C-111
GENERAL REEVALUATION REPORT
Appendix A
Hydrology and Hydraulic Analysis

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Hydrology and Hydraulic Analysis

1. General. This appendix addresses the hydrologic modeling and hydraulic design efforts for providing a more natural distribution of runoff into Everglades National Park while providing 40% SPF protection for the C-111 upper watershed. For the environmental impact analysis the model simulated daily runoff for the 25-year period 1965-1989. For flood damage analysis, a 20-day storm event for the 2-, 10-, 50-year, and Standard Project Flood was applied on a selected month to establish the flood damages that could be expected from maintaining water levels at authorized levels.

2. Basin Description. The L-31N/C-111 canal system drains an area of 97.3 square miles. This canal system also drains an area of 12.67 square miles through pump station S-331 whenever water levels at the downstream structures are below design stages. The combined drainage area is bounded by Tamiami Trail on the north, L-31N and L-31W levees and Everglades National Park on the west, C-111 canal on the south, and State Road 27 and U.S. Highway 1 on the east. Structures S-331, S-338, S-194 and S-196 are closed during floods and act as northern and eastern boundaries to surface flow.

3. Soils. There are four major soil groups in the study area: Marl, Rockdale, Rockland and organic. The soils in the basin have a slow infiltration rate when thoroughly wetted. However, they form only a discontinuous, relatively thin layer, over the very porous limestone rock of the Biscayne Aquifer.

4. Modeling. Previous hydraulic models of lower L-31 and C-111 include HEC-2 backwater models for channel sections and overland areas below the gaps in C-111. In 1988, a channel operation model, CHANOP, was built to include the reaches between S-197 and S-331. CHANOP is a one-dimensional unsteady flow model that simulates channel flow, structure operations, and overland flow. Groundwater is accounted for only in the loss rates included in the hydrologic analysis. A comparison of flood stages produced by CHANOP and the 1x1 South Florida Water Management model produced similar results near the existing channel alignment. Flood stages and recession rates inland did not compare well between the models. Both models budget total water volume. However, CHANOP deals only with surface runoff, and assumes that available ground storage has been satisfied, while the 1x1 SFWMM utilizes groundwater storage along with the aquifer's capacity to act as a flow medium.

The movement of water in Dade County is influenced not only by the manmade canals, structures and levees, but also by the flat terrain and the highly porous limestone aquifer. Under contract with the Jacksonville District the South Florida Water Management District has developed a digital surface-ground water model covering Dade, Broward, and Palm Beach Counties. Big Cypress Swamp in Collier County is now included, also. The model uses a square grid network to model two-dimensional movement of water. A two-by-two (2x2) mile node spacing is used. Surface (overland) flow modeling adds rainfall and surface

inflow to beginning storage then subtracts evapotranspiration, infiltration, and surface outflow. One day time steps are used. Evapotranspiration varies with depth of water table below the land surface. Overland flow is computed using Manning's equation with Manning's "n" varying with depth of flow. Infiltration is either at the maximum rate read in at each grid point or the amount available in groundwater storage. Channel flow is calculated by reading in upstream inflow while downstream outflows and seepage are calculated by an iterative process. Outflow is estimated using actual discharge rating characteristics or a simplified weir equation and the head difference at the structure. Operation of the significant water control structures is simulated in the ROUTE subroutine. Groundwater flow is calculated using a two-dimensional flow equation for a porous aquifer. Subroutines are provided in the model to simulate hydrologic responses in the Everglades Agricultural Area and Lake Okeechobee. A detailed documentation of the model is contained in SFWMD's Technical Publication 84-3. A higher definition version of the 2x2 model exists for the area south of Tamiami Canal. This version has 1 square-mile grids (1x1) instead of 4 square-mile grids (2x2). The denser grid network presents a more accurate picture of water levels. Using the 2x2 model to provide boundary conditions, the 1x1 model was used to analyze the base and alternative plans. The denser 1x1 mile grid network better defines water levels in the East Everglades area. Because the 1x1 model does not include the northern two-thirds of the lower east coast drainage basin, it must be assigned the flow or stages for each day for the period 1965-89 along its northern boundary. Daily discharges at S-334 and S-335 are input to the 1x1 model in a file designated FLO2x2. Daily stages are given by the 2x2 file KNSTGS at 35 grid cells along the northern boundary. These cells in turn are interpolated to obtain the stages for the 71 one-square-mile grid cells making up the northern boundary of the 1x1 model. Discharges are not assigned to the S-12 structures because flow is determined from stages developed along the northern boundary by the 2x2 model and the overland flow is computed from these stages.

5. Calibration. The model was calibrated using the period 1969 to 1975. This period was used because it contained both an extremely wet year, 1969, and an extremely dry year, 1971. All measured flows and rainfall were used as inputs to the model and factors such as potential evapotranspiration rate, Manning's overland flow coefficient, and the coefficient of conductivity between canals and the aquifer were adjusted until the stages predicted by the model were in satisfactory agreement with those actually recorded at key locations throughout the area. The calibration is described in the documentation report referenced above. A base condition for the evaluation of alternatives was defined by adding the South Dade Conveyance System, which was not operable during the calibration period. The results of this run became the baseline for comparison with all other model scenarios. The base condition is the current best estimate of the physical and operational water management system. Alternatives for redistributing flow to the Everglades were simulated for the 1965-89 period.

6. Rainfall Frequency. A frequency analysis was performed of peak annual rainfall in the project area for durations of one through 20 days. A log-Pearson Type III distribution was utilized to compute rainfall frequencies. Procedures prescribed in "Guidelines for

Determining Flood Flow Frequency", Bulletin No. 17B of the Hydrology Committee, United States Water Resources Council, Revised September 1981, were used in this analysis.

7. Data. The Homestead Experiment Station is the only long-term record rain gage in the project area. The same rainfall data developed in the survey report based on 1914-1977 rainfall records was used in this analysis. Periods of missing record were checked to determine if a large storm event caused a gage failure. No such cases were identified. Therefore, years with significant cumulative rainfall totals in each year for periods of from one to 20 consecutive days were used for the annual rainfall analysis.

8. Skew Factors. A regional skew analysis was conducted for south Florida. The results of the analysis were used to select skew factors for the rain gages. It was found that skew factors approach zero as the duration increases. The skew factors used at the gage for each duration are shown below.

SKEW FACTORS FOR RAINFALL ANALYSIS

Gage	Duration (days)					
	1	2	5	10	20	>30
Homestead	.3	.1	.1	.1	.1	0

9. Rainfall Frequencies. The point rainfall depth-duration-frequency curves for expected probability for Homestead Experiment Station are presented in Figure A-1.

10. Design Storms. Point rainfall was reduced using the depth area reduction curves in National Weather Service publication "A Methodology for Point-to-Area Rainfall Frequency Ratios," dated February 1980. The 1x1 model accepts daily rainfall input to 13 rain gages, each with its respective area of influence. The areas assigned to the rain gages vary from 26 to 536 square miles. An elliptically shaped storm similar to that often used for the Standard Project Storm was used to help rank the gages in the order of expected rainfall depth. The ellipse was centered between S-176 and S-196 and aligned in a north-northeasterly direction. The respective areas assigned to each rain gage were cumulatively totaled. An appropriate percent of point rainfall was assigned each rain gage such that the total average percent of 24-hour point rainfall agreed with the depth-area curve. The depth-area relationship for a 30-day rainfall was obtained from Table 5, Part VI, Sect. 6 of the C&SF Project GDM. This was used to interpolate an appropriate percent of point rainfall for durations of 2 to 20 days. The rainfall pattern chosen centers the storm about the eleventh day with the next heaviest daily rainfall occurring on the tenth day, the third heaviest rainfall on the twelfth day, etc. Table A-1 shows the percent of point rainfall assigned each rainfall gage number. The 2-year, 10-year and 50-year, 100-year design storm rainfall at each gage are listed in

Table A-2 and Table A-3 respectively. Not shown is the Standard Project Storm which traditionally has been taken to be 125 percent of the 100-year storm on all C&SF structures.

11. Antecedent Moisture Condition. A suitable month had to be selected to apply the four different storm events. Since the design water level for L-31 North borrow canal between S-176 and S-331 is 5.5 feet, NGVD, a stable period with water levels around that level was selected. July 1969 was the most suited to begin the 20-day rainfall.

12. Seasonal Flood Occurrence. Table A-4 shows the number of 1-day and 5-day storm events exceeding a range of rainfall totals for each month of the year for the 1914-1977 period of record. For evaluating agricultural damages, the percent chance of a storm occurring in any given month during the growing season must be known. Since maximum stage occurs a few days after peak rainfall in the most vulnerable of the agricultural areas, the 5-day total rainfall was selected for establishing the seasonal occurrence of the storm events. The 2-year 5-day rainfall total of 7.2 inches was used to represent the beginning of damaging floods. A total of 41 storms equal to or exceeding 7-inches occurred. This is sufficient to get a fair distribution of damaging flood events without including smaller non-damaging storm events that fall outside the flood season. The distribution is presented below. Although the worst storm events all occurred in May, June, September and October, the same percent chance of occurrence was used for the more infrequent flood events as for the 2-year storm.

