 8%, $5,538,600 at 6%, and $5,547,500 at 2 1/2%.

Plan Alternatives - Eight alternatives have been selected for study. Each of the alternatives basically provide similar hydrologic and hydraulic responses. Slight changes in flood damage effects are noted since some of the plans require different quantities of land purchases in the Frog Pond area located in the south-west portion of the economic area. The effect of land purchases is to remove crop acreage from production and therefore reduce flood damage prevention benefits. Plan 1 requires no land purchases in the Frog Pond Area. Plan 2 is evaluated with the west 1/2 of the Frog Pond removed. Plans 3, 4, 5, 6, and 6A are evaluated with the entire Frog Pond removed. Plan 1A is essentially the same as Plan 1 with the exception that environmental features are reduced to a level of minimum acceptability. Evaluations indicated that the all alternatives would improve flood drainage in the study area and substantially reduce flooding durations, dollar damages, and crop land flooded during the 10 year and 2 year storm events.

Existing Damage Potential, Plan 1 and Plan 1A - The hydrologic results occurring from the Standard Project Flood, 100-year, 50-year, 25-year,10-year, and 2-year flood frequencies were used to estimate damages using alternative project conditions. The same procedures as discussed for without project conditions were utilized to measure the damage susceptibility of the proposed project.

The proposed project virtually eliminates flooding and crop damage during a 2-year storm, and generally provides slightly less than 10 year protection. Effects upon benefits are most significant for the 10 year and more frequent flood events. An evaluation of damage reduction benefits indicates a virtual absence of damage to fruit trees and nurseries, minor damage to vegetable crops, and only minor damage to urban lawns, pavement, shrubs, streets with a 10-year or more frequent flood event. For 25-year and more severe storms, the proposed project would benefit fruit tree and ornamental nurseries substantially more than row crops. This primarily reflects a significant reduction in flooding on tracts utilized for avocado groves and nurseries where flood damages can be significant. Flood damage susceptibility for the Plan 1 and Plan 1A condition in the year 2001 is shown in tables 20, 21, and 22. Average annual damage with Plan 1 and Plan 1A is expected to be $2,310,300.

Future Damage Potential, Plan 1 and Plan 1A - Flood damage potential for this condition is computed in the same manner as the future potential for without project conditions. Average annual damages are expected to be $2,361,900. Flood damage susceptibility for the Plan 1 and Plan 1A condition in the year 2006 is shown in table 23. The future annual increase in flood damages is amortized and discounted at 8%, 6%, and 2 1/2% to calculate the average annual equivalent of these flood damages. The result of this analysis is average annual equivalent flood damages for the Plan 1 and Plan 1A condition. Average annual equivalent damages are estimated to be $2,354,600 at 8%, $2,356,100 at 6%, and $2,358,400 at 2 1/2%.

Existing and Future Damage Potential, Plan 2 - Plan 2 is evaluated with the west 1/2 of the Frog Pond removed. Average annual damage for the 2001 condition is estimated to be $ 2,242,000. Average annual damage for the 2006 condition is estimated to be $2,293,500. Average annual equivalent damages for Plan 2 is estimated to be $2,286,300 at 8%, $2,287,700 at 6%, and $2,290,000 at

2 1/2%. Flood damage susceptibility for the 2001 and 2006-2051 conditions are shown in table 24 and table 25.

Existing and Future Damage Potential, Plans 3, 4, 5, 6, 6A - Plans 3, 4. 5, 6, and 6A are evaluated with the entire Frog Pond removed. Average annual damage for the 2001 condition is estimated to be $ 1,984,800. Average annual damage for the 2006 condition is estimated to be $ 2,071,000. Average annual equivalent damages for Plans 3, 4, 5 and 6 are estimated to be $2,058,900 at 8%, $2,061,200 at 6%, and $2,065,200 at 2 1/2%. Average annual flood damages for the 2001 and 2006-2051 conditions are shown in table 26 and table 27.

Benefit Evaluation. Average annual equivalent flood reduction benefits are measured as the difference between without and with project average annual equivalent flood damages. Since hydrologic response is expected to be approximately the same for all plans, the only difference among benefits is due to the reduction of benefits from reduced production in the basin with the purchase of frog pond land. Average annual flood damage summaries with and without project for the years 2001 and 2006 are shown in tables 28 and 29. Average annual equivalent flood reduction benefits for each plan calculated at an 8 % interest rate are shown in table 30.

Maximization of Net Benefits - It is required in the "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies", March, 1983, that various alternative plans are to be formulated in a systematic manner to ensure that all reasonable alternatives are evaluated. Another requirement is that a plan that reasonably maximizes net national economic development benefits should be formulated. The formulation of this alternative requires an analysis to determine what degree of flood control protection will maximize net flood control benefits. Net flood control benefit functions are analyzed by plotting average annual equivalent inundation reduction benefits less the average annual equivalent costs, for an array of plans. The resulting functions are measures of economic efficiency and the respective maximums identify the degree of protection at which net benefits are maximized.

As discussed previously, each of the alternatives provide similar hydrologic and hydraulic responses and significantly reduce damage potential from the 10 year flood event. Slight changes in flood damage effects are noted since some of the plans require different quantities of land purchases in the Frog Pond area located in the south-west portion of the economic study area. Since the annual value of the procurement cost of these lands is larger than the reduced damage susceptibility achieved by removing their productive potential, incremental net benefits will decrease for those alternatives which purchase the Frog Pond.

The design of this segment which is part of the original C&SF project provided for containment of 40% of SPF flow and 10 year agricultural protection. Since initial project construction in the 1960's, damage susceptibility has increased due to the increased value of crops and agricultural encroachment which has taken place in the floodplain. Alternatives have been designed to approximately re-instate the original project protection. Designs larger than 10 year design would greatly escalate construction costs for channel excavation and pump costs for flood control due to the severely restricted outlet capacity

caused by the lack of sufficient head differentials at the structures. Additional flood damage reduction might be achieved, but at a very large cost. Smaller designs would not meet the intent of restoring protection originally designed under the original authorization.

All plans provide approximately the same net flood protection benefits. Therefore, the plan selection process becomes totally a function of environmental efficiency. The benefit-to-cost ratio for the flood control portion of all alternatives based upon benefits and costs of alternative 1A is approximately 1.05-to-1 at an 8 percent interest rate. Project costs and benefits are shown for the eight alternatives at an 8 percent interest rate are shown in table 31. Net benefits for the eight alternatives at a 6 percent interest rate and a 2 1/2 percent interest rate are shown in tables 32 and 33.

C-111
GENERAL REEVALUATION REPORT
Appendix E
Social and Economic Analysis

TABLES

Table 1
C-111 Study Area, 1986 Land Use

Type of Use	Acres	% of Agricultural Land	% of Total
Row and Field Crops	23,117	62.9%	54.1%
Fruit and Tree Crops	12,558	34.1%	29.4%
Nurseries	1,093	3.0%	2.6%
Sub-Total	36,768	100.0%	86.1%
Wetlands and Other Open Land	4,157		9.7%
Urban Land	1,783		4.2%
Total Acres	42,708		100.0%
Total Damage[1] Susceptible Acreage	36,772		86.1%

[1] Productive acreages are reduced by 10% to allow for infrastructure. Infrastructure includes roads, right of ways for electrical lines, drainage ditches, etc. Productive acreages are again reduced by approximately 4% to account for the average percentage of agricultural land that lies fallow within a given productive operation.

Table 2
C-111 Study Area, 2001 Land Use

Land Use	Estimated Acreage	Sub-total
Tomatoes	9,921.08[2]	
Potatoes	804.19	
Squash	2,306.02	
Snap Beans	3,390.86	
Pole Beans	41.65	
Cabbage	35.84	
Corn	2,447.07	
Lettuce	246.02	
Peppers	84.59	
Sweet Potatoes	173.51	
Malanga	410.84	
Calabanza	491.16	
Okra	315.25	
Yuca	398.18	
Mixed Vegetables	3,639.43[3]	
Cucumbers	74.25	
General Agriculture	532.50	25,312.44
Limes	1,565.91	
Mangos	582.74	
Avocados	3,697.10	
Maturing Limes	1,842.09	
Maturing Mangos	194.25	
Maturing Avocados	943.05	8,825.14
Papaya	309.16	
Bananas	42.66	
Guava	185.65	
Lychee	46.21	583.68
Sunflower	57.55	
Nursery	1,035.40	
Wetland and Other Open Land	4,018.18	5,111.13
Urban	2,199.96[4]	2,199.96
Total Acres		42,032.35
Adjusted Acreage [5]		36,749.41

[2] Excludes tomato acreage in the Frog Pond at or below 4.25ft msl. The evaluation assumes the without and with project conditions will be operated at authorized stages. This acreage is included under wetland and other open acreage.

[3] 50% of the downed fruit tree acreage will not be replanted. This acreage will remain in mixed vegetables.

[4] Urban land use acreage is primarily single family residential and mobile homes. Some airport and recreational acreage is included in this value.

[5] Productive acreages are reduced by 10% to allow for infrastructure. Infrastructure includes roads, right of ways for electrical lines, drainage ditches, etc. Productive acreages are again reduced by approximately 4% to account for the average percentage of agricultural land that lies fallow within a given productive operation.

Table 3
Agricultural Land Use Classifications, Root Depths
and Bedding Heights

	Land Use Class	Decreased Topographic Adjustment (Feet)	Root Depth (Feet)	Bedding Height (Feet)
Tomatoes	1	0.17	0.67	0.50
Potatoes	2	0.17	0.67	0.50
Squash	3	0.17	0.67	0.50
Snap Beans	4	0.17	0.67	0.50
Cabbage	5	0.17	0.67	0.50
Corn	6	0.17	0.67	0.50
Lettuce	7	0.17	0.67	0.50
Peppers	8	0.17	0.67	0.50
Okra	9	0.17	0.67	0.50
Mixed Vegetables	10	0.17	0.67	0.50
Cucumbers	11	0.17	0.67	0.50
Sweet Potatoes	12	0.17	0.67	0.50
Malanga	13	0.17	0.67	0.50
Calabanza	14	0.17	0.67	0.50
Yuca	15	0.17	0.67	0.50
Pole Beans	16	0.17	0.67	0.50
Limes	17	0.08	1.50	1.42
Mangos	18	0.08	1.50	1.42
Avocados	19	0.08	1.50	1.42
Papaya	20	-0.42	1.00	1.42
Bananas	21	-0.17	1.25	1.42
Guava	22	-0.67	0.75	1.42
Lychee	23	-0.17	1.25	1.42
Nursery	24	0.28[6]	2.00	1.42

[6] The actual computed root zone depth of 0.58 feet is reduced to 0.28 feet below ground to compensate for horticulture plants which are in containers with roots at ground level. The actual composite root length was computed by weighting foliage nursery plants, woody ornamental plants and field nursery plant root zones by the percentages of productive acreage for each crop.