Percent Occurrence of 5-day Event Storms Exceeding 7.00-inches

Month	Apr	May	Jun	Jul	Aug	Sep	Oct
% Chance	4.9	31.7	19.5	2.5	2.4	26.8	12.2

13. General. Originally, plans called for modeling the environmental impacts using the SFWMM 1x1 version for the 1965-1989 period of record. Flood damage assessment and design were to be based on a runoff model and a dynamic flood routing model using a much shorter computation time interval. The study time frame was shortened, consequently the SFWMM 1x1 was also used for flood damage assessment.

14. Structure Operating Levels. Table A-5 presents the design structure operation water levels and the water levels used in the model. Please note that data for alternative 6A, the recommended plan, is the same as for alternative 6, shown in table A-5.

15. Base Condition. A base condition was established to which all the alternatives could be compared. Base condition was taken to be all the authorized structures, levees, and canals as they presently exist, along with the Modified Water Deliveries to Everglades National Park, which has been authorized by Congress but not yet constructed. This includes the optimum water levels to be maintained upstream of all structures as specified in the authorizing

documents. No optimum was specified for the dry season when it is not feasible to maintain the authorized optimum water levels, so the existing policy practiced by water managers was followed.

16. Alternative Plans. Alternative plans are described in detail in the main report. Model changes were incorporated to reflect structural improvements unique to each plan and operational levels are described in paragraph 14. Boundary conditions, rainfall and evaporation remained constant for all alternatives. Alternative plans are described briefly as:

ALT 1 - S-332 improved to 1000 cfs, S-174 improved to 1500 cfs,lower C-111 remains as is, two 50 cfs pumps provide rehydration to Context Road and the C-109/C-110 area.

ALT 1A - same as ALT 1 except that the 50 cfs pump and canal at the C-109/C-110 area is deleted.

ALT 2 - 1000 cfs pump added at S-174 and lower L-31W backfilled, two 50 cfs pumps provide rehydration to Context Road and the C-109/C-110 area.

ALT 3 - 1630 cfs pump added at S-174, Frog Pond converted to surge pool, 500 cfs pump added to the C-109/C-110 area, lower C-111 backfilled to S-197.

ALT 4 - Four 300 cfs pumps west of L-31N, L-31W backfilled, 500 cfs pump added to the C-109/C-110 area, lower C-111 backfilled to S-197.

ALT 5 - 1000 cfs pump added at S-174 and lower L-31W partially backfilled, 500 cfs pump added to the C-109/C-110 area, lower C-111 partially backfilled to S-197.

ALT 6 - Four 300 cfs pumps west of L-31N, L-31W backfilled, 50 cfs pump added to the C-109/C-110 area.

ALT 6A - Four 300 cfs pumps along L-31N, L-31W backfilled, 50 cfs pump added to the C-109/C-110 area.

The structural improvements associated with each alternative are presented on Plates A-1 through A-8.

17. Model Results.

a. General. Figure A-2 shows a location grid for the 1x1 model and can be used to locate cells referenced in this report. Table A-6 presents the flood durations for each alternative at 54 selected cells, based on the 25 year (1965-1989) period of record simulations. Please note that data for alternative 6A, the recommended plan, is the same as for alternative 6, shown in table A-6. The cells are evenly distributed for environmental impact analysis to include the affected areas within Everglades National Park, as well as the basin reaches east of L-31N and C-111. Table A-7 presents flood event peak stages based on the 20 day rainfall simulations for the 2-year, 10-year, 50-year and SPF storms. Please note that data for alternative 6A, the recommended plan, is the same as for alternative 6, shown in table A-7. The peak stages are provided for flood damage assessment for key cells east of L-31N and C-111. Figure A-3 shows time series hydrographs for key cells east and west of L-31N and C-111. The hydrographs compare the 10-year storm peak stages for the Base

condition and the six alternatives.

b. Operational Plan. All alternatives were operated under the same optimum canal stages and design water levels. Optimum and design water levels in the project canals were established on the basis of desirable water control conditions in each area, i.e., optimum groundwater levels, intake and/or discharge structure elevations and removal rates for flood control. Water availability was limited to basin rainfall, existing S-331 water supply releases and seepage inflows form Shark River Slough restoration of Modified Deliveries to Everglades National Park. Lack of available water severely limited the alternatives from reaching their full restoration capabilities; however, each alternative was evaluated under the same conditions and their performance was evaluated relative to each other.

c. Sensitivity Analyses. To test the sensitivity of the area with the recommended plan, two model runs for the 10 year rainfall event were made with pump capacities larger and smaller than those in the recommended plan. These two runs were then compared to results shown by the recommended plan. The first run increased the total pump capacities from 1200 cfs to 2000 cfs (four 500 cfs pump stations were used to deliver water to ENP). The second run decreased the total pump capacities from 1200 cfs to 800 cfs (four 200 cfs pump stations were used to deliver water to ENP). All the pump s[illegible]re located in the L-31N canal and were modeled in the same location for the sensitiv[illegible]sis.

Stage hydrographs were plotted for the recommended plan and the other two variations of this plan for several grid cells throughout the area. These are shown in figure A-4. Some of those grid cells are located between the two middle pump stations (S-332B & C) and to east of this area.

Review of the model output indicated two main conclusions. First, stages in the area in question are not sensitive to changes in total pump capacity. There were less than 0.2 feet stage differential between the high pump capacity (2000 cfs) and the low pump capacity (800 cfs). Stage differences between the high pump capacity plan a[illegible]e recommended plan was found to be less than 0.12 feet. These stages were found in grid [illegible]s next to the L-31N canal and as far as two miles east of the canal. When the analysis was extended to three miles east of the canal stage differentials fell to less than 0.05 feet. These results are indicative of the high horizontal transmissivities and the lack of secondary drainage.

Second, as expected flood durations are shortened by as much as three days at a stage of 7.00 feet, NGVD, with higher total pumping capacity for cells next to the canal and up to two miles east. Durations are less than one day for areas three miles east of the L-31N canal.

d. Structure 197 (S-197). Figure A-5 shows flows through Structure 197. Flow releases decreased by about 39 percent with the proposed plan. Further reductions are likely through changes in operation for this structure. Increasing the stage at which S-197 discharges flood waters would result in reductions in volume releases. Volumes not released

by S-197 would increase sheet flows south of the lower C-111 canal thus bringing greater environmental benefits for this area.

e. Operational Plan-Studies. A proposed buffer zone would separate the agricultural lands to the east of the existing L-31N from the proposed retention/detention zone to the west of the proposed S-332D Tieback. Groundwater seepage studies will enable optimal sighting of the proposed S-332D Tieback levee at the western edge of the buffer zone. This will be critical to the performance of the selected plan, both for environmentally important backseepage and storage of detention flows, but also in selecting optimal canal stages. Rainfall delivery schedules will enable discharges to be timed and hydrograph volumes computed based on measured rainfall. This will allow the hydroperiods in Taylor Slough to best represent restored conditions, not only in water plentiful times, but also during periods of minimal water availability. Regional studies are also underway which will examine water allocations to users, the means of capturing flows that are being lost from the system from coastal canals, and reuse of agricultural runoff. These efforts will lead to a larger available water supply and improved performance of the restored Taylor Slough.

18. Plan For Water Control, ENP-South Dade Conveyance System.

a. South Dade County. The purposes of the project works in South Dade County are to remove the 40-percent standard project flood runoff from the effective drainage area, to reduce depth and duration of larger floods; provide water control to prevent overdrainage in the area; prevent saltwater intrusion; and provide facilities to convey up to 500 cfs to Everglades National Park when normal runoff is available. The ENP-South Dade Conveyance System modified the existing project works in South Dade County.

b. Water Supply. The ENP-South Dade Conveyance System was authorized for the purpose of improving the supply and distribution of water supplies to Everglades National Park, and for expanding agricultural and urban needs. Before supplemental water is introduced into the system from Water Conservation Area No. 3, canal stages are permitted to recede approximately 1.5 feet below the design optimums. The design optimums were established as shown in Table A-8. The above does not include the upstream reaches of the coastal salinity control structures where the design optimum will be maintained.

19. Overall Plan For Water Control - Everglades National Park.

a. Authorization History. In House Document 90-369 preservation of Everglades National Park was recognized as a project purpose and that available water should be provided on an equitable basis with other users. A minimum water supply to Everglades National Park (ENP) from the C&SF Project was guaranteed in June 1970 by PL 91-282. This law stipulated that a annual minimum of 315,000 acre-feet would be distributed to the Park on a monthly basis. This included 270,000 acre-feet to Shark River Slough via the S-12's, 37,000 acre-feet to Taylor Slough at S-332, and 18,000 acre-feet to the Eastern Panhandle at S-18C. Senate Document 91-895, which accompanied the law, provided a

formula for deciding when the 16.5 percent quantity applied. The formula was found to be faulty and hasn't been applied since the earliest months of the application of this Act. PL 91-282 did not specify the origin but guaranteed the quantity to be delivered to the Park. Prior to this time deliveries originated from Lake Okeechobee. Consequently, discharges from WCA No. 3A to ENP are allocated from water stored in WCA No. 3A, except when supplemental water is required from other areas (such as Lake Okeechobee). Transfers from WCA No. 3A will be made whenever local runoff is insufficient to meet the minimum monthly release criteria at S-332 and S-18C.

PL 99-190, and subsequent acts, have authorized the Corps of Engineers to modify the schedule of water deliveries to ENP and to conduct the Experimental Program of Water Deliveries to Everglades National Park. The Experimental Program has consisted of a series of iterative field tests for the purpose of collecting hydrologic and biologic data with the ultimate goal being the development of an optimum water delivery plan for ENP. A General Design Memorandum (GDM) for Modified Water Deliveries to Everglades National Park developed a plan for improved water deliveries to the park in conjunction with the Experimental Program of Modified Water Deliveries. The Experimental Program is providing a degree of immediate improvement in water deliveries and is also allowing collection of hydrological and ecological data. This data will be used to identify correlations between water management and the ecological well-being of Everglades National Park.

The ENP-South Dade County Conveyance System was authorized by PL 90-483, 90th Congress, 2d Session, Flood Control Act of 1968. The Conveyance System was authorized for the purpose of conservation and conveyance of water supplies to ENP, and for expanding agricultural and urban needs. As a part of the Conveyance System necessary modifications to the C&SF Project were constructed upstream of L-31W (including improvement of the L-31N Borrow Canal upstream of its confluence with C-103) to enable adequate delivery of water to Taylor Slough and the Park's Eastern Panhandle. No canal improvements were made to L-31W or C-111 as a part of the conveyance system. However, S-332 was added as a part of the system to pump water deliveries to Taylor Slough from L-31W borrow canal. S-332 is operated to satisfy the minimum delivery requirements of Taylor Slough as specified in PL 91-282. In 1976, the specific operation of S-332 was agreed upon in an Agreement and Permit signed by the U.S. Army Corps of Engineers, National Park Service and the C&SF Flood Control District. Although the total annual volume of 37,000 acre-feet to be delivered to Taylor Slough remained the same, the monthly distribution used in the agreement varied slightly from that prescribed in PL 91-282. The average monthly flows in cubic feet per second shown in Table A-9 are the minimum pumping rates governing the operation of Pumping Station 332 and are subject to the availability of water in the system. During flood periods such rates may be exceeded, up to the capacity of the pumping station, upon mutual agreement of the National Park Service, the SFWMD, and the Corps of Engineers. Construction of S-332 was completed in 1980.

The original operational plan for L-31W called for leaving S-175 and S-176 closed during normal wet seasons to provide sufficient head for the discharge of water from L-31W

into Taylor Slough. Provided that L-31N borrow canal could be maintained at 6.5 ft., NGVD under these conditions, 500 cfs capacity could be discharged from L-31W to the slough. However, under flood conditions when S-176 would be open, L-31N would be drawn down to elevation 6.0 ft., NGVD. Since 500 cfs of flood flows were to be discharged via L-31W and since stages in the L-31W borrow canal would be about 5.2 ft., NGVD - at which stage only limited flows would pass to the slough - S-175 would be the major outlet for design flood flows. Consequently, S-175 is designed for 500 cfs capacity.

The area between L-31W and C-111 also known as the "Frog Pond" was considered to be included in the C-111 basin. Therefore, secondary drainage of this area (when constructed) would discharge into C-111, not the L-31W borrow canal. At this time only limited secondary drainage works have been constructed.

The Frog Pond consists of 5,000 acres located between L-31W and C-111. A portion of the area, lying along the eastern edge adjacent to C-111 has been used for agriculture since the 1920's. Prior to 1981, there were no water management actions taken to benefit agriculture in the Frog Pond. In 1981, following severe flooding associated with Tropical Storm Dennis, the SFWMD, ENP, and the farmers developed operating criteria that constituted the basis for water management in 1982 and 1983. These criteria called for maintaining a wet season stage of 4.5 ft., NGVD upstream of S-175 and S-177. During the dry season, supplemental water deliveries would be made as necessary to maintain these stages at 3.0 ft., NGVD, if sufficient water was available. There were no intentional lowering of canal stages for the benefit of agriculture. The criteria stated that after stages had receded naturally and tomatoes were planted, S-175 and S-177 discharges would be made following large rainfall events to alleviate flooding.

In 1984, farmers stated that market conditions required earlier land preparation and planting in the Frog Pond. After a series of coordination meetings between the ENP and the farmers, an agreement was reached to conduct a one-year test to evaluate the impacts of the Frog Pond drawdown on Taylor Slough. The operating criteria used during the test was honored by the SFWMD. The criteria called for L-31W and S-177 headwater stages to be lowered to 3.5 ft., NGVD by October 15. This stage was to be maintained in L-31W throughout the growing season. After the tomatoes were planted, the S-177 headwater was to be maintained at 3.7 ft., NGVD until crops were harvested. The Frog Pond drawdowns were conducted in 1984, and continued in 1985, and 1986.

During this same time, the Rain-Driven Water Deliveries to ENP test was being conducted. The congressionally mandated Experimental Water Delivery Program to Everglades National Park (Public Law 98-181, Section 1302), passed by Congress in December 1983, authorized the Corps of Engineers, with the concurrence of the National Park Service and the South Florida Water Management District (SFWMD) to conduct an experimental program of water deliveries from the Central and Southern Florida (C&SF) project. The Act further authorized the Secretary of the Army to acquire interest in lands currently in agricultural production and to construct necessary flood protection measures for

homes impacted by any modification of the water delivery schedule to the Park. In the Conference Report (98-551) Congress stated that the change in water delivery could have an adverse impact on privately owned lands east of the Park and recognized the need to address and resolve this situation and treat fairly private land owners whose properties may be affected as a result of water delivery modifications necessary to protect ENP.

On July 12, 1985 an agreement was reached between the SFWMD and the Frog Pond farmers in response to the Kendall et. al. v. Marsh, et. al lawsuit. This agreement permitted the Water Delivery Experiment program to continue without further litigation by the farmers in exchange for lower canal levels during the growing season. In 1985 the Corps of Engineers performed an Environmental Assessment and filed a Finding Of No Significant Impact (FONSI) dated June 7, 1985 for the Experimental Program. On July 24, 1985 a Letter of Agreement between the Corps of Engineers, Everglades National Park (ENP), and SFWMD for the testing process was signed. To date there have been 6 Addenda to the original Letter of Agreement. Addendum 1 presented the operational procedures used in a 2-year test of the Rain-Driven plan for Water Deliveries to the ENP that ended on June 14, 1987. Addendum 2 prescribed operational procedures for the Rain-Driven Plan used through July 10, 1988. Addenda 3,4, and 5 represent continuation of the operational procedures contained in Addendum 2. Section 107 of Public Law 102-104 authorized continuation of the Experimental Program of Water Deliveries to ENP until the modifications to the C&SF Project authorized under Section 104 of Public Law 102-229 are completed and implemented.

b. Taylor Slough Demonstration Project.

(1) General. In June 1993, the U.S. Army Corps of Engineers, SFWMD, and ENP began another experimental water program known as the "Taylor Slough Demonstration Project". In addition to carrying on the Rain-Driven Water Deliveries, the Taylor Slough Demonstration Project returned the stage in L-31N Borrow Canal from 4.5 ft. to 5.0 ft., NGVD during the wet season. This was done to prevent seepage from water pumped into Taylor Slough at S-332 back into the L-31W borrow canal. In addition several portable diesel pumps were added to S-332 to bring the current pumping capacity to 365 cfs. Additional portable pumps will be added to bring the total capacity of S-332 to 500 cfs. Operating criteria for this test is contained in Addendum 6 of the Letters of Agreement. In November 1993, the Frog Pond farmers filed a complaint against the SFWMD and the Corps seeking an injunction to stop the test. The farmers claim that the higher water levels during the test are preventing them from preparing and planting their tomato crop. In the first hearing, the Federal Judge rejected the farmers motion for a temporary restraining order permitting the test to continue. It is expected that the farmers will continue to seek lower water levels to permit agricultural activities in the Frog Pond area to begin in October when market conditions are favorable.

(2) Test Results. Data from the Taylor Slough Demonstration Project is being collected by the South Florida Water Management District, Everglades National Park, Dade County Environmental Resources Management (DERM), and other agencies, and was

not available to be included in this General Reevaluation Report. However, several items were noted during the test as a direct result of the higher canal stages and increased pumping at S-332.

With the increased flows down Taylor Slough the Old Ingraham Highway (old Park entrance) was being overtopped. The old road had several small culverts and were insufficient to pass increased flows down the slough and ultimately to Florida Bay. The SFWMD is planning to remove 0.6 miles of the road to increase conveyance down the slough.

With the increased capacity at S-332 it was noticed that the marsh vegetation directly in front of the pump station was impeding flow down the slough. Water was mounding up in front of the pump station and overtopping the spoil bank to the north of S-332. The SFWMD removed vegetation directly in front of the pump station creating a clear get away channel early in the test.

c. Water Deliveries to the Eastern Panhandle of ENP via C-111. The purpose of S-18C is to maintain desirable water levels in the upstream reach of Canal 111 north of the structure, pass flood flows up to 40 percent SPF without exceeding design stages upstream, and act as a control point for water deliveries to the Eastern Panhandle of ENP. Gate operations are remotely controlled to maintain an optimum range between 2.0 and 2.4 feet, NGVD above the structure while making minimum monthly water releases for ENP as shown in Table A-10.