Table 4
Root Zone Depths
Citrus and Selected Fruit Crops

Crop	Minimum	Maximum	Used in Study
Limes	N/A	N/A	18 inches
Mangos	N/A	N/A	18 inches
Avocados	N/A	N/A	18 inches
Papaya	N/A	N/A	12 inches
Bananas	12 inches	18 inches	15 inches
Guava	6 inches	12 inches	9 inches
Lychee	12 inches	18 inches	15 inches

Table 5
Vegetable Crop Loss Per Acre [7]

Crop	Inundation Period To Plant Mortality	Loss Per Acre [8]
Tomatoes	12 Hrs.	3,872
Potatoes	24 Hrs.	1,656
Squash	12 Hrs.	1,289
Snap Beans	12 Hrs.	1,241
Pole Beans	12 Hrs.	1,550
Cabbage	12 Hrs.	1,130
Corn	12 Hrs.	1,402
Leaf Crops	12 Hrs.	1,913
Peppers	12 Hrs.	4,537
Sweet Potatoes	24 Hrs.	900
Malanga	12 Hrs.	1,300
Calabaza	12 Hrs.	625
Okra	12 Hrs.	1,265
Yuca	12 Hrs.	900
Mixed Vegetables	12 Hrs.	1,311
Cucumbers	12 Hrs.	1,940

[7] Information provided by the Institute of Food and Agricultural Sciences (IFAS), University of Florida, Gainesville and the Dade County Extension Service, Homestead, Florida.

[8] Includes pre-harvest operating costs and fixed costs (rent, depreciation, licenses, and insurance). Per acre loss includes all costs incurred by grower up to harvest period.

Table 6
Fruit Crop Loss Per Acre[9]

	Fruit Loss Per Acre	Age Of Mature Replacement Tree	Fruit and Tree Loss Per Acre [10]
Limes	$2,050	6 Years	$11,050
Mangoes	$3,200	7 Years	13,700
Avocados	$2,050	8 Years	14,050
Papaya	$2,500	1 Year	4,000
Carambola	$2,950	3 Years	7,450
Banana [11]	-	-	-
Guava	-	-	-
Lychee	-	-	-

[9] Information provided by the Dade County Extension Service and the University of Florida Tropical Research Station. Homestead, Florida.

[10] Tree loss includes operating and fixed costs during the tree maturity period.

[11] Bananas, guava, and lychee are highly water tolerant. No data is available on water-resistance periods and no known damages have occurred in previous flooding situations.

Table 7
Tolerance Periods for Fruit Crops [12]

1. Limes
   a. Fruit losses will begin after 2 days with 100% loss in 2 weeks.
   b. Tree losses will begin after 7 days with 100% loss in 2 weeks.

2. Avocados
   a. Fruit losses will occur from the beginning of the flood and continue to 100% loss in 8 to 12 hours. Maximum loss will occur at 10 hours in this analysis.
   b. Tree losses will occur from the beginning of the flood with 100% loss in 24 hours.

3. Mangos are somewhat flood tolerant but very disease susceptible.
   a. Fruit losses will occur from the beginning of the flood with 100% loss in 10 days.
   b. Tree losses will begin after 10 days with 100% loss in 6 weeks.

4. Papaya is very damage susceptible.
   a. Fruit losses will occur from the beginning of the flood with 100% loss in 6 hours.
   b. Tree losses will occur from the beginning of the flood with 100% loss in 12 hours.

5. Carambola
   a. Fruit losses will occur from the beginning of the flood with 100% loss in 18 hours.
   b. Tree losses will begin after 7 days with 100% loss in 3 weeks.

6. Lychee are somewhat water tolerant but not highly water tolerant.
   a. Fruit losses will occur from the beginning of the flood with 100% loss in 10 days.
   b. Tree losses will begin after 10 days with 100% loss in 6 weeks.

7. No information is available for Bananas. Bananas are highly water tolerant and no damage was recorded to bananas in the 1981 flood. Therefore, damage susceptibility of bananas are not considered in the study.

8. No information is available for Guava. Guava is highly water tolerant and no damage was recorded to guava in the 1981 flood. Therefore, damage susceptibility of guava is not considered in the study.

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[12] Source: Dade County Extension Service (IFAS), Homestead, Florida.

Table 8
Horticultural Plants Grown in the C-111 Basin

Foliage Nurseries	Field Nurseries
Agleonema species	Acacia species
Aralia species	Bauhinia species
Brassia species	Brassia actinophylla
Chamaedorea species	Bucida species
Codieum variegatm	Callistemon viminalis
Chrysalidocarpus lutescens	Callophyllum antillanum
Dieffenbachia species	Cocoloba uvifera
Dracaena species	Conocarpus erectus
Ficus benjamina	Dalbergia sissoo
Ficus "Broad Leaf Species"	Ligustrum
Phoenix roebellinii	Palms
Philodendron seloum	Podocarpus species
Pleomele reflexa	Quercus virginiana
	Swietenia mahogani
	Tabebuia species

Woody Ornamental Nurseries

Asparagus springerii	Ixora coccinea "species"
Bougainvillea species	Jasmine species
Brassia species	Ligustrum species
Carissa macrocarpa	Liriope species
Chamaedorea species	Nerium oleander
Chrysalidocarpus lutescens	Philodendron selloum
Chrysobalanus icaco	Phoenix roebellinii
Crinum asiaticum	Pilea macrocarpa
Euphorbia millii	Pittosporum species
Eugenia uniflora	Podocarpus species
Ficus benjamina	Viburnum species
Hibiscus species	

Table 9
Horticulture Loss Calculations

	Total Value Crops 83-84	Productive Acreage in 83-84	Productive Acreage in 1986	Value per Acre in 1986	Production Costs per acre [13]	Maximum Production Losses per acre
Foliage Nurseries	$66,000,000	2,000	2,400	$33,000	$29,601	$20,720 [14]
Woody Ornamentals	$18,000,000	667	800	$27,000	$24,165	$20,540 [15]
Field Nurseries	$42,000,000	2,000	3,000	$21,000	$17,178	$17,178

[13] Production costs per acre are estimated using percentages computed from tables 2 and 3 in the publication, "Business Analysis of Ornamental Plant Nurseries in Florida, 1990", Economic Information Report EI 92-1r, IFAS, University of Florida, May 1992.

[14] Reduced by 30% as described in text.

[15] Reduced by 15% as discussed in text.

Table 10
Horticulture Damage Relationship

Time (Days)	Damage per Acre					
	Foliage Nurseries	Adjusted[16] Foliage Nurseries	Woody Ornamental	Adjusted[17] Woody Ornamentals	Field Nurseries	Average[18]
1.0	11,092.00	$7,764.40	14,937.16	$12,696.59	63.63	4,674.63
2.0	29,601.00	$20,720.70	17,426.87	$14,812.84	423.05	10,136.95
3.0	29,601.00	$20,720.70	21,749.00	$18,486.65	1,426.34	11,096.45
4.0	29,601.00	$20,720.70	21,749.00	$18,486.65	3,151.24	11,931.08
5.0	29,601.00	$20,720.70	21,749.00	$18,486.65	4,935.38	12,794.38
6.0	29,601.00	$20,720.70	21,749.00	$18,486.65	6,303.51	13,456.38
7.0	29,601.00	$20,720.70	21,749.00	$18,486.65	7,354.94	13,965.13
8.0	29,601.00	$20,720.70	21,749.00	$18,486.65	8,253.49	14,399.91
9.0	29,601.00	$20,720.70	21,749.00	$18,486.65	9,133.96	14,825.95
10.0	29,601.00	$20,720.70	21,749.00	$18,486.65	10,096.71	15,291.80
11.0	29,601.00	$20,720.70	21,749.00	$18,486.65	11,223.31	15,836.92
12.0	29,601.00	$20,720.70	21,749.00	$18,486.65	12,521.89	16,465.27
13.0	29,601.00	$20,720.70	21,749.00	$18,486.65	13,948.44	17,155.54
14.0	29,601.00	$20,720.70	21,749.00[19]	$18,486.65	15,460.00[20]	17,886.94

[16] Assumed 30% of foliage nurseries are protected at the time of the flood.

[17] Assumes 15% of Woody Ornamentals are protected at the time of the flood.

[18] Average is weighted by the percentage of total productive acreage for each classification.

[19] Maximum duration-damage estimate is based upon 90% of production costs per acre shown in table 9.

[20] Maximum duration-damage estimate is based upon 90% of production costs per acre shown in table 9.

Table 11
Dade County (1991-1992 Prices)
Field Crop Production Costs
Crop: Tomatoes

	Average per acre	%	Loss/acre after land preparation	%	Loss/acre at end of growth pd	%	Loss/acre at end of harvest
Operating Costs:							
Seed	$201.70	100%	$201.70	100%	$201.70	0%	$0.00
Fertilizer	$339.50	33%	$112.04	100%	$339.50	0%	$0.00
Spray and Dust	$810.73	0%	$0.00	100%	$810.73	0%	$0.00
Labor	$694.23	33%	$229.10	100%	$694.23	0%	$0.00
Machinery	$235.97	25%	$58.99	100%	$235.97	0%	$0.00
Interest	$187.25	0%	$0.00	100%	$187.25	0%	$0.00
Miscellaneous							
Custom Equipment	$412.50	100%	$412.50	100%	$412.50	0%	$0.00
Custom Work							
Stake Depreciation and Maint.	$128.00	0%	$0.00	100%	$128.00	0%	$0.00
Plastic Disposal	$75.00	0%	$0.00	100%	$75.00	0%	$0.00
Tie Plants	$130.68	100%	$130.68	100%	$130.68	0%	$0.00
Scouting	$35.00	0%	$0.00	100%	$35.00	0%	$0.00
Well Maintenance	$15.00	0%	$0.00	100%	$15.00	0%	$0.00
Farm Vehicles	$20.83	33%	$6.87	100%	$20.83	0%	$0.00
Frost Protection	$100.00	0%	$0.00	100%	$100.00	0%	$0.00
Sub-totals:			$1,151.88		$3,386.39	0%	$0.00
Fixed Costs:							
Rent	$200.00	0%	$0.00	100%	$200.00	0%	$0.00
Machinery Depreciation	$125.66	0%	$0.00	100%	$125.66	0%	$0.00
Overhead	$384.52	33%	$126.89	100%	$384.52	0%	$0.00
Sub-totals:	$710.18		$126.89		$710.18		$0.00
Total:		31.22%	$1,278.77		$4,096.57		$0.00

Table 12
Daily Production Cost Expenditures[21]

Date	Early[22] Planters First (1/3) Preparation	Early[23] Planters First(1/3) Growth	Early[24] Planters First(1/3) Harvest	Early Planters Second(1/3) Preparation	Early Planters Second(1/3) Growth	Early Planters Second(1/3) Harvest	Early Planters Last(1/3) Preparation	Early Planters Last(1/3) Growth	Early Planters Last (1/3) Harvest
01-Aug-93									
02-Aug-93									
03-Aug-93									
04-Aug-93									
05-Aug-93									
06-Aug-93									
07-Aug-93									
08-Aug-93									
09-Aug-93									
10-Aug-93									
11-Aug-93									
12-Aug-93									
13-Aug-93									

[21] This information is an example using only the early season planters.

[22] Land preparation costs are computed using the following equation: (1/3 * 1/3 * 31% * D_n/14). The equation represents 1/3 of the planters planting the first third of their acreage. Acreage production costs are estimated at 31% of the total. At the D_{14}th day, the last factor becomes 1 indicating all land preparation costs for these crops are in the ground.