The purpose of S-197 is to maintain optimum water control stages in Canal 111 to prevent saltwater intrusion. Most of the time S-197 is closed to promote discharges from S-18C to spill from the canal banks in to the panhandle of the Everglades National Park. S-197 only releases water during major floods. Structure 197 was originally built as a slide-gate controlled three barrel 84-inch corrugated metal pipe culvert with an invert elevation of minus 8.0 with an earthen plug across C-111. It originally had 3 manually operated slide gates attached to the upstream end of the pipes. In 1990 the SFWMD constructed ten additional culverts with two metal slide gates at the face of each riser. The gates can be operated from the timber operating platform.

d. Modified Water Deliveries General Design Memorandum (GDM). The GDM presents a structural plan that will allow adequate operational flexibility to satisfy environmental objectives without adversely impacting developed areas. More recently, the Everglades Protection and Expansion Act of 1989 authorized acquisition of approximately 107,600 acres and modification of the C&SF Project to restore the Park's natural hydrologic conditions for restoration of its ecosystem. This Act authorized the construction of modifications to the Central and Southern Florida Project to improve water deliveries to the park and to the extent practicable permits steps to restore the natural hydrological conditions within the park. These modifications are "justified by the environmental benefits to be derived by the Everglades ecosystem in general and the park in particular". The plan being considered will also restore water flows through WCA No. 3B that would more closely match the pre-project conditions. Along with the C-111 plan, the structural features of the plan would enable enough operational flexibility to accomplish a wide range of operational strategies for meeting project objectives and environmental restoration.

The purpose of S-331 is to function as a component of the conveyance canal system to Everglades National Park. The system is designed to provide supplemental water from Water Conservation Area No. 3A to satisfy peak dry season demands of ENP and south Dade County agricultural users during a 1-in-10 year drought. S-331 is required to lift water to obtain adequate hydraulic head in the L-31N borrow canal to enable the southward conveyance of water. S-331 would be operated as necessary when stages in the downstream conveyance canals recede 1.5 ft. below their design optimums.

However, during the experimental water delivery program, concerns over increased water deliveries to Northeast Shark River Slough (NESRS) prompted a change in the way S-331 is operated. For the experimental water delivery program Restricted Rain-Driven Test, S-331 has been used to provide flood mitigation for residents of an area known as the 8-1/2 square mile area rather than its original water supply purpose. In the flood mitigation mode, discharge is performed in response to the stage at a groundwater monitoring well known as Angels Well. If the stage at Angels Well is below 6.0 ft., NGVD, discharge through S-331 will be made so as to maintain an average headwater of 5.0 ft. NGVD. If the stage at Angels Well exceeds 6.0 ft., NGVD, discharge is made to maintain and average headwater stage of 4.5 ft., NGVD until Angels Well drops to 5.7 ft., NGVD, whereupon the S-331 headwater is allowed to rise to 5.0 ft., NGVD. During any of these operations, the discharge of S-331 will be limited so as to not to cause downstream structures to exceed their design stages.

Currently, the Corps of Engineers is designing the Modified Water Deliveries to Everglades National Park plan. The proposed structural features will permit S-331 to return to its design purpose of providing water supply deliveries southward to Everglades National Park. The approved Modified Water Delivery plan provides flood mitigation to the residents of the 8-1/2 square mile area by the addition of levees and a pump station dedicated for mitigating the increased water deliveries into NESRS.

20. Hydraulic Design Criteria.

a. General. Hydraulic design criteria and procedures discussed here are in accordance with standard engineering practice and applicable provisions of Corps of Engineer Engineering Manuals and other technical guidance. Criteria used to address special and local conditions are in accordance with those used previously by the Jacksonville District relative to the Central & Southern Florida Project.

b. Existing Hydraulic Conditions. The Central and Southern Florida Project, Part V, Supplement 37 -- General Design Memorandum, South Dade County (September 12, 1963) presents the existing design condition water surface profiles for the project area. These have been reproduced and included in this report as plates A-10, A-11, and A-12. Plate A-10 shows hydraulic data for C-111 from Structure 18C to Structure 176, plate A-11 shows 3.4 miles of C-111E from its junction with C-111, and plate A-12 shows 11.4 miles of L-31N borrow canal from S-176 up to the drainage divide at S-173, adjacent to pump station S-331.

The existing design condition water surface profiles for the reach of C-111 from S-18C to the outfall at Barnes Sound have not been included here. The original C-111 design included S-18C, located upstream from the coast with the end of the canal open to Barnes Sound, as the canal's downstream salinity barrier. A number of elements in the environmental community feared that salt water would move up the canal and possibly contaminate the freshwater aquifer or spill over the south bank through the gaps destroying the portion of Everglades National Park south of C-111. During the construction of the canal, these interests became very vocal and mounted a campaign to have some sort of structure at the end of the canal. As part of the construction, a bypass for U.S. Highway 1 was used while the bridge over C-111 was constructed. About the time the bypass was to be removed, the controversy over the open end of the canal reached a peak. As a temporary solution, a plug and culvert structure (S-197) were placed in the canal immediately downstream of the U.S. Highway 1 bridge. The plug was to be removed for flood control purposes and also for passage of barges. However, the plug was never removed for navigation purposes. In 1989, the SFWMD modified S-197 by adding 10 culverts to increase the discharge capacity to 2,300 cfs.

The gaps along the southern bank of lower C-111 below S-18C have been subject to recent cleanout initiated by the local sponsor agency, SFWMD. This cleanout entailed removal of vegetation that had grown over gap getaway areas and restricted overland flow southward to the eastern panhandle of Everglades National Park.

c. Post-Project Hydraulic Conditions. Water surface elevations within Shark River Slough and Taylor Slough were determined with the 1X1 model. Elevations at hydraulic structures were determined by considering possible stages at locations in Shark River Slough and Taylor Slough at the structure sites. HEC-2 models were used to "backwater" to the structure from appropriate distances in the marsh to ensure proper design tailwater conditions. Where required, channels between marsh discharge points and pump stations to outlet structures were also checked to ensure proper design tailwater conditions were addressed.

Recent surveys taken as a result of the Hurricane Andrew recovery effort showed that the existing canals were in excellent condition with respect to required conveyance capability. The proposed project plan calls for canal capacities which are less than the original design in all reaches of the existing canal network. Therefore, enlargement of existing canals is required. New canal segments were designed according to the latest Corps of Engineers criteria.

d. Canal Characteristics.

(1) Design water surface in canals. Due to the limited head available in the canals, the design water surface was held to at or just below the existing ground along the canal. In the low areas adjacent to the coast, when ground elevation is less than 2 feet the design water surface was held as close as practicable to the ground elevation. In the back

areas where slope was available the design water surface was established at a minimum of 0.5 feet below ground elevation.

(2) Maximum permissible velocities. Since the canals are located in limestone of varying hardness with little or no overburden, a maximum velocity of 4.0 feet per second was considered permissible. However, because of slope-control design limitations, canal velocities do not exceed 1.6 feet per second.

(3) Side slopes. Side slopes of 1 vertical to 1 horizontal are based on the most economical stable slopes for limestone material found in the area.

(4) Cross-sections. Within the limitations of depth, canal sections are based on the most economical section that would carry the design discharge at the design water surface and slope.

(5) Transitions. Because of low design velocities, transition lengths were not critical elements of the design and are based on Corps design guidance.

(6) Roughness coefficients.

Earth Canals. All existing canals are located in limestone rock. A Manning's roughness coefficient "n" of 0.035 was used in the design of canal sections and tabulation of water surface profiles. This value has provided satisfactory results in past designs.

Concrete-lined Canals. Concrete-lined canals are proposed to convey discharge from pump stations to the marsh areas. A Manning's roughness coefficient "n" of 0.018 was chosen to simulate weathered concrete.

Marsh Flow Analyses. Analyses and calibration of storm discharges through Florida marshes have shown that Manning's roughness coefficient "n" values are usually in the range of 0.15 to 0.43. Roughness coefficient values as high a 1.0 for densely vegetated areas have been documented. The type of vegetation encountered in Shark River Slough and Taylor Slough is not expected to produce Manning's n-values in excess f of 0.40. However, sensitivity analyses were performed to determine the worst possible roughness conditions on flow.

(7) Sensitivity Analyses. Sensitivity analyses were done using HEC-2 to determine the response of the water surface profile to different vegetative growth densities. The purpose was to analyze head losses across a retention/detention area. Models were developed for a marsh reach extending from the discharge canal outfall area out about 0.5 miles into the wetland area. Photos A-1 and A-2 show aerial views of the marsh land adjacent to L-31W borrow canal near S-332. This can be considered typical for vegetation in this wetland area.

A range of wetland water surface stages were used for the starting water surface. These "tailwater" depths for the HEC-2 model represent probable water depths out in the marsh or slough, and ranged from a depth of 0.3 feet to 3.5 feet. Three roughness coefficients were used to model the marsh/wetland: Manning's n-value= 0.15, 0.43, and 1.0. These yielded maximum increases in depth at the discharge canal outfall of 1.6, 1.9, and 4.5 feet, respectively, for a "tailwater" depth in the marsh of 0.3 feet. Higher tailwater depths in the marsh tended to drown out the water surface profile rise at the discharge outfall. Results of these analyses were used in determining the maximum pumping head and top of discharge canal elevations.