[23] The growth period is handled similarly to the land preparation period using the following equation. (1/3 * 1/3 * 69% * D_n/ 70) This equation represents 1/3 of the planters planting the first third of their acreage. Costs incurred during the growing period are estimated to be 69% of the total. At the D_{70}th day, the last factor becomes 1 indicating all growing costs have been expended and the crop is ready for harvest.

[24] During the harvest, the crop is removed from the ground and production costs are re-claimed. Therefore, losses that would result with a flood during this period decrease during the harvest period. Production costs claimable during the harvest period are computed using the following equation where total cost is the sum of land preparation costs and growing period costs: (Total Cost - (Total Cost * D_n/14)). At the D_{14}th day, the last factor becomes 1 and the expression becomes 0 indicating all production costs have been re-claimed.

Table 12 (Continued)
Daily Production Cost Expenditures

Date	Early Planters First (1/3) Preparation	Early Planters First(1/3) Growth	Early Planters First(1/3) Harvest	Early Planters Second(1/3) Preparation	Early Planters Second(1/3) Growth	Early Planters Second(1/3) Harvest	Early Planters Last(1/3) Preparation	Early Planters Last(1/3) Growth	Early Planters Last (1/3) Harvest
14-Aug-93									
15-Aug-93									
16-Aug-93									
17-Aug-93									
18-Aug-93	0.246%								
19-Aug-93	0.492%								
20-Aug-93	0.738%								
21-Aug-93	0.984%								
22-Aug-93	1.230%								
23-Aug-93	1.476%								
24-Aug-93	1.722%								
25-Aug-93	1.968%								
26-Aug-93	2.214%								
27-Aug-93	2.460%								
28-Aug-93	2.706%			0.246%					
29-Aug-93	2.952%			0.492%					
30-Aug-93	3.198%			0.738%					
31-Aug-93	3.444%			0.984%					
01-Sep-93	3.444%	0.110%		1.230%					
02-Sep-93	3.444%	0.219%		1.476%					
03-Sep-93	3.444%	0.329%		1.722%					
04-Sep-93	3.444%	0.438%		1.968%					
05-Sep-93	3.444%	0.548%		2.214%					
06-Sep-93	3.444%	0.657%		2.460%					
07-Sep-93	3.444%	0.767%		2.706%			0.246%		
08-Sep-93	3.444%	0.876%		2.952%			0.492%		

Table 12 (Continued)
Daily Production Cost Expenditures

Date	Early Planters First (1/3) Preparation	Early Planters First(1/3) Growth	Early Planters First(1/3) Harvest	Early Planters Second(1/3) Preparation	Early Planters Second(1/3) Growth	Early Planters Second(1/3) Harvest	Early Planters Last(1/3) Preparation	Early Planters Last(1/3) Growth	Early Planters Last (1/3) Harvest
09-Sep-93	3.444%	0.986%		3.198%			0.738%		
10-Sep-93	3.444%	1.095%		3.444%			0.984%		
11-Sep-93	3.444%	1.205%		3.444%	0.110%		1.230%		
12-Sep-93	3.444%	1.314%		3.444%	0.219%		1.476%		
13-Sep-93	3.444%	1.424%		3.444%	0.329%		1.722%		
14-Sep-93	3.444%	1.533%		3.444%	0.438%		1.968%		
15-Sep-93	3.444%	1.643%		3.444%	0.548%		2.214%		
16-Sep-93	3.444%	1.752%		3.444%	0.657%		2.460%		
17-Sep-93	3.444%	1.862%		3.444%	0.767%		2.706%		
18-Sep-93	3.444%	1.971%		3.444%	0.876%		2.952%		
19-Sep-93	3.444%	2.081%		3.444%	0.986%		3.198%		
20-Sep-93	3.444%	2.190%		3.444%	1.095%		3.444%		
21-Sep-93	3.444%	2.300%		3.444%	1.205%		3.444%	0.110%	
22-Sep-93	3.444%	2.410%		3.444%	1.314%		3.444%	0.219%	
23-Sep-93	3.444%	2.519%		3.444%	1.424%		3.444%	0.329%	
24-Sep-93	3.444%	2.629%		3.444%	1.533%		3.444%	0.438%	
25-Sep-93	3.444%	2.738%		3.444%	1.643%		3.444%	0.548%	
26-Sep-93	3.444%	2.848%		3.444%	1.752%		3.444%	0.657%	
27-Sep-93	3.444%	2.957%		3.444%	1.862%		3.444%	0.767%	
28-Sep-93	3.444%	3.067%		3.444%	1.971%		3.444%	0.876%	
29-Sep-93	3.444%	3.176%		3.444%	2.081%		3.444%	0.986%	
30-Sep-93	3.444%	3.286%		3.444%	2.190%		3.444%	1.095%	
01-Oct-93	3.444%	3.395%		3.444%	2.300%		3.444%	1.205%	
02-Oct-93	3.444%	3.505%		3.444%	2.410%		3.444%	1.314%	
03-Oct-93	3.444%	3.614%		3.444%	2.519%		3.444%	1.424%	
04-Oct-93	3.444%	3.724%		3.444%	2.629%		3.444%	1.533%	
05-Oct-93	3.444%	3.833%		3.444%	2.738%		3.444%	1.643%	
06-Oct-93	3.444%	3.943%		3.444%	2.848%		3.444%	1.752%	
07-Oct-93	3.444%	4.052%		3.444%	2.957%		3.444%	1.862%	

Table 12 (Continued)
Daily Production Cost Expenditures

Date	Early Planters First (1/3) Preparation	Early Planters First(1/3) Growth	Early Planters First(1/3) Harvest	Early Planters Second(1/3) Preparation	Early Planters Second(1/3) Growth	Early Planters Second(1/3) Harvest	Early Planters Last(1/3) Preparation	Early Planters Last(1/3) Growth	Early Planters Last (1/3) Harvest
08-Oct-93	3.444%	4.162%		3.444%	3.067%		3.444%	1.971%	
09-Oct-93	3.444%	4.271%		3.444%	3.176%		3.444%	2.081%	
10-Oct-93	3.444%	4.381%		3.444%	3.286%		3.444%	2.190%	
11-Oct-93	3.444%	4.490%		3.444%	3.395%		3.444%	2.300%	
12-Oct-93	3.444%	4.600%		3.444%	3.505%		3.444%	2.410%	
13-Oct-93	3.444%	4.710%		3.444%	3.614%		3.444%	2.519%	
14-Oct-93	3.444%	4.819%		3.444%	3.724%		3.444%	2.629%	
15-Oct-93	3.444%	4.929%		3.444%	3.833%		3.444%	2.738%	
16-Oct-93	3.444%	5.038%		3.444%	3.943%		3.444%	2.848%	
17-Oct-93	3.444%	5.148%		3.444%	4.052%		3.444%	2.957%	
18-Oct-93	3.444%	5.257%		3.444%	4.162%		3.444%	3.067%	
19-Oct-93	3.444%	5.367%		3.444%	4.271%		3.444%	3.176%	
20-Oct-93	3.444%	5.476%		3.444%	4.381%		3.444%	3.286%	
21-Oct-93	3.444%	5.586%		3.444%	4.490%		3.444%	3.395%	
22-Oct-93	3.444%	5.695%		3.444%	4.600%		3.444%	3.505%	
23-Oct-93	3.444%	5.805%		3.444%	4.710%		3.444%	3.614%	
24-Oct-93	3.444%	5.914%		3.444%	4.819%		3.444%	3.724%	
25-Oct-93	3.444%	6.024%		3.444%	4.929%		3.444%	3.833%	
26-Oct-93	3.444%	6.133%		3.444%	5.038%		3.444%	3.943%	
27-Oct-93	3.444%	6.243%		3.444%	5.148%		3.444%	4.052%	
28-Oct-93	3.444%	6.352%		3.444%	5.257%		3.444%	4.162%	
29-Oct-93	3.444%	6.462%		3.444%	5.367%		3.444%	4.271%	
30-Oct-93	3.444%	6.571%		3.444%	5.476%		3.444%	4.381%	
31-Oct-93	3.444%	6.681%		3.444%	5.586%		3.444%	4.490%	
01-Nov-93	3.444%	6.790%		3.444%	5.695%		3.444%	4.600%	
02-Nov-93	3.444%	6.900%		3.444%	5.805%		3.444%	4.710%	
03-Nov-93	3.444%	7.010%		3.444%	5.914%		3.444%	4.819%	
04-Nov-93	3.444%	7.119%		3.444%	6.024%		3.444%	4.929%	

Table 12 (Continued)
Daily Production Cost Expenditures

Date	Early Planters First (1/3) Preparation	Early Planters First(1/3) Growth	Early Planters First(1/3) Harvest	Early Planters Second(1/3) Preparation	Early Planters Second(1/3) Growth	Early Planters Second(1/3) Harvest	Early Planters Last(1/3) Preparation	Early Planters Last(1/3) Growth	Early Planters Last (1/3) Harvest
05-Nov-93	3.444%	7.229%		3.444%	6.133%		3.444%	5.038%	
06-Nov-93	3.444%	7.338%		3.444%	6.243%		3.444%	5.148%	
07-Nov-93	3.444%	7.448%		3.444%	6.352%		3.444%	5.257%	
08-Nov-93	3.444%	7.557%		3.444%	6.462%		3.444%	5.367%	
09-Nov-93	3.444%	7.667%		3.444%	6.571%		3.444%	5.476%	
10-Nov-93	0.000%	0.000%	10.317%	3.444%	6.681%		3.444%	5.586%	
11-Nov-93			9.524%	3.444%	6.790%		3.444%	5.695%	
12-Nov-93			8.730%	3.444%	6.900%		3.444%	5.805%	
13-Nov-93			7.937%	3.444%	7.010%		3.444%	5.914%	
14-Nov-93			7.143%	3.444%	7.119%		3.444%	6.024%	
15-Nov-93			6.349%	3.444%	7.229%		3.444%	6.133%	
16-Nov-93			5.556%	3.444%	7.338%		3.444%	6.243%	
17-Nov-93			4.762%	3.444%	7.448%		3.444%	6.352%	
18-Nov-93			3.968%	3.444%	7.557%		3.444%	6.462%	
19-Nov-93			3.175%	3.444%	7.667%		3.444%	6.571%	
20-Nov-93			2.381%	0.000%	0.000%	10.317%	3.444%	6.681%	
21-Nov-93			1.587%			9.524%	3.444%	6.790%	
22-Nov-93			0.794%			8.730%	3.444%	6.900%	
23-Nov-93			0.000%			7.937%	3.444%	7.010%	

Table 13
Seasonal Adjustments for Field Crops

Month	Monthly Probabilities of Flooding	Cumulative Percentages Production Costs
January	0.00%	30.95%
February	2.00%	20.93%
March	3.00%	26.70%
April	5.00%	7.04%
May	11.00%	0.00%
June	20.00%	0.00%
July	2.00%	0.00%
August	12.00%	0.09%
September	23.00%	11.19%
October	20.00%	23.23%
November	2.00%	35.56%
December	0.00%	24.73%

Table 14
Floodprone Area Summary[25]
By Frequency and Land Use Classification
No Frog Pond Purchases
Without Project (in acres)

Land Use	SPF	100 Year	50 Year	25 Year	10 Year	2 Year
Tomatoes	7,800	5,893	5,131	4,127	2,447	1,530
Potatoes	692	674	598	514	132	60
Squash	1,698	1,261	925	811	241	134
Snap Beans	2,659	2,299	1,840	1,380	462	41
Pole Beans	36	31	31	29	16	0
Cabbage	31	31	31	31	0	0
Corn	1,842	1,325	1,232	869	233	164
Lettuce	212	212	212	212	0	0
Peppers	73	73	62	37	0	0
Sweet Potatoes	149	98	70	58	0	0
Malanga	354	354	354	327	194	23
Calabanza	423	423	382	358	144	0
Okra	271	220	174	139	11	0
Yuca	343	335	264	199	0	0
Mixed Vegetables	2,835	2,091	1,553	965	175	0
Cucumbers	64	64	64	0	0	0
Limes	1,202	865	575	367	55	0
Mangos	479	357	300	220	23	0
Avocados	2,790	1,952	1,551	1,013	84	0
Papaya	261	211	158	52	28	0
Bananas	37	17	14	0	0	0
Guava	143	80	0	0	0	0
Lychee	40	30	0	0	0	0
Nursery	883	844	740	715	257	78
General Agriculture	337	337	337	144	0	0
Fallow	3,857	3,423	3,386	3,307	2,992	2,499
Maturing Limes	1,402	1,009	671	429	64	0
Maturing Mangos	160	119	100	73	8	0
Maturing Avocados	721	503	400	261	22	0
Sum:	31,794	25,129	21,154	16,638	7,585	4,528

[25] Acreage in table 14 is cataloged as floodprone when flood elevations are above ground level. Affected field crop acreage may be less than shown depending upon the growing season of the crop and the seasonal occurrence of the flood.

Table 15
Floodprone Area Summary[26]
By Frequency and Land Use Classification
No Frog Pond Purchases
With Project (in acres)

Land Use	SPF	100 Year	50 Year	25 Year	10 Year	2 Year
Tomatoes	6,559	4,320	4,045	3,291	1,985	662
Potatoes	653	586	546	385	61	8
Squash	1,211	1,030	841	645	189	61
Snap Beans	2,306	1,825	1,579	958	149	0
Pole Beans	20	15	15	13	0	0
Cabbage	31	31	31	31	0	0
Corn	1,466	1,012	916	623	34	24
Lettuce	212	212	212	212	0	0
Peppers	73	73	62	37	0	0
Sweet Potatoes	149	98	58	58	0	0
Malanga	342	342	342	304	122	50
Calabanza	406	385	364	279	96	0
Okra	239	176	146	109	0	0
Yuca	343	314	249	168	0	0
Mixed Vegetables	2,496	1,952	1,483	835	50	0
Cucumbers	64	3	3	0	0	0
Limes	1,034	764	501	321	26	0
Mangos	407	352	294	209	23	0
Avocados	2,273	1,795	1,391	814	0	0
Papaya	257	165	59	52	28	0
Bananas	28	14	0	0	0	0
Guava	143	71	0	0	0	0
Lychee	30	30	0	0	0	0
Nursery	663	575	489	331	0	0
General Agriculture	337	337	337	57	0	0
Fallow	3,275	2,841	2,622	2,309	1,758	838
Maturing Limes	1,206	891	585	374	30	0
Maturing Mangos	136	117	98	70	8	0
Maturing Avocados	588	462	358	210	0	0
Sum:	26,946	20,790	17,626	12,693	4,559	1,642

[26] Acreage in table 15 is cataloged as floodprone when flood elevations are above ground level. Affected field crop acreage may be less than shown depending upon the growing season of the crop and the seasonal occurrence of the flood.

Table 16
Damage Potential
Fruit Crops, Nurseries, and Urban
Without Project Condition
2001 Land Use Condition

Land Use	SPF	100yr	50yr	25yr	10yr	2yr
Limes	1,358,110.68	455,481.23	165,943.62	90,978.51	8,616.20	0.00
Mangos	859,013.15	475,902.29	329,776.40	182,146.35	29,694.39	0.00
Avocados	39,049,197.52	26,769,496.82	21,186,817.79	13,861,270.23	1,144,531.88	0.00
Papaya	1,044,360.00	842,759.99	580,525.61	208,280.00	110,040.00	0.00
Maturing Limes	542,644.23	143,890.58	84.05	2,802.15	0.00	0.00
Maturing Mangos	3,992.48	2,234.15	0.00	0.00	0.00	0.00
Maturing Avocadoes	8,622,269.47	5,873,035.69	4,642,278.50	3,039,740.89	250,790.72	0.00
Total Fruit Crops	51,479,587.53	34,562,800.75	26,905,425.97	17,385,218.13	1,543,673.19	0.00
Nursery	13,045,577.23	11,478,483.46	10,185,369.18	8,447,332.30	4,346,550.24	1,335,911.63
Urban	24,669,774.83	11,904,773.08	8,872,090.28	6,749,192.23	1,067,743.08	298,220.91

Table 17
Full Production Damage Potential
Vegetable Crops
Without Project Condition
2001 Land Use Condition
No Frog Pond Land Purchases

Land Use	SPF	100yr	50yr	25yr	10yr	2yr
Tomatoes	29,947,247.74	22,821,435.15	19,866,200.21	15,894,519.95	9,413,990.93	5,924,993.77
Potatoes	1,146,708.36	1,112,398.25	975,554.35	850,757.44	211,358.88	98,815.91
Squash	2,187,435.86	1,614,077.98	1,193,498.19	1,046,545.58	310,441.09	166,486.70
Snap Beans	3,298,292.82	2,802,095.09	2,283,654.78	1,713,339.92	525,805.14	51,108.91
Pole Beans	55,583.00	48,174.00	48,174.00	44,516.00	24,443.50	0.00
Cabbage	34,890.01	34,890.01	34,890.01	34,890.01	0.00	0.00
Corn	2,583,045.26	1,857,709.30	1,715,541.33	1,218,994.64	310,085.83	230,050.59
Lettuce	405,353.60	405,353.60	405,353.60	405,353.60	0.00	0.00
Peppers	330,427.29	330,427.29	280,196.17	167,845.45	0.00	0.00
Sweet Potatoes	134,451.00	88,488.00	55,764.87	52,407.00	0.00	0.00
Malanga	459,849.00	459,849.00	459,849.00	424,671.00	248,604.75	29,887.00
Calabanza	264,306.25	264,306.25	238,593.75	223,481.25	88,227.77	0.00
Okra	343,489.23	278,557.45	219,611.39	176,053.57	13,312.85	0.00
Yuca	308,556.00	301,599.00	233,423.45	178,992.00	0.00	0.00
Mixed Vegetables	3,717,215.36	2,733,721.14	2,031,027.27	1,265,424.70	201,720.36	0.00
Cucumbers	124,055.54	124,055.54	124,055.54	0.00	0.00	0.00
General Agriculture	441,811.10	441,811.10	441,811.10	189,190.28	0.00	0.00
Field Crops	45,782,717.42	35,718,948.15	30,607,199.01	23,886,982.39	11,347,991.10	6,501,342.88

Table 18
Expected Damage Potential
Without Project Conditions
2001 Land Use Condition
No Frog Pond Land Purchases

Full Production Field Crop Flood Damage			SPF 45,782,717.42	100yr 35,718,948.15	50yr 30,607,199.01	25yr 23,886,982.39	10yr 11,347,991.10	2yr 6,501,342.88
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$191,628.14	$149,505.23	$128,109.49	$99,981.35	$47,498.15	$27,212.02
March	3.00%	26.70%	$366,747.04	$286,130.21	$245,182.03	$191,349.06	$90,904.22	$52,079.66
April	5.00%	7.04%	$161,178.06	$125,748.56	$107,752.64	$84,094.12	$39,950.60	$22,887.98
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$5,015.95	$3,913.37	$3,353.32	$2,617.06	$1,243.29	$712.29
September	23.00%	11.19%	$1,178,731.00	$919,627.18	$788,019.07	$614,999.03	$292,167.65	$167,384.87
October	20.00%	23.23%	$2,126,973.49	$1,659,430.89	$1,421,949.25	$1,109,741.43	$527,204.97	$302,039.39
November	2.00%	35.56%	$325,625.00	$254,047.45	$217,690.64	$169,893.77	$80,711.45	$46,240.15
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$4,355,898.67	$3,398,402.88	$2,912,056.45	$2,272,675.82	$1,079,680.33	$618,556.36
Nursery			13,045,577.23	11,478,483.46	10,185,369.18	8,447,332.30	4,346,550.24	1,335,911.63
Fruit Crops			51,479,587.53	34,562,800.75	26,905,425.97	17,385,218.13	1,543,673.19	0.00
Urban			24,669,774.83	11,904,773.08	8,872,090.28	6,749,192.23	1,067,743.08	298,220.91
Sum:			$93,550,838.26	$61,344,460.17	$48,874,941.88	$34,854,418.48	$8,037,646.84	$2,252,688.90

Table 19
Expected Damage Potential
Without Project Conditions
2006 Land Use Condition
No Frog Pond Land Purchases

Full Production Field Crop Flood Damage			SPF 45,782,717.42	100yr 35,718,948.15	50yr 30,607,199.01	25yr 23,886,982.39	10yr 11,347,991.10	2yr 6,501,342.88
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$191,628.14	$149,505.23	$128,109.49	$99,981.35	$47,498.15	$27,212.02
March	3.00%	26.70%	$366,747.04	$286,130.21	$245,182.03	$191,349.06	$90,904.22	$52,079.66
April	5.00%	7.04%	$161,178.06	$125,748.56	$107,752.64	$84,094.12	$39,950.60	$22,887.98
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$5,015.95	$3,913.37	$3,353.32	$2,617.06	$1,243.29	$712.29
September	23.00%	11.19%	$1,178,731.00	$919,627.18	$788,019.07	$614,999.03	$292,167.65	$167,384.87
October	20.00%	23.23%	$2,126,973.49	$1,659,430.89	$1,421,949.25	$1,109,741.43	$527,204.97	$302,039.39
November	2.00%	35.56%	$325,625.00	$254,047.45	$217,690.64	$169,893.77	$80,711.45	$46,240.15
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$4,355,898.67	$3,398,402.88	$2,912,056.45	$2,272,675.82	$1,079,680.33	$618,556.36
Nursery			13,045,577.23	11,478,483.46	10,185,369.18	8,447,332.30	4,346,550.24	1,335,911.63
Fruit Crops			54,278,403.25	36,129,811.19	28,024,553.12	18,080,520.06	1,607,819.32	0.00
Urban			24,669,774.83	11,904,773.08	8,872,090.28	6,749,192.23	1,067,743.08	298,220.91
Sum:			$96,349,653.98	$62,911,470.61	$49,994,069.03	$35,549,720.41	$8,101,792.97	$2,252,688.90

Table 20
Damage Potential
Fruit Crops, Nurseries, and Urban
Plans 1,1A Project Condition
2001 Land Use Condition
No Frog Pond Purchases