(8) Freeboard. The project area has very little topographic relief. Consequently, canal designs were developed that would not provide freeboard. Water surface profiles for flood flows were set at the highest non-damaging levels.

e. Levees. In addition to flood control benefits, this project provides for enhancement of natural values within the project area by rerouting flow into areas to benefit flora and fauna. New levees proposed for the project include levees which block backflow from areas designated to have increased stages for environmental reasons. Adjacent and parallel existing levees, east of the proposed levees, would continue to provide protection for flood control.

Modifications to existing levees described in this report include levee segments that would be degraded to allow flow into an area acquired for environmental enhancement of Taylor Slough. Because of this, one new section of levee would be required to maintain flood protection to the east. That levee would divide the "Frog Pond" into two sections. The crest elevation of that levee was chosen to tie in to the remaining existing segments of levee. The same level of flood control would therefore be provided to the eastern segment of the Frog Pond and the areas east of C-111 above S-18C.

f. Water Control Structures. This plan presents no new spillway structure designs or modifications to existing spillways. There would be four 300 cfs pump stations and one 50 cfs pump station. The project requires continued operation of existing structures within normal operating ranges.

(1) Optimum and Design Water Levels. Optimum and design water levels in the project canals are established on the basis of desirable water control elevations in each area, i.e., optimum groundwater levels, intake and/or discharge structure elevations and removal rates for flood control. Along the east coast, salinity control is included as a requirement of canal-level design criteria.

(2) Salinity Control. The project area lies over the Biscayne Aquifer. The Biscayne Aquifer underlies about 3,000 square miles of Dade, Broward, and southern Palm Beach County. It is a surficial, highly permeable, wedge shaped aquifer that is about 200 feet thick at the coast but thins to a few feet thick near its western boundary 35 to 40 miles

inland. This aquifer, and surficial aquifers in Palm Beach County, provide water for municipal and industrial (M&I) water supply and agricultural irrigation along the southeast coast. Seepage and water supply releases from the Water Conservation Areas prevent saltwater intrusion along the coast and recharge the surficial aquifers. The original design considered that except at coastal salinity structures, canal stages in general would be permitted to recede approximately 1.5 feet below optimum levels before supplemental water was introduced into the ENP-South Dade Conveyance System. The alternatives evaluated would use this criteria, therefore it is anticipated that there would be no salinity encroachment.

g. Bridges. There is one shallow box culvert type bridge over Taylor Slough. It would be replaced by a 1000-foot long elevated roadway over the shallow slough.

h. Disposal Mound Areas. Existing disposal mounds along the south bank of the most southerly leg of C-111 would be removed and used as fill for the L-31W Tieback. Haul routes and the amount of material to be placed along L-31W Tieback are discussed in Appendix D, Design and Cost Estimates.

i. Sediment Potential. The project area is very flat, and project channels were designed with very little hydraulic slope. Such slope-controlled design result in very low velocities and little sediment movement through the canal system. Referring to the Jacksonville Districts's September 1992 C-111 Rehabilitation Report for damage from Hurricane Andrew, this report noted that relatively little shoal removal was required. For the reach of C-111 between S-177 and S-176, only about 0.2 feet of aggradation occurred on average over this canal reach for the more than 20 years project life. Based on this, it appears that the potential for loss of conveyance due to sediment is negligible.

21. Hydraulic designs.

a. Alternatives. Eight alternatives were developed, with two of these being slight modifications to other alternatives. Hydraulic designs were developed to maintain the authorized level of flood control and to protect the natural values associated with Everglades National Park, as discussed in the 1989 Everglades National Park Protect and Expansion Act. Alternative plans are described in detail in the main report. Brief descriptions of features are as follows.

(1) Plate A-1 shows alternative 1, which included enlarging S-174 to 1500 cfs capacity, enlarging S-332 to 1000 cfs capacity, adding a 50 cfs pump at Context Road, adding a spreader canal with a 50 cfs pump north of C-111, plugging C-109 and C-110, and degrading the spoil mounds along the southern leg of C-111.

(2) Plate A-2 shows alternative 1A, a slight modification to alternative 1. The spreader canal and 50 cfs pump are not a part of alternative 1A.

(3) Plate A-3 shows alternative 2. It calls for an additional 1000 cfs pump at S-174, backfill of a portion of L-31W borrow canal, and similar to alternative 1, the 50 cfs pump at Context Road, the spreader canal and 50 cfs pump north of C-111, plugs in C-109 and C-110, and degrading spoil mounds along the southern leg of C-111.

(4) Plate A-4 shows alternative 3. It calls for an additional 1630 cfs pump near S-174, and creation of a Stormwater Detention Area (SDA) with a surge pond in the Frog Pond area, backfill of the southern portion of L-31W borrow canal, and similar to alternative 1, a spreader canal with a 500 cfs pump station, plugs in C-109 and C-110, but backfill of C-111 from below the junction with C-111E to S-197.

(5) Plate A-5 shows alternative 4. It calls for an four additional 300 cfs pump station along a new levee that would run parallel with L-31N, modifications to S-357 and its seepage canal (these are a part of the Modified Water Deliveries for ENP Project, which has not yet been constructed), backfill of the upper portion of L-31W borrow canal, and similar to alternative 3, the spreader canal and 500 cfs pump north of C-111, plugs in C-109 and C-110, and backfill of the southern leg of C-111 from below the junction with C-111E to S-197.

(6) Plate A-6 shows alternative 5. It calls for an additional 1000 cfs pump stations near S-174, backfill of the lower portion of L-31W borrow canal, and similar to alternative 3, the spreader canal and 500 cfs pump north of C-111, plugs in C-109 and C-110, but only partial backfill of the southern leg of C-111 from below the junction with C-111E to S-197.

(7) Plate A-7 shows alternative 6. It can briefly be described as a combination of the upper part of alternative 4, which includes the four 300 cfs pump stations, new levee, modification to S-357 and its seepage levee, backfill of a segment of L-31W; and the lower portion of alternative 1, which includes adding a spreader canal with a 50 cfs pump north of C-111, plugging C-109 and C-110, and degrading the spoil mounds along the southern leg of C-111.

(8) Plate A-8 shows alternative 6A, the recommended plan. Upstream of the existing S-177, the plan of modifications is somewhat similar to alternative 6, and includes four 300 cfs pump stations, two new levees, and backfill of a segment of L-31W. The lower portion of the recommended plan is similar to alternative 1, which includes adding a spreader canal with a 50 cfs pump north of C-111, plugging C-109 and C-110, and degrading the spoil mounds along the southern leg of C-111. This plan is discussed in detail below.

b. Proposed Plan. The proposed plan for flood control and environmental restoration would maintain the existing flood protection. Plate A-8 presents the proposed modifications to the L-31(N)/C-111 canal system. The plan provides flexibility of water transfer from L-31N borrow canal and C-111 to various points along their alignments including the Context Road (Rocky Glades) area and Taylor Slough, and the east-west

alignment of C-111 above the eastern panhandle of the Everglades National Park. The following description of actions and features necessary that make up the proposed plan is broken down into water transfer areas.

(1) The Rocky Glades area south of S-331 and west of L-31N, and Taylor Slough west of C-111 and south of S-175, would be served by modified as follows. Four new 300 cfs capacity pump stations would pump water from L-31N borrow canal westward toward Everglades National Park, across an area known as Rocky Glades. The four 300 cfs pump stations would be located along the existing L-31N borrow canal, and each would have a westward flowing concrete-lined getaway canal, to reduce back-seepage to the L-31N borrow canal.

The getaway canals would terminate just past the first of two new levees, designated S-332D Tieback; the second levee, designated L-31W Tieback, would be parallel to and 0.5 miles further west. This pair of levees would provide for separation of the agricultural areas to the east from the Everglades National Park to the west. The area bounded on the east by the existing L-31N and on the west by the new S-332D Tieback levee would be a buffer zone. The area bounded on the east by the new S-332D Tieback levee and on the west by the new L-31W Tieback would be a retention/detention zone. The L-31W Tieback would have twenty-four 36-inch culvert-risers spaced at 1000-foot intervals, for spreading flow westward into Everglades National Park. A typical profile of flow from L-31N borrow canal through the buffer zone, the retention/detention area, and into ENP is shown on plate A-9.

Adjacent to the area known as the Frog Pond, a segment of the L-31W borrow canal would be filled in from S-332 northward to where the western-most new levee (L-31W Tieback) crosses north to south. The existing canal would be filled to natural grade. Backfill material will be taken from the adjacent levee L-31W. The purpose is to encourage sheet flow toward Taylor Slough and to restore flow to the historic flood plain within the Frog Pond. Pump station S-332 would remain in service. A connector canal from C-111 would provide water to the west (to S-332) and south (to S-175). The L-31W levee would be severed near S-175, to provide a connection for the connector canal and the L-31W canal. Three sections of the Frog Pond areas would have to be acquired to serve as floodway for this alternative and the five remaining sections would act as a buffer zone.