Land Use	SPF	100yr	50yr	25yr	10yr	2yr
Limes	714,234.66	215,588.28	102,480.62	35,309.55	0.00	0.00
Mangos	704,777.67	386,880.81	275,773.64	106,736.14	3,397.41	0.00
Avocados	31,836,241.43	24,201,621.21	19,323,323.25	9,564,040.15	0.00	0.00
Papaya	1,028,480.00	657,437.48	235,440.00	208,280.00	110,040.00	0.00
Maturing Limes	75,972.68	0.00	0.00	0.00	0.00	0.00
Maturing Mangos	0.00	0.00	0.00	0.00	0.00	0.00
Maturing Avocadoes	7,033,047.02	5,286,591.27	4,243,538.32	2,044,877.41	0.00	0.00
Total Fruit Crops	41,392,753.46	30,748,119.05	24,180,555.83	11,959,243.25	113,437.41	0.00
Nursery	8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Urban	17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00

Table 21
Full Production Damage Potential
Vegetable Crops
Plans 1,1A Project Condition
2001 Land Use Condition
No Frog Pond Purchases

Land Use	SPF	100yr	50yr	25yr	10yr	2yr
Tomatoes	25,047,171.37	16,568,341.29	15,637,586.92	12,746,343.08	7,688,192.98	2,453,108.74
Potatoes	1,081,940.63	970,985.95	883,800.44	636,780.51	77,626.28	12,801.19
Squash	1,562,137.30	1,327,430.27	1,084,970.21	827,672.72	244,129.90	77,426.74
Snap Beans	2,848,460.64	2,246,209.59	1,960,171.87	1,185,559.62	102,838.72	0.00
Pole Beans	31,139.50	23,730.50	23,730.50	20,072.50	0.00	0.00
Cabbage	34,890.01	34,890.01	34,890.01	34,890.01	0.00	0.00
Corn	2,049,842.40	1,419,372.14	1,273,312.84	869,650.64	48,183.71	33,066.70
Lettuce	405,353.60	405,353.60	405,353.60	405,353.60	0.00	0.00
Peppers	330,427.29	330,427.29	280,196.17	167,845.45	0.00	0.00
Sweet Potatoes	134,451.00	88,488.00	52,407.00	52,407.00	0.00	0.00
Malanga	444,353.00	444,353.00	444,353.00	394,784.00	153,046.52	64,415.00
Calabanza	253,506.25	240,350.00	227,793.75	174,418.75	59,712.50	0.00
Okra	302,854.67	223,268.63	183,709.30	138,051.21	0.00	0.00
Yuca	308,556.00	282,654.00	221,462.66	151,254.00	0.00	0.00
Mixed Vegetables	3,270,759.65	2,529,594.09	1,904,988.75	1,080,284.20	53,860.34	0.00
Cucumbers	124,055.54	6,228.97	6,228.97	0.00	0.00	0.00
General Agriculture	441,811.10	441,811.10	441,811.10	74,994.35	0.00	0.00
Field Crops	38,671,709.95	27,583,488.43	25,066,767.09	18,960,361.64	8,427,590.95	2,640,818.37

Table 22
Expected Damage Potential
Plans 1,1A Project Conditions
2001 Land Use Condition
No Frog Pond Purchases

Full Production Field Crop Flood Damage			SPF 38,671,709.95	100yr 27,583,488.43	50yr 25,066,767.09	25yr 18,960,361.64	10yr 8,427,590.95	2yr 2,640,818.37
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$161,864.31	$115,453.45	$104,919.46	$79,360.49	$35,274.52	$11,053.41
March	3.00%	26.70%	$309,783.60	$220,960.29	$200,799.84	$151,883.87	$67,510.06	$21,154.54
April	5.00%	7.04%	$136,143.75	$97,107.67	$88,247.55	$66,749.95	$29,669.33	$9,297.00
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$4,236.87	$3,022.05	$2,746.32	$2,077.30	$923.33	$289.33
September	23.00%	11.19%	$995,649.58	$710,170.01	$645,374.00	$488,157.26	$216,978.44	$67,991.04
October	20.00%	23.23%	$1,796,610.30	$1,281,473.71	$1,164,551.87	$880,860.48	$391,529.02	$122,687.14
November	2.00%	35.56%	$275,048.67	$196,184.80	$178,284.87	$134,853.68	$59,940.40	$18,782.56
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$3,679,337.09	$2,624,371.98	$2,384,923.91	$1,803,943.03	$801,825.11	$251,255.01
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			41,392,753.46	30,748,119.05	24,180,555.83	11,959,243.25	113,437.41	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$71,885,811.87	$48,356,682.54	$37,898,706.18	$22,345,253.07	$1,137,649.76	$251,255.01

Table 23
Expected Damage Potential
Plans 1,1A Project Conditions
2006 Land Use Condition
No Frog Pond Purchases

Full Production Field Crop Flood Damage			SPF 38,671,709.95	100yr 27,583,488.43	50yr 25,066,767.09	25yr 18,960,361.64	10yr 8,427,590.95	2yr 2,640,818.37
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$161,864.31	$115,453.45	$104,919.46	$79,360.49	$35,274.52	$11,053.41
March	3.00%	26.70%	$309,783.60	$220,960.29	$200,799.84	$151,883.87	$67,510.06	$21,154.54
April	5.00%	7.04%	$136,143.75	$97,107.67	$88,247.55	$66,749.95	$29,669.33	$9,297.00
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$4,236.87	$3,022.05	$2,746.32	$2,077.30	$923.33	$289.33
September	23.00%	11.19%	$995,649.58	$710,170.01	$645,374.00	$488,157.26	$216,978.44	$67,991.04
October	20.00%	23.23%	$1,796,610.30	$1,281,473.71	$1,164,551.87	$880,860.48	$391,529.02	$122,687.14
November	2.00%	35.56%	$275,048.67	$196,184.80	$178,284.87	$134,853.68	$59,940.40	$18,782.56
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$3,679,337.09	$2,624,371.98	$2,384,923.91	$1,803,943.03	$801,825.11	$251,255.01
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			43,590,977.53	32,076,738.45	25,126,448.24	12,455,108.81	114,570.37	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$74,084,035.94	$49,685,301.94	$38,844,598.59	$22,841,118.63	$1,138,782.72	$251,255.01

Table 24
Expected Damage Potential
Plan 2 Project Conditions
2001 Land Use Condition
West 1/2 of Frog Pond Removed

Full Production Field Crop Flood Damage			SPF 35,026,954.20	100yr 23,938,732.68	50yr 21,422,011.34	25yr 15,315,605.88	10yr 4,924,004.23	2yr 858,081.22
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$146,608.82	$100,197.96	$89,663.97	$64,105.00	$20,609.91	$3,591.58
March	3.00%	26.70%	$280,586.92	$191,763.61	$171,603.16	$122,687.19	$39,444.23	$6,873.75
April	5.00%	7.04%	$123,312.39	$84,276.31	$75,416.19	$53,918.59	$17,334.96	$3,020.87
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$3,837.55	$2,622.73	$2,347.00	$1,677.98	$539.47	$94.01
September	23.00%	11.19%	$901,810.97	$616,331.40	$551,535.39	$394,318.65	$126,774.40	$22,092.33
October	20.00%	23.23%	$1,627,282.24	$1,112,145.64	$995,223.80	$711,532.42	$228,759.39	$39,864.74
November	2.00%	35.56%	$249,125.71	$170,261.84	$152,361.91	$108,930.72	$35,021.49	$6,103.02
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$3,332,564.60	$2,277,599.49	$2,038,151.43	$1,457,170.55	$468,483.85	$81,640.30
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			41,392,753.46	30,748,119.05	24,180,555.83	11,959,243.25	113,437.41	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$71,539,039.38	$48,009,910.05	$37,551,933.70	$21,998,480.59	$804,308.50	$81,640.30

Table 25
Expected Damage Potential
Plan 2 Project Conditions
2006 Land Use Condition
West 1/2 of Frog Pond Removed

Full Production Field Crop Flood Damage			SPF 35,026,954.20	100yr 23,938,732.68	50yr 21,422,011.34	25yr 15,315,605.88	10yr 4,924,004.23	2yr 858,081.22
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$146,608.82	$100,197.96	$89,663.97	$64,105.00	$20,609.91	$3,591.58
March	3.00%	26.70%	$280,586.92	$191,763.61	$171,603.16	$122,687.19	$39,444.23	$6,873.75
April	5.00%	7.04%	$123,312.39	$84,276.31	$75,416.19	$53,918.59	$17,334.96	$3,020.87
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$3,837.55	$2,622.73	$2,347.00	$1,677.98	$539.47	$94.01
September	23.00%	11.19%	$901,810.97	$616,331.40	$551,535.39	$394,318.65	$126,774.40	$22,092.33
October	20.00%	23.23%	$1,627,282.24	$1,112,145.64	$995,223.80	$711,532.42	$228,759.39	$39,864.74
November	2.00%	35.56%	$249,125.71	$170,261.84	$152,361.91	$108,930.72	$35,021.49	$6,103.02
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$3,332,564.60	$2,277,599.49	$2,038,151.43	$1,457,170.55	$468,483.85	$81,640.30
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			43,590,977.53	32,076,738.45	25,126,448.24	12,455,108.81	114,570.37	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$73,737,263.45	$49,338,529.45	$38,497,826.11	$22,494,346.15	$805,441.46	$81,640.30

Table 26
Expected Damage Potential
Plans 3, 4, 5, 6, and 6A Project Conditions
2001 Land Use Condition
Total Frog Pond Removed

Full Production Field Crop Flood Damage			SPF 27,970,842.10	100yr 18,340,362.40	50yr 15,823,641.04	25yr 10,096,211.01	10yr 985,510.10	2yr 228,810.49
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$117,074.76	$76,765.42	$66,231.43	$42,258.70	$4,124.95	$957.71
March	3.00%	26.70%	$224,063.23	$146,917.31	$126,756.86	$80,876.71	$7,894.53	$1,832.91
April	5.00%	7.04%	$98,471.35	$64,567.25	$55,707.13	$35,543.71	$3,469.49	$805.53
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$3,064.49	$2,009.37	$1,733.64	$1,106.14	$107.97	$25.07
September	23.00%	11.19%	$720,142.89	$472,194.64	$407,398.63	$259,939.07	$25,373.14	$5,891.00
October	20.00%	23.23%	$1,299,469.38	$852,056.56	$735,134.72	$469,049.77	$45,784.83	$10,630.08
November	2.00%	35.56%	$198,939.82	$130,443.99	$112,544.06	$71,808.29	$7,009.34	$1,627.39
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$2,661,225.91	$1,744,954.53	$1,505,506.46	$960,582.39	$93,764.25	$21,769.68
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			41,392,753.46	30,748,119.05	24,180,555.83	11,959,243.25	113,437.41	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$70,867,700.69	$47,477,265.09	$37,019,288.73	$21,501,892.43	$429,588.90	$21,769.68

Table 27
Expected Damage Potential
Plans 3, 4, 5, 6, and 6A Project Conditions
2006 Land Use Condition
Total Frog Pond Removed

Full Production Field Crop Flood Damage			SPF 27,970,842.10	100yr 18,340,362.40	50yr 15,823,641.04	25yr 10,096,211.01	10yr 985,510.10	2yr 228,810.49
Date or Growing Season (Mid-month)	% chance occurrence	Average Basin wide % of total production costs	SPF Adjusted Frequency Damage	100yr Adjusted Frequency Damage	50yr Adjusted Frequency Damage	25yr Adjusted Frequency Damage	10yr Adjusted Frequency Damage	2yr Adjusted Frequency Damage
January	0.00%	30.95%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
February	2.00%	20.93%	$117,074.76	$76,765.42	$66,231.43	$42,258.70	$4,124.95	$957.71
March	3.00%	26.70%	$224,063.23	$146,917.31	$126,756.86	$80,876.71	$7,894.53	$1,832.91
April	5.00%	7.04%	$98,471.35	$64,567.25	$55,707.13	$35,543.71	$3,469.49	$805.53
May	11.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
June	20.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
July	2.00%	0.00%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
August	12.00%	0.09%	$3,064.49	$2,009.37	$1,733.64	$1,106.14	$107.97	$25.07
September	23.00%	11.19%	$720,142.89	$472,194.64	$407,398.63	$259,939.07	$25,373.14	$5,891.00
October	20.00%	23.23%	$1,299,469.38	$852,056.56	$735,134.72	$469,049.77	$45,784.83	$10,630.08
November	2.00%	35.56%	$198,939.82	$130,443.99	$112,544.06	$71,808.29	$7,009.34	$1,627.39
December	0.00%	24.73%	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Field Crops	100.00%		$2,661,225.91	$1,744,954.53	$1,505,506.46	$960,582.39	$93,764.25	$21,769.68
Nursery			8,838,798.58	6,646,146.80	5,468,346.21	3,373,662.23	0.00	0.00
Fruit Crops			43,590,977.53	32,076,738.45	25,126,448.24	12,455,108.81	114,570.37	0.00
Urban			17,974,922.74	8,338,044.71	5,864,880.23	5,208,404.56	222,387.24	0.00
Sum:			$73,065,924.76	$48,805,884.49	$37,965,181.14	$21,997,757.99	$430,721.86	$21,769.68

Table 28
Average Annual Damage Summary
Damage in ($)
2001 Land Use

Frequency	No Frog Pond Purchased Without Project	No Frog Pond Purchased Plans 1,1A	West Frog Pond Purchased Without Project	West Frog Pond Purchased Plan 2	Total Frog Pond Purchased Without Project	Total Frog Pond Purchased Plans 3,4,5,6,6A
SPF	$93,550,838	$71,885,812	$93,204,066	$71,539,039	$92,530,374	$70,867,701
100 Year	$61,344,460	$48,356,683	$60,997,688	$48,009,910	$60,435,754	$47,477,265
50 Year	$48,874,942	$37,898,706	$48,528,169	$37,551,934	$47,979,112	$37,019,289
25 Year	$34,854,418	$22,345,253	$34,507,646	$21,998,481	$33,959,013	$21,501,892
10 Year	$8,037,647	$1,137,650	$7,690,874	$804,309	$7,297,388	$429,589
2 Year	$2,252,689	$251,255	$1,919,348	$81,640	$1,685,033	$21,770
Average Annual	$5,366,800	$2,310,300	$5,157,600	$2,242,000	$4,698,600	$1,984,800

Table 29
Average Annual Damage Summary
Damage in ($)
2006 Land Use

Frequency	No Frog Pond Purchased Without Project	No Frog Pond Purchased Plans 1,1A	West Frog Pond Purchased Without Project	West Frog Pond Purchased Plan 2	Total Frog Pond Purchased Without Project	Total Frog Pond Purchased Plans 3,4,5,6,6A
SPF	$96,349,654	$74,084,036	$96,002,882	$73,737,263	$95,329,190	$73,065,925
100 Year	$62,911,471	$49,685,302	$62,564,698	$49,338,529	$62,002,764	$48,805,884
50 Year	$49,994,069	$38,844,599	$49,647,297	$38,497,826	$49,098,239	$37,965,181
25 Year	$35,549,720	$22,841,119	$35,202,948	$22,494,346	$34,654,314	$21,997,758
10 Year	$8,101,793	$1,138,783	$7,755,020	$805,441	$7,361,534	$430,722
2 Year	$2,252,689	$251,255	$1,919,348	$81,640	$1,685,033	$21,770
Average Annual	$5,560,500	$2,361,900	$5,271,800	$2,293,500	$5,008,500	$2,071,000

Table 30
Average Annual Equivalent Benefit Evaluation
Values Amortized and Discounted at 8%
(in $)

	No Frog Pond Purchased Without Project	No Frog Pond Purchased Plans 1,1A	West Frog Pond Purchased Without Project	West Frog Pond Purchased Plan 2	Total Frog Pond Purchased Without Project	Total Frog Pond Purchased Plans 3,4,5,6,6A
Average Annual 2001 Land Use	$5,366,800	$2,310,300	$5,157,600	$2,242,000	$4,698,600	$1,984,800
Average Annual 2006 Land Use	$5,560,500	$2,361,900	$5,271,800	$2,293,500	$5,008,500	$2,071,000
Average Annual Equivalent	$5,533,300	$2,354,600	$5,255,700	$2,286,300	$4,964,900	$2,058,900
Average Annual Equivalent Flood Damages Prevented		$3,178,700		$2,969,400		$2,906,000

Table 31
Project Benefit and Cost Summary
Values Amortized and Discounted at 8%
(in $)

	Alternative 1	Alternative 1A	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 6A
Construction Cost	36,529,775	26,222,075	38,726,895	54,951,640	77,636,106	42,260,805	71,239,100	70,723,200
Lands	286,175	280,075	6,943,750	19,820,250	50,690,000	19,826,500	50,690,000	50,690,000
Total Construction Cost	36,815,950	26,502,150	45,670,645	74,771,890	128,326,106	62,087,305	121,929,100	121,413,200
Interest During Construction	8,023,727	5,759,652	8,506,323	12,070,071	17,052,691	9,282,542	15,647,595	15,534,278
Total Project Investment	44,839,677	32,261,802	54,176,968	86,841,961	145,378,797	71,369,847	137,576,695	136,947,478
Interest and Amortization	3,665,323	2,637,172	4,428,580	7,098,710	11,883,678	5,833,975	11,245,912	11,194,478
Annualized Replacements	34,158	34,158	34,999	70,452	67,532	41,203	54,322	96,914
Operation and Maintenance	357,550	353,750	384,550	536,194	934,694	478,694	891,550	747,900
Total Annual Equivalent Costs	4,057,031	3,025,080	4,848,129	7,705,356	12,885,904	6,353,872	12,191,784	12,039,292
Total Annual Equivalent Benefits	3,178,700	3,178,700	2,969,400	2,906,000	2,906,000	2,906,000	2,906,000	2,906,000

Table 32
Project Benefit and Cost Summary
Values Amortized and Discounted at 6%
(in $)

	Alternative 1	Alternative 1A	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 6A
Construction Cost	36,529,775	26,222,075	38,726,895	54,951,640	77,636,106	42,260,805	71,239,100	70,723,200
Lands	286,175	280,075	6,943,750	19,820,250	50,690,000	19,826,500	50,690,000	50,690,000
Total Construction Cost	36,815,950	26,502,150	45,670,645	74,771,890	128,326,106	62,087,305	121,929,100	121,413,200
Interest During Construction	5,878,063	4,219,435	6,231,605	8,842,354	12,492,547	6,800,252	11,463,195	11,380,180
Total Project Investment	42,694,013	30,721,585	51,902,250	83,614,244	140,818,653	68,887,557	133,392,295	132,793,380
Interest and Amortization	2,708,691	1,949,109	3,292,901	5,304,846	8,934,139	4,370,522	8,462,979	8,424,981
Annualized Replacements	42,366	42,366	43,367	87,296	83,677	51,054	67,309	120,026
Operation and Maintenance	357,550	353,750	384,550	536,194	934,694	478,694	891,550	747,900
Total Annual Equivalent Costs	3,108,607	2,345,225	3,720,818	5,928,336	9,952,510	4,900,270	9,421,838	9,292,907
Total Annual Equivalent Benefits	3,178,700	3,178,700	2,969,400	2,906,000	2,906,000	2,906,000	2,906,000	2,906,000

Table 33
Project Benefit and Cost Summary
Values Amortized and Discounted at 2.5%
(in $)

	Alternative 1	Alternative 1A	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 6A
Construction Cost	36,529,775	26,222,075	38,726,895	54,951,640	77,636,106	42,260,805	71,239,100	70,723,200
Lands	286,175	280,075	6,943,750	19,820,250	50,690,000	19,826,500	50,690,000	50,690,000
Total Construction Cost	36,815,950	26,502,150	45,670,645	74,771,890	128,326,106	62,087,305	121,929,100	121,413,200
Interest During Construction	2,350,773	1,687,450	2,492,163	3,536,262	4,996,059	2,719,578	4,584,397	4,551,198
Total Project Investment	39,166,723	28,189,600	48,162,808	78,308,152	133,322,165	64,806,883	126,513,497	125,964,398
Interest and Amortization	1,380,943	993,911	1,698,127	2,760,993	4,700,680	2,284,965	4,460,620	4,441,260
Annualized Replacements	54,450	54,450	55,791	112,303	107,650	65,679	86,593	154,416
Operation and Maintenance	357,550	353,750	384,550	536,194	934,694	478,694	891,550	747,900
Total Annual Equivalent Costs	1,792,943	1,402,111	2,138,468	3,409,490	5,743,024	2,829,338	5,438,763	5,343,575
Total Annual Equivalent Benefits	3,178,700	3,178,700	2,969,400	2,906,000	2,906,000	2,906,000	2,906,000	2,906,000

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Appendix E
Social and Economic Analysis