(2) The eastern Panhandle area of Everglades National Park (ENP), south of the east-west run of C-111, would be modified as follows. A new canal, designated Canal 111 North (C-111N) would be constructed to increase water supply for environmental restoration of the area. The C-111N would receive pumped water from existing C-111E and provide conveyance east with overflow going south. Water from C-111E would be pumped by a new 50 cfs pump station, designated S-332E. Canal 111 North would act as a spreader canal. Water would pass over the south bank and be conveyed as sheet flow southward. A berm would be placed on the north bank to minimize the impact on stages north of the spreader canal.

Existing canals C-109 and C-110 were constructed by side casting methods which created spoil berms on the east and west banks of both canals. Nine plugs would be constructed in C-109 and ten plugs would be constructed in C-110. These plugs would overdraining to the wetlands. Material for construction of the plugs would be obtained from adjacent spoil mounds. A typical plug would be 200 feet long with a top elevation equal to the adjacent natural grade. East and west bank spoil mounds at the north end of each plug would be joined to prevent water from entering unplugged sections of the canals. This procedure would also be followed at the south end of each plug.

There are spoil banks along the east-west run of C-111 upstream of S-197. On the south bank, gaps were left to allow flow southward into the panhandle area of ENP. The proposed plan provides for removal of all spoil along this southern bank of C-111. This spoil would be used as levee fill material for the new levee, L-31W Tieback.

c. Pump Stations. The four new pump stations along the new levee would each have 300 cfs capacity. They are numbered S-332A, S-332B, S-332C, and S-332D and their locations are shown on plate A-8. Each pump station would be equipped with four 75 cfs capacity pumps. Hydraulic design data for these pumps are shown in tables marked table A-11, Table A-12, Table A-13, and Table A-14, respectively.

A 50 cfs pump station, S-332E, would pump water into a new canal, designated C-111N. Water would be pumped from the junction of C-111 and C-111E and provide for flows to the east across canals C-109 and C-110. Hydraulic design data for this pump is shown in Table A-15.

d. Canals.

(1) Pump Stations S-332A & S-332B Discharge Canals. Pump stations S-332A and S-332B would discharge water into 0.5-mile long concrete-lined canals extending westerly from L-31N borrow canal across the buffer zone. The purpose of the concrete lining is to inhibit seepage and reduce pumping of return flow by increasing the seepage flow path back to the L-31W borrow canal. This is typical for all four pump station discharge canals. A schematic plan and profile sketch is shown on plate A-9. The S-332A and S-332B discharge canals would each have a 10-foot bottom width, 1 to 1 side slopes, and an invert of 3.2 feet, NGVD. The top of channel would be at elevation 10.5 feet, NGVD. A berm would be required on each side of the canal, since existing ground elevations are about 7 feet, NGVD, in this area. Figure A-6 shows a schematic water surface profile extending from the pump station down the discharge canal, across the retention/detention area, and through the culvert/riser.

(2) Pump Station S-332C Discharge Canal. Pump station S-332C would discharge water into a 0.5-mile long concrete-lined canal extending westerly from L-31N Borrow Canal. This canal would have a 10-foot bottom width, 1 to 1 side slopes, and an invert of 2.7 feet, NGVD. The top of channel would be at elevation 9.8 feet, NGVD. A

berm would be required on each side of the canal, since existing ground elevations are about 6.5 feet, NGVD, in this area. A schematic profile sketch of this canal is shown on plate A-9. Figure A-6 shows a schematic water surface profile extending from the pump station down the discharge canal, across the retention/detention area, and through the culvert/riser.

(3) Pump Station S-332D Discharge Canal. Pump station S-332D would be placed immediately downstream of S-174, and discharge water into the existing L-31W borrow canal. This canal would be concrete-lined for about one-half mile, extending westerly from L-31N Borrow Canal. A schematic plan layout is shown on plate A-9. The top of channel would be at elevation 9.3 feet, NGVD. The S-332D Tieback berm would be constructed along the north side of the canal, where existing ground elevations are about 6.5 feet, NGVD.

(4) Pump Station S-332 Connector Canal. Existing pump station S-332 would remain in service. A connector canal from C-111 would provide water to the west (to S-332) and south (to S-175). A culvert structure, discussed in paragraph 21(f) below, would be placed on the existing L-31W borrow canal, and the proposed connector canal would extend eastward form this point to C-111. A schematic plan view layout is shown in figure A-7. The connector canal would have a 10-foot bottom width, 1 to 1 side slopes, and an invert of -12.0 NGVD.

(5) Canal 111 North (spreader canal). A 50 cfs pump station, S-332E, would pump water into a spreader canal designated the C-111N. Water would be pumped from the junction of C-111 and C-111E and provide for flows to the east across canals C-109 and C-110. Hydraulic design data for this canal is shown in Table A-16. A schematic profile of the canal and water surface is shown on Figure A-8. Figure A-9 shows how the flow would rise and exit the canal, as sheet flow moving southward.

(6) Existing Canals C-109 and C-110. Earth plugs would be placed in C-109 and C-110, for the purpose of allowing flow to spread and sheet flow in a more natural manner southward from the new C-111N.

e. Levees.

(1) Levee 31 West Tieback. A new north-south levee would be created that would run parallel to L-31N, designated L-31W Tieback. It would be located about one mile west of L-31N, and have two segments that would tie-into the existing L-31W. The northern segment would extending the existing L-31W west of S-14 to high ground in the Rocky Glades area. This northern segment of levee would form the western boundary of a retention/detention area. The levee top would be about four feet above existing ground elevations.

The northern segment of the proposed L-31W Tieback and the S-332D Tieback levee discussed below would create a retention/detention area between ENP to the west and agricultural lands to the east. The L-31W Tieback levee would also have riser culverts through it and an emergency spillway. The culverts and the emergency spillway are discussed in paragraphs 21(e) and 21(f), above.

The southern segment of L-31W Tieback would run southerly from an existing segment of L-31W, crossing the bottom leg of the existing L-31W at a proposed culvert structure in the L-31W borrow canal to tie in to S-175. The levee top would be about three to four feet above existing ground elevations. Levee top elevations are shown in Table A-17. Borrow material for the L-31W Tieback levee would come from the south bank disposal mounds on the southern most leg of C-111.

(2) S-332D Tieback. An additional new north-south levee would be created that would run parallel to L-31N, designated S-332D Tieback. It would be located about one-half mile west of L-31N, bisecting the lands between the existing L-31N and the proposed L-31W Tieback. The northern terminus of S-332D Tieback would tie into high ground in the Rocky Glades area, somewhat north and one-half mile west of the junction of C-102 and L-31N borrow canal. A southern segment of the levee would turn eastward and run parallel to L-31W about one-half mile west of L-31N, and tie into a new pump station that would be located immediately west of S-174. The levee top would be about three to four feet above existing ground elevations. Levee top elevations are shown in table A-18. Borrow material for this levee would come from either the existing disposal mounds along C-111, or an adjacent borrow canal. This borrow canal would not be continuous, and it would not carry flow.

As noted above, the northern segment of the proposed L-31W Tieback and the S-332D Tieback levee would create a retention/detention area, west of the S-332D Tieback levee. The area east of the S-332D Tieback levee to the existing L-31N would create a buffer zone between the retention/detention area to the west and agricultural lands to the east.

(3) Modifications to Existing L-31W. A long segment of L-31W, extending from the tie-in with the new L-31W Tieback southward to existing pump station S-332, would be totally degraded as shown on plate A-8. This segment encompasses the western-most part of the Frog Pond. The levee material would be returned to the adjacent borrow canal.

(4) Modifications to Existing Berms along C-111. There are disposal banks along the east-west run of C-111 upstream of S-197. On the south bank, gaps were left to allow flow southward into the panhandle area of ENP. The proposed plan provides for removal of all disposal mounds along this southern bank of C-111. The spoil would be deposited in C-109 and C-110, and used in levee construction, as described above.

f. Culvert/Riser Structures.

(1) Culverts through L-31W Tieback. Culvert/riser structures would be provided to convey water from the retention/detention area westward toward Everglades National Park. Twenty-four 36-inch diameter culvert/risers would be placed through L-31W Tieback at 1000-foot intervals. The culverts were sized to pass 50% of the maximum pump capacity of the three pump stations S-332B, S-332C, and S-332D, with 0.5 feet of head difference. An overflow spillway, described below, would pass the balance of the pump capacity. The 1000-foot spacing is based on providing dispersion of flow into Everglades National Park. Hydraulic design data for a typical culvert is shown in table A-19. Figure A-6 shows a schematic water surface profile extending from the pump station down the discharge canal, across the retention/detention area, and through the culvert/riser.

The culverts would be set so that the pipe soffit is at adjacent grade, and would have a 10-foot wide exit sump as shown in the sketch on plate A-9. The riser would have a moveable plate to adjust discharges.