FIGURES

Figure E-1
Floodprone Area Without Project

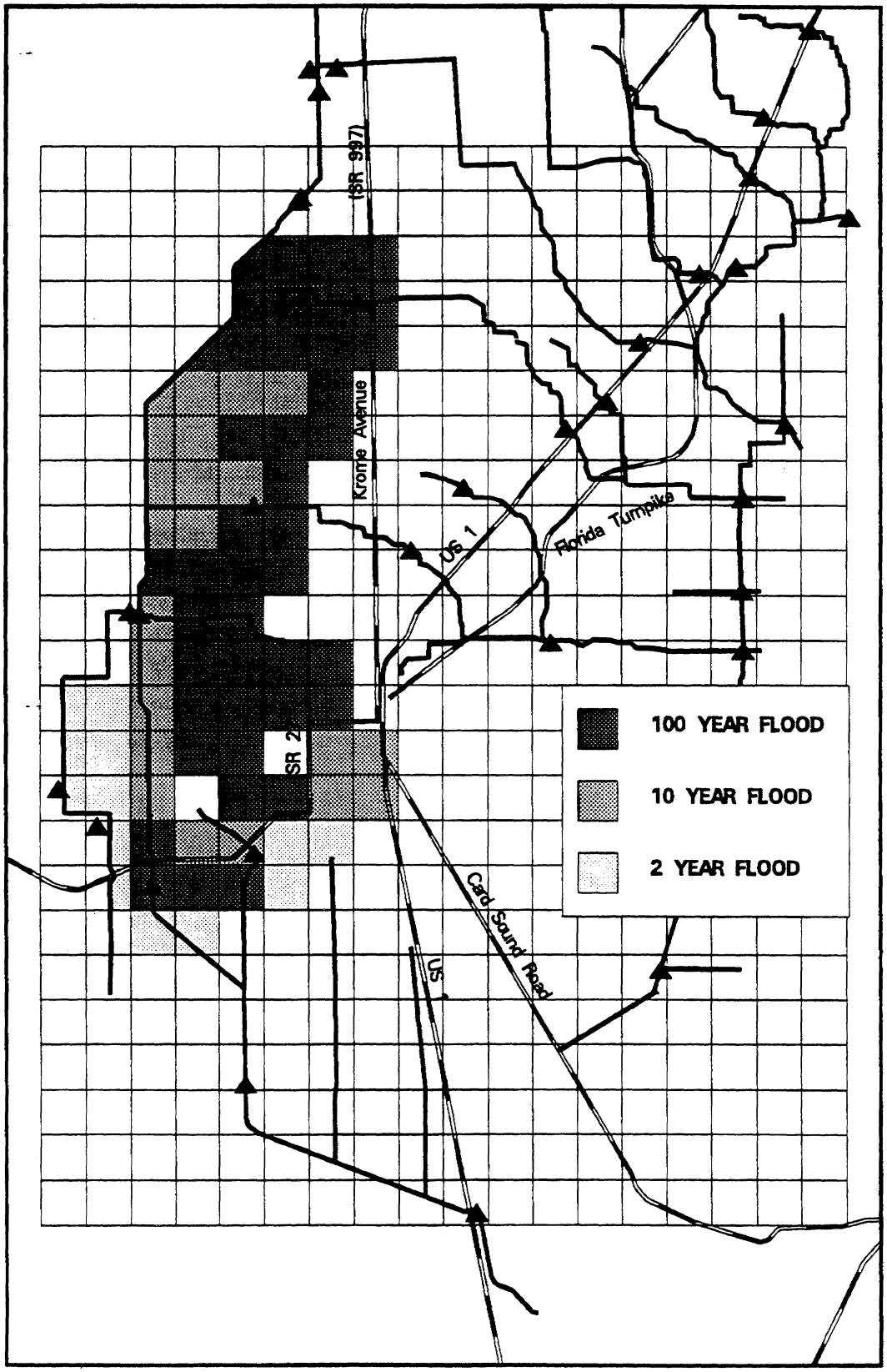
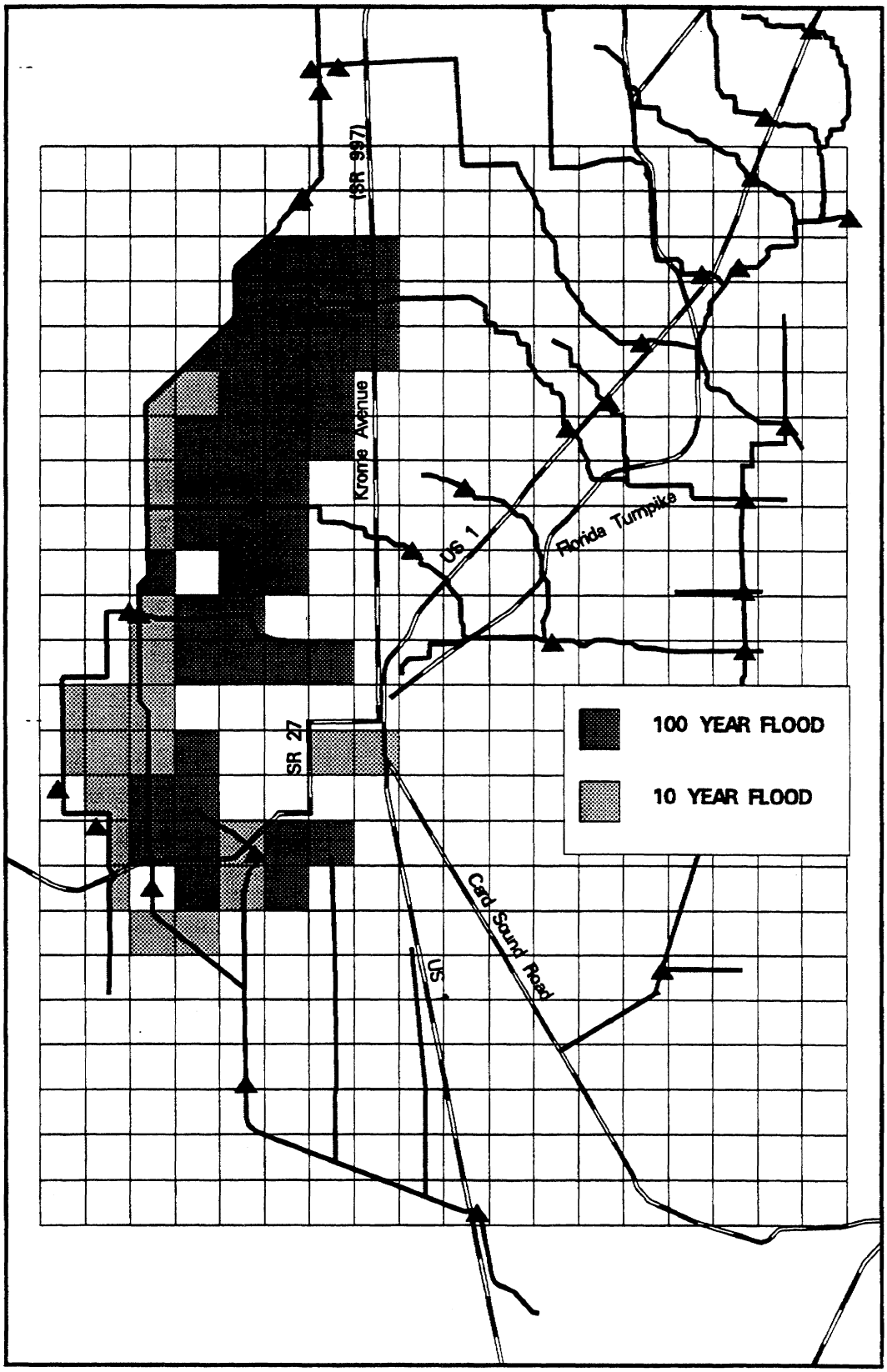


Figure E-2
Floodprone Area With Project



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Appendix F
1988 General Design Memorandum
Formulation of Alternative Plans

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Appendix F
1988 General Design Memorandum
Formulation of Alternative Plans

1. Authority. Authority to prepare the 1988 Addendum to the General Design Memorandum were the 1962 and 1968 Flood Control Acts.

2. Study Purpose and Constraints. This 1988 report was prepared in General Design Memorandum (GDM) scope and covered the Canal 111 (C-111) basin and other parts of the Central and Southern Florida Project which affected flows to and through the basin. The purpose of the study was to complete the authorized plan of improvement for flood control, environmental enhancement and water management in the C-111 basin as constructed in the 1960's. A major focus of the study was the difficulty in system management and loss of benefits resulting from a temporary solution to an environmental problem, the S-197 culvert structure and plug near U.S. Highway 1. This problem occurred during initial construction of the canal. This report provides a solution to the problem that insures the authorized flood protection and vastly increases management options for the benefit of the environment and the economy.

3. Planning Objectives. This Corps study began in 1983 and continued until submittal in 1988. Over the years concern for the lack of flood protection resulting from the temporary culvert structure S-197 and plug located in C-111 near U.S. Highway 1. The structure and plug were a temporary solution to the problem of potential salt water intrusion into the surficial aquifer and surface waters of the Everglades National Park via the canal. The plug was removed during flood events to use the conveyance of C-111 and relieve flooding upstream. The coordination and removal of this plug was slow and cumbersome. Reinstallation of the plug required closing S-18C, which caused water levels to rise upstream. The fines in the plug material were lost due to repeated removal and installation so that the plug was no longer a barrier to water movement through the plug when there is any head differential across it. Additionally, when the plug was removed, the water flowed uncontrolled into Barnes Sound, introducing a large component of fresh water into an estuarine system. This resulted in very little water flowing overland from the canal toward Florida Bay.

To develop and analyze potential solutions to water resource problems certain goals and objectives were defined. The objectives for this study were:

a. Develop a plan that would provide the flood protection authorized for the South Dade County area, which is defined as 40 percent of the SPF (which approximates a 10-year return).

b. Reintroduce sheetflow to the marsh adjacent to C-111 and to northeast Florida Bay via Everglades National Park that would be of sufficient frequency and duration to restore modern historic ecosystem conditions.

c. Reduce large freshwater flows to Barnes Sound.

d. Protect, preserve, or minimize impacts on significant historic or cultural resources.

Plans were formulated to meet the Federal objective of water and related land resources project planning.

4. Plan Criteria. There were four criteria to consider in developing alternatives. These criteria were:

a. Completeness -- The extent to which a given plan provides and accounts for all necessary investments or other actions to ensure the realization of plan benefits.

b. Effectiveness -- The extent to which a plan alleviates the problems and achieves the study objectives.

c. Efficiency -- The extent to which a plan is most cost effective in alleviating the problems, achieves the objectives, and is consistent with protecting the Nation's environment.

d. Acceptability -- The workability and viability of a plan with respect to its acceptance by State and local entities, the public, and its compatibility with existing laws, regulations, and public policies.

5. Alternative Plans Considered. Alternative plans of action were formulated and evaluated to accomplish the study objectives. Because of the nature of the problems addressed, a solely non-structural plan was not found to be an effective measure to accomplish the objectives of the study. Combinations of structural and non-structural components were determined to be the most feasible options for implementation to meet these objectives.

Several alternative plans were suggested by various interest groups which focused on environmental restoration of the lower basin, rather than on the overall objectives. The main objective of the study was to formulate an economically justified plan which would complete the construction in the C-111 basin in a manner that would provide the authorized flood protection while providing maximum flexibility of operation for environmental purposes, both inside and outside of the Everglades National Park. Some of the alternatives considered are list in the following paragraphs.

a. No Action Alternative. This alternative would maintain the existing project as it is currently configured. This plan was not determined feasible because change was needed both for flood control and environmental purposes.

b. Plan A -- Eastern Floodway. This proposal would eliminate nearly all of C-111 from S-18C south and create a large continuous marsh. The marsh would be about 4 miles wide and extend from an area 2 miles north of S-18C to northeast Florida Bay. Overland flow in the

marsh would be dependent on local rainfall plus water pumped into the north end of the area from C-111. Major components included: backfilling of C-111 from the bend below S-18C to Manatee Bay; provide a pumping station and distribution canal above S-18C; and backfill Canals 110 and 109. Estimated cost for this plan would exceed $19 million. Operation and maintenance costs would be continuous for pumping. No improvements would be generated in the upstream portion of the basin. There would be no economic benefits derived because the plan would continue the status quo upstream. Further there would be no positive drainage outlet for large storms, if needed.

c. Plan B -- Eastern Impoundment. This proposal would create a 15-square-mile impoundment north of C-111 with the canal partially backfilled from the bend south of S-18C to U.S. Highway 1. C-111 would be completely backfilled from U.S. 1 to Barnes Sound. A pump station and distribution canal would be provided to place large flows from C-111 into the impoundment. Flood waters in the impoundment area would be released during the dry season, if available. The initial estimated cost for this plan would be $15.8 million. Operation and maintenance costs would be continuous for pump operations. No economic benefits would be gained since the ability to remove flood waters upstream remains the same. There would be no positive outlet for drainage from large storms, if needed.

d. Plan C -- Western Floodway. This alternative would be used in conjunction with the Eastern Floodway or Eastern Impoundment proposals. A structure or pump station would be located in the western levee of C-111 placing excess water into an improved channel along side the Aerojet access road. The water would flow south from the canal overland toward Florida Bay. Initial costs for this alternative would be approximately $20 million. The placement of water in the western portion of the basin could adversely affect the Cape Sable Seaside Sparrow, an endangered species.

e. Plan D -- Low Level Dike. This proposal would provide for a lowlevel dike to be constructed near the existing active agricultural area. The dike would be located between the 4- and 5-foot elevation contours from L-31W eastward. This alternative would eliminate most of C-111 from S-18C south and restore about 25 sections of wetlands. The major elements would include backfilling C-111 from U.S. Highway 1 to Barnes South and partial C-109, and providing pump station at C-111 and C-111E where they pass through the dike. Initial cost of this plan would be $24.4 million. Operation and maintenance of the pumping stations would be significant. The water levels north of the dike would cause damage to some agricultural areas. Pumps large enough to evacuate the flood waters would be prohibitively expensive.

f. Plan E -- C-111E Culverts. This proposal would effectively eliminate C-111 below S-18C. Water levels at S-18C would be increased and water released east thorough culverts in C-111E. This would restore wetland conditions in the area. Initial costs of this plan were estimated to be approximately $18.3 million. The plan assumes no change to upstream water levels. There are no economic benefits to be derived.

g. Plan F -- Extended Canal 109. This proposal would require that C-109 be improved and extended north then west connecting to C-111E. It also would incorporate the Eastern Floodway plan except that C-111 would remain from its junction with C-109 to Manatee Bay. The plan would allow restoration of a large portion of wetlands while providing some positive drainage from the system. Initial estimated costs for this alternative are $36.8 million. The plan would duplicate some features of other plans, but at a higher cost. Additionally, the northern leg of the extend canal would tend to reduce ground water levels in the northern portion of the area.

h. Plan G -- Existing Project with New Structure at S-197. This alternative would maintain the existing project upstream of S-197. The plan would replace the plug and S-197 with a water control structure. The structure would pass flood flows during major storm events but remain closed for most discharges (which would go through the C-111 gaps). The structure would allow for gradual increase in releases thus forcing more water through the gaps prior to and after the flood peak. Total waters released to Barnes Sound would be significantly less than with the current structure and plug.

i. Plan H -- Enlargement of Other Existing Canals. This alternative consists of evaluating the feasibility of enlarging other existing C&SF project canals. The canals considered were C-1, C-102, and C-103. Two increased volumes of flow were considered, 500 cfs and 800 cfs. Initial estimated costs were $12.6 million and $16.3 million, respectively.

j. Plan I -- Modification of C-111, C-111E and Structures. This alternative would eliminate freshwater flows to Manatee Bay. The plan would include enlarging C-111 from S-176 to S-18C, enlarging C-111E, S-176, S-177, S-178 and the modification of associated culverts. Further analysis of this plan revealed that some discharge capacity was required for larger storms. It was combined with Plan G for further analysis. The need for enlarging S-178 was questioned as development in this portion of the basin had not taken place as envisioned in the original report. It was doubtful that additional drainage was required north of S-178.

6. Other Options. An option was considered that could be used with several alternatives. This consisted of a number of overflow sections placed in the eastern levee of C-111 from S-18C to the junction with C-111E. The headwater at S-18C would be held 0.2 to 0.4 feet higher than current operating criteria. The purpose would be to place low level flows into the eastern marsh when available. This action would enhance the flow to this area and permit more sheetflow through the marsh.

7. Coordination. This study was initiated in cooperation with the South Florida Water Management District (SFWMD), the local sponsor for the project. The uncompleted portion of the authorized C-111 project, the plug and the structure 197, have been discussed intermittently since the 1920's. In 1983 the SFWMD proposed several changes to the project. Coordination with other Federal, State, and local agencies and groups was initiated and maintained throughout the study.

A draft coordination report presenting study alternatives was made available to interested parties in October 1986. Numerous comments were provided in response to the request for input into the study.

8. Rational for Plan Selection. The plan selected for recommendation was the one which both met the planning objectives, and was the most cost effective. It was fully coordinated with the South Florida Water Management District and the Everglades National Park. The proposed alternative as shown on Figure 5, is a combination of Plan I (Modification of C-111, C-111E and Structures) and Plan G (New Structure at S-197). The alternative includes enlarging C-111 from S-176 to S-18C, enlarging C-111E, S-176, S-177, S-178, several culverts and a new permanent structure at S-197. The canal and structure enlargements are needed to provide the authorized degree of protection in the developed area. Structure 197 was needed to protect the Park and Barnes Sound from excessive flows and as a salinity barrier.

This plan would provide the flood protection authorized for the C&SF Project and allow maximum flexibility for environmental purposes. Freshwater discharges to Barnes Sound through C-111 would be significantly reduced with the water directed to northeast Florida Bay. Additionally, daily flows would be diverted, if available and desired, to the marsh east of C-111. The operating criteria for S-197 would be coordinated with the Everglades National Park, the U.S. Fish and Wildlife Service, and the South Florida Water Management District, fully utilizing the results of ongoing environmental studies currently being conducted in the area. Construction would be deferred on Canal 111E and Structure 178 until such time as the drainage basin developed sufficiently to contribute design discharge.

The formulation of the selected plan was driven primarily by developing a least cost alternative to accomplish the planning objectives. Benefits from the agricultural area are more than sufficient to justify the costs. The other alternatives investigated were either more expensive or did not meet the planning objectives. The selected plan was considered to be the NED plan considering the limitations placed on formulation, that there be no change in the authorized level of protection. It should be noted that secondary drainage works must be provided by the local sponsor to realize the maximum economic benefit associated with the recommended plan of action in this report.

The U.S. Fish and Wildlife Service preferred a variation of the selected plan whereby the canal would be backfilled downstream of the U.S. Highway 1 bridge, eliminating the need for S-197. This plan was considered, but rejected because it required all flow from the basin to pass overland thorough ENP. This was considered to be objectionable by the Park, which preferred the flexibility of releasing flows to the coast through S-197 when the Park had too much water.

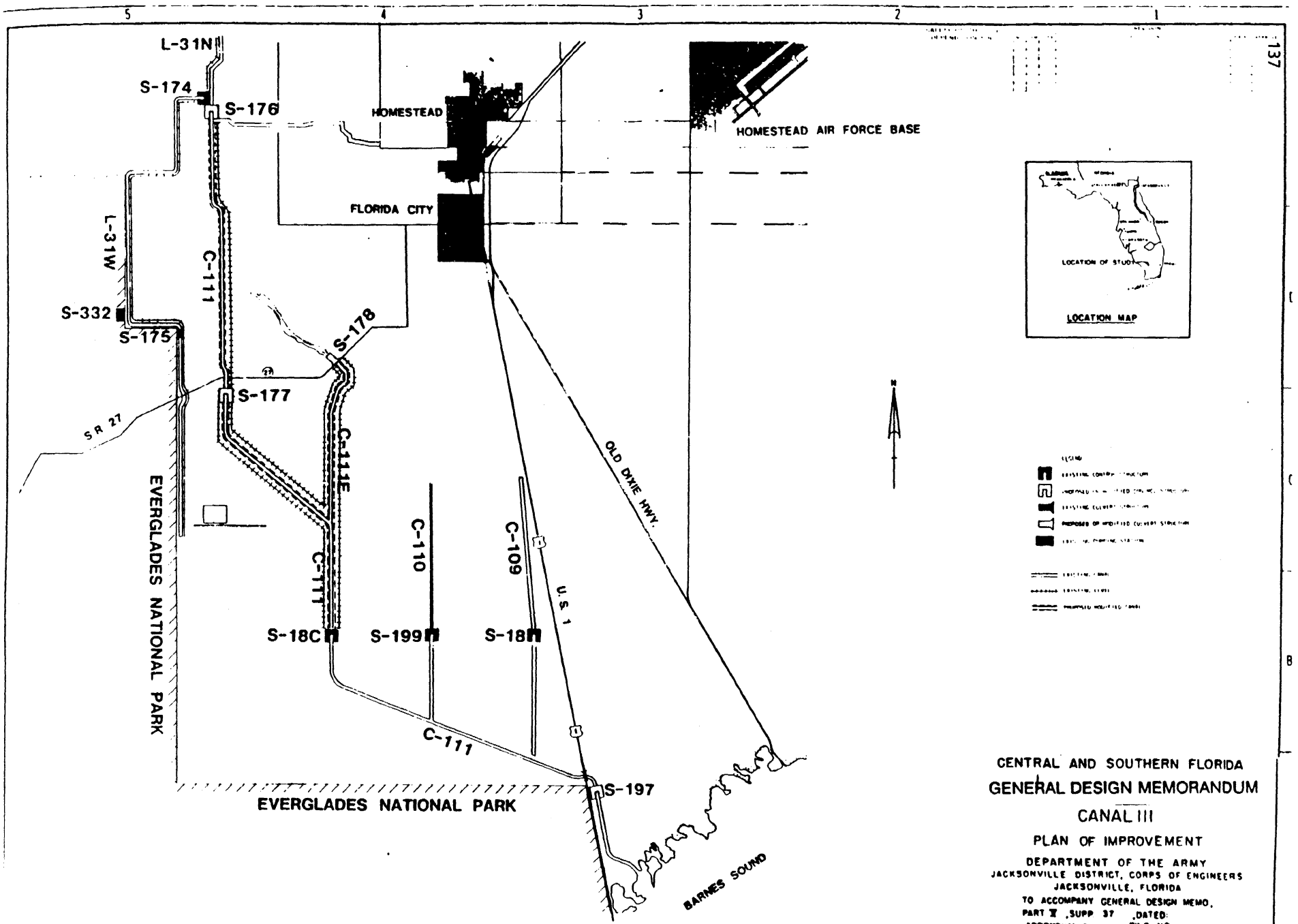
9. Conclusion. The Corps submitted the report in 1988 but it was returned for revision to include obtaining and integrating the Fish and Wildlife Coordination Act Report, and obtaining current letters of support from the local sponsor and the Everglades National Park.

At an interagency meeting on November 9, 1988, the Fish and Wildlife Service stated that they

did not have adequate hydrologic information to do their coordination report and the Everglades National Park stated that other alternatives needed to be addressed, since the current plan recommended too much water going down C-111 and a continuation of inadequate deliveries to Taylor Slough via L-31W.

C-111
GENERAL REEVALUATION REPORT
Appendix F
1988 General Design Memorandum
Formulation of Alternative Plans

FIGURES


L-31N
S-174
S-176
HOMESTEAD
HOMESTEAD AIR FORCE BASE
FLORIDA CITY
L-31W
C-111
S-332
S-175
S-178
S-177
SR 27
C-111E
C-111
C-110
C-109
OLD DIXIE HWY.
U.S. 1
S-18C
S-199
S-18
EVERGLADES NATIONAL PARK
C-111
S-197
EVERGLADES NATIONAL PARK
BARNES SOUND
LOCATION MAP
CENTRAL AND SOUTHERN FLORIDA
GENERAL DESIGN MEMORANDUM
CANAL III
PLAN OF IMPROVEMENT
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
TO ACCOMPANY GENERAL DESIGN MEMO.
PART II ,SUPP 37 ,DATED:
ADDENDUM 2 FILE NO.
JUNE 1968