(2) Culvert from C-111 Connector Canal to S-332. Since existing pump station S-332 would remain in service, a connector canal from C-111 would provide water to the west (to S-332) and south (to S-175). A culvert structure on the existing L-31W borrow canal would pass water to S-332, with a flap-gate on the west end to prohibit backflow toward C-111. The proposed L-31W Tieback would tie into this structure. A schematic plan view layout is shown in Figure A-7. Hydraulic design data for the culvert is provided in table A-20.

g. Overflow Spillway on L-31W Tieback. There would be one overflow spillway across L-31W Tieback, as shown on plate A-8. It would be a trapezoidal spillway, with a length of 300 feet. As shown in figure A-10, the spillway would be a 1-foot notch in the levee, with 1 on 10 ramps down to the spillway crest. The downstream spillway face would be armored as shown in the figure, for a design velocity of 4 feet per second and depth of 1 foot.

The spillway crest length was determined to pass 50% of the maximum pump capacity of the three pump stations S-332B, S-332C, and S-332D. The culvert/risers would pass the balance of the pump capacity.

h. Bridges. An elevated roadway is proposed for the segment of State Road 9336 (State Road 27) that crosses Taylor Slough within Everglades National Park. There is an existing shallow box culvert crossing of Taylor Slough that is about 60 feet long. This can be seen in Photo A-3. The new bridge would replace this crossing with a 1000-foot long concrete bridge, built next to the existing SR 9336. This would provide for continuous access during construction of the new bridge. After new approaches are connected to the bridge from SR 9336, the old road bed and box culverts would be removed. The bridge low cord would be set at 2.5 feet above the maximum target stage in Taylor Slough of 6.5 feet,

NGVD. Riprap would not be required because velocities would be less than 1.5 feet per second.

The Old Ingraham Highway also crosses Taylor Slough, downstream and south of State Road 9336. There is no bridge on this unpaved road, which was constructed in the early 1910's. Photo A-4 is an eastward facing aerial view of the road. The SFWMD has removed 0.6 miles of this road as part of the Taylor Slough Demonstration Project.

i. Existing Canals and Water Control Structures.

(1) Table A-21 lists as-built canal data. Locations are shown on plate A-1. The Levee 31 West borrow canal, Canal 111, and Canal 111 East are hydraulically linked and hydrologically inseparable. They provide drainage for both the C-111 basin and the Taylor Slough basin. The canal systems discharge into Everglades National Park at important hydrological and environmental locations. The system is designed to distribute normal and flood discharges between the natural Taylor Slough basin and the eastern panhandle of Everglades National Park.

The Levee 31 North borrow canal was designed to discharge agricultural runoff southward to the L-31W borrow canal and/or C-111. This canal is also used for conveyance of water supply deliveries to Everglades National Park and to coastal canals. Photo A-5 was taken looking north along the alignment of L-31N, near S-176.

The west leg of L-31W was designed to prevent flooding from the Everglades area from causing damage in the agricultural and industrial areas to the east. The existing levee extends from its junction with L-31N to the Everglades National Park boundary, which it then follows southward for about 8 miles. Photo A-6 is a westward view into ENP from just north of pump station S-332, across the L-31W borrow canal. The L-31W borrow canal was designed to discharge flood releases and water supply discharges to replenish fresh water supply in Taylor Slough.

Canal 111 East originates at State Road 27, four-tenths of a mile west of Country Club Road. The canal extends three miles to the south to its open channel junction with C-111. Flow in the canal is to the south. C-113 begins at Richard Road on-fourth mile north of Mowery Drive and extends west to its open channel junction with C-111 just downstream of S-176. Flow in C-113 is to the west. C-111E and C-113 have the following functions: (1) provide drainage and flood protection for the C-111 basin; (2) supply water to the C-102, C-103, and C-111 basins, and to Everglades National Park; (3) prevent slat water intrusion into local groundwater.

Canal 111 was designed for flood protection. During a flood event, a portion of the Taylor Slough basin runoff is discharged down C-111. Photo A-7 is a view of the south bank of C-111, with one of the recently cleaned out gaps that provides for flow toward the panhandle area of ENP. The southern portion of the C-111 basin was to have been

drained by C-109 and C-110. C-109 was completed and C-110 was partially completed before work on these canals was stopped. Earthen plugs have been placed at the confluence of these canals with C-111. Neither canal has a connection with C-111.

(2) Table A-22 lists as-built structure data for S-174, S-175, S-176, S-177, S-18C, S-197, and S-332. The following are design functions of the existing structure works. Locations are shown on Plate A-1.

Structure 174 is a gated-spillway located in the east end of L-31W borrow canal and near the intersection of the existing C-111, Section 3 Extension, and L-31N borrow canal. Photo A-8 looks west at S-174. S-174, together with S-176, maintains a desirable water control stage upstream in L-31N borrow canal, passing releases to L-31W. It passes the design flood (40 percent of the SPF) without exceeding the upstream flood design stage, and restricts downstream flood stages and discharge velocities to non-damaging levels. It also passes the required flows (up to 500 cfs) to Taylor Slough in Everglades National Park. During low-flow periods, S-174 can pass sufficient discharges to maintain stages downstream.

S-175 is a gated, three barrel, 84-inch corrugated metal pipe culvert with reinforced concrete headwalls, located near the top of the most southerly leg of L-31W borrow canal. Photo A-9 shows the upstream side of S-175. This structure maintains optimum upstream water control stages in the L-31W borrow canal. It passes the design flood (40 percent of the SPF) without exceeding the upstream flood design stage, and restricts downstream flood stages and channel velocities to non-damaging levels. S-175 operates to discharge the flow from S-174 and to support an optimum upstream water elevation of 4.5 ft. Under flood control operations, this structure diverts the L-31W borrow canal discharge overload into Taylor Slough or passes it south to distribute the flow overland from L-31W borrow canal to south of State Road 27.

Structure 176 is a gated-spillway located in the south end of L-31N borrow canal. Photo A-10 shows the upstream side of S-176. S-176, together with S-174, maintains a desirable water control stage upstream in L-31N borrow canal. It passes the design flood (40 percent of the SPF) without exceeding the upstream flood design stage, and restricts downstream flood stages and discharge velocities to non-damaging levels. During low-flow periods, S-176 can pass sufficient discharges to maintain stages downstream.

Structure 177 is located in Canal 111, 300 feet south of State Road 27. S-177 is a reinforced concrete, one bay, U-shaped spillway with automatically controlled vertical-lift gate and manually operated slide gates. Photo A-11 is a view looking downstream at S-177. This structure maintains optimum water control upstream in Canal 111. It passes the design flood (40 percent of the SPF) without exceeding the upstream flood design stage, and restricts downstream flood stages and discharge velocities to non-damaging levels. During low-flow periods, S-177 can maintain desirable water control conditions upstream in Canal 111.

S-178 is a gated culvert located in C-111E at State Road 27. It controls local inflows to C-111E from local drainage. Photo A-12 is a view of S-178 looking upstream. The structure maintains desirable water control stages upstream from the structure during low flow period; passes all discharges up to the design capacity without exceeding desirable stages; and restricts discharge during floods to that which will not cause damaging velocities or stage downstream.

S-194 is a gated culvert located in C-102 on the divide between the C-102 and C-111 basins. The structure is normally open to supply water to the C-102 basin from L-31N borrow canal. During flooding the gates at S-194 are closed to prevent water from passing from one basin to another.

S-196 is a gated culvert located in C-103 on the divide between the C-103 and C-111 basins. The structure is normally open to supply water to the C-103 basin from L-31N borrow canal. During flooding the gates at S-196 are closed to prevent water from passing from one basin to another.

Structure 18C is located in Canal 111, Section 1. Control structure S-18C is a two bay, U-shaped gated spillway, with a trapezoidal weir and cable operated vertical-lift gates with slide gates. Photo A-13 shows the gates out of the water at S-18C. S-18C maintains a desirable freshwater head against northerly salt water intrusion into Canal 111. The structure maintains optimum water control stages upstream in Canal 111; it passes the design flood (40 percent of the SPF) without exceeding upstream flood design stage, and restricts downstream flood stages and discharge velocities to non-damaging levels and assists in preventing saline intrusion. It also makes discharges to the eastern panhandle of the Everglades National Park.

Structure 197 is in Canal 111 near the mouth of the canal, about 3 miles from Manatee Bay and 750 ft. east of U.S. Highway 1. S-197 was originally built as a gated, three barrel, 84-inch, corrugated metal, pipe culvert with an invert elevation of -8.0 feet. It originally had 3 manually operated slide gates attached to the upstream end of the pipes. In 1990, the local sponsor (SFWMD) built ten additional culverts. Photo A-14 shows the three original culverts and the ten additional culverts adjacent. S-197 maintains optimum water control stages in Canal 111 and prevents saltwater intrusion during high tides. Usually S-197 is closed, which forces discharge from S-18C overland to the panhandle of the Everglades National Park. S-197 releases water only during major floods under established guidelines.

Structure 332 is located at the head of Taylor Slough in the Everglades National Park about 6 miles west of Homestead, Florida. It is on the west side of L-31(W) borrow canal, as shown in Photos A-1 and A-2. S-332 is an electric motor-driven pumping station with a variable pump arrangement. Its purpose is to function as a component of the conveyance canal system to ENP and South Dade County, and provide water to ENP. Under normal regulation, S-332 is required to deliver a minimum of 37,000 acre-feet of water per year from L-31(W) borrow canal to Taylor Slough in ENP. These flows are subject to water

availability. During flood periods S-332 may exceed the monthly rate, up to the capacity of the pumping station, upon mutual agreement of the National Park Service, the South Florida Water Management District, and the U. S. Army Corps of Engineers.

j. Performance/water surface profiles. Water surface profiles are shown on plates A-10, A-11, and A-12. The design water surface profiles are based on a flood recurrence interval of 1 in 10-years. The measures proposed in this document are designed to provide environmental enhancement and increased water supply to Everglades National Park (ENP). Flood control capabilities of the existing system will also be increased somewhat. Flood protection is currently provided by the alignment and height of levees L-31N and L-31W, and conveyance capabilities of canal C-111. Proposed project features would provide for redirection of the majority of C-111 flood discharges directly to ENP. This would allow reduced discharge requirements at S-197 and thus reduce freshwater discharge to Florida Bay. The proposed features would not compromise existing flood control capabilities. Benefits to agricultural lands and residential properties would not be reduced and flood risk to people in the project areas would not be increased.

C-111
GENERAL REEVALUATION REPORT
Appendix A
Hydrology and Hydraulic Analysis

TABLES

DEPTH–AREA IN PERCENT OF POINT RAINFALL FOR 1X1 MODEL FOR STORM CENTERED OVER C111

DURATION	RATIO	RAINGAGE NUMBER												
DAYS	TO 1 DAY	7	6	10	4	1	8	3	2	5	9	11	13	12
1	1.000	94.5	91.7	90.5	89.3	88.5	87.8	87.3	87	86.7	86.3	80.4	80.4	80.4
2	1.016	96.0	93.2	91.9	90.7	89.9	89.2	88.7	88.4	88.1	87.7	81.7	81.7	81.7
3	1.023	96.7	93.8	92.6	91.4	90.5	89.8	89.3	89.0	88.7	88.3	82.2	82.2	82.2
4	1.028	97.1	94.3	93.0	91.8	91.0	90.3	89.7	89.4	89.1	88.7	82.7	82.7	82.7
5	1.031	97.4	94.5	93.3	92.1	91.2	90.5	90.0	89.7	89.4	89.0	82.9	82.9	82.9
6	1.034	97.7	94.8	93.6	92.3	91.5	90.8	90.3	90.0	89.6	89.2	83.1	83.1	83.1
7	1.036	97.9	95.0	93.8	92.5	91.7	91.0	90.4	90.1	89.8	89.4	83.3	83.3	83.3
8	1.037	98.0	95.1	93.8	92.6	91.8	91.0	90.5	90.2	89.9	89.5	83.4	83.4	83.4
9	1.038	98.1	95.2	93.9	92.7	91.9	91.1	90.8	90.3	90.0	89.6	83.5	83.5	83.5
10	1.039	98.2	95.3	94.0	92.8	92.0	91.2	90.7	90.4	90.1	89.7	83.5	83.5	83.5
11	1.040	98.3	95.4	94.1	92.9	92.0	91.3	90.8	90.5	90.2	89.8	83.6	83.6	83.6
12	1.041	98.4	95.5	94.2	93.0	92.1	91.4	90.9	90.6	90.3	89.8	83.7	83.7	83.7
13	1.043	98.6	95.6	94.4	93.1	92.3	91.6	91.1	90.7	90.4	90.0	83.9	83.9	83.9
14	1.044	98.7	95.7	94.5	93.2	92.4	91.7	91.1	90.8	90.5	90.1	83.9	83.9	83.9
15	1.045	98.8	95.8	94.6	93.3	92.5	91.8	91.2	90.9	90.6	90.2	84.0	84.0	84.0
16	1.046	98.8	95.9	94.7	93.4	92.6	91.8	91.3	91.0	90.7	90.3	84.1	84.1	84.1
17	1.046	98.8	95.9	94.7	93.4	92.6	91.8	91.3	91.0	90.7	90.3	84.1	84.1	84.1
18	1.047	98.9	96.0	94.8	93.5	92.7	91.9	91.4	91.1	90.8	90.4	84.2	84.2	84.2
19	1.047	98.9	96.0	94.8	93.5	92.7	91.9	91.4	91.1	90.8	90.4	84.2	84.2	84.2
20	1.048	99.0	96.1	94.8	93.6	92.7	92.0	91.5	91.2	90.9	90.4	84.3	84.3	84.3

TABLE A–1

C-111 10-YR STORM FOR 13 RAINFALL BASINS

DAY	POINT RAINFALL	7	6	10	4	1	8	3	2	5	9	11	13	12
1	0.45	0.45	0.43	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.38	0.38	0.38
2	0.50	0.49	0.48	0.47	0.47	0.46	0.46	0.46	0.46	0.45	0.45	0.42	0.42	0.42
3	0.50	0.49	0.48	0.47	0.47	0.46	0.46	0.46	0.46	0.45	0.45	0.42	0.42	0.42
4	0.50	0.49	0.48	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.42	0.42	0.42
5	0.55	0.54	0.53	0.52	0.51	0.51	0.50	0.50	0.50	0.50	0.49	0.46	0.46	0.46
6	0.60	0.59	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.50	0.50	0.50
7	0.60	0.59	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.50	0.50	0.50
8	0.70	0.68	0.66	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.62	0.58	0.58	0.58
9	0.75	0.73	0.71	0.70	0.69	0.68	0.68	0.67	0.67	0.67	0.67	0.62	0.62	0.62
10	2.00	1.92	1.86	1.84	1.81	1.80	1.78	1.77	1.77	1.76	1.75	1.63	1.63	1.63
11	6.75	6.38	6.19	6.11	6.03	5.97	5.93	5.89	5.87	5.85	5.83	5.43	5.43	5.43
12	0.80	0.77	0.75	0.74	0.73	0.72	0.72	0.71	0.71	0.71	0.71	0.66	0.66	0.66
13	0.70	0.68	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.62	0.58	0.58	0.58
14	0.65	0.64	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.58	0.58	0.54	0.54	0.54
15	0.60	0.59	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.50	0.50	0.50
16	0.55	0.54	0.52	0.52	0.51	0.51	0.50	0.50	0.50	0.50	0.49	0.46	0.46	0.46
17	0.55	0.54	0.53	0.52	0.51	0.51	0.50	0.50	0.50	0.50	0.50	0.46	0.46	0.46
18	0.50	0.49	0.48	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.42	0.42	0.42
19	0.50	0.49	0.48	0.47	0.47	0.46	0.46	0.46	0.46	0.45	0.45	0.42	0.42	0.42
20	0.45	0.45	0.43	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.38	0.38	0.38

C-111 2-YEAR STORM FOR 13 RAINGAGE BASINS

DAY	POINT RAINFALL	AREALLY REDUCED RAINFALL IN INCHES FOR 13 RAINGAGE BASINS AS NUMBERED 7	6	10	4	1	8	3	2	5	9	11	13	12
1	0.35	0.35	0.34	0.33	0.33	0.32	0.32	0.32	0.32	0.32	0.32	0.29	0.29	0.29
2	0.40	0.35	0.34	0.33	0.33	0.32	0.32	0.32	0.32	0.32	0.32	0.29	0.29	0.29
3	0.40	0.40	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.34	0.34	0.34
4	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.34	0.34	0.34
5	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.33	0.33	0.33
6	0.40	0.39	0.38	0.38	0.37	0.37	0.36	0.36	0.36	0.36	0.36	0.33	0.33	0.33
7	0.45	0.44	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.40	0.40	0.38	0.38	0.38
8	0.45	0.44	0.43	0.42	0.42	0.41	0.41	0.41	0.40	0.40	0.40	0.37	0.37	0.37
9	0.70	0.68	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.62	0.62	0.58	0.58	0.58
10	1.15	1.10	1.07	1.06	1.04	1.03	1.03	1.02	1.02	1.01	1.01	0.94	0.94	0.94
11	4.10	3.87	3.76	3.71	3.66	3.63	3.60	3.58	3.57	3.55	3.54	3.30	3.30	3.30
12	0.75	0.73	0.70	0.69	0.69	0.68	0.67	0.67	0.67	0.67	0.66	0.62	0.62	0.62
13	0.50	0.49	0.47	0.47	0.46	0.46	0.45	0.45	0.45	0.45	0.44	0.41	0.41	0.41
14	0.45	0.44	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.40	0.40	0.37	0.37	0.37
15	0.45	0.44	0.43	0.42	0.42	0.41	0.41	0.41	0.41	0.40	0.40	0.38	0.38	0.38
16	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.33	0.33	0.33
17	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.34	0.34	0.34
18	0.40	0.40	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.34	0.34	0.34
19	0.40	0.40	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.34	0.34	0.34
20	0.35	0.35	0.34	0.33	0.33	0.32	0.32	0.32	0.32	0.32	0.32	0.29	0.29	0.29

TABLE A-2

C-111 50-YR STORM FOR 13 RAINGAGE BASINS

	POINT	AREALLY REDUCED RAINFALL IN INCHES FOR 13 RAINGAGE BASINS AS NUMBERED											
DAY	RAINFALL	7	6	10	4	1	8	3	2	5	9	11	13	12
1	0.60	0.59	0.58	0.57	0.56	0.56	0.55	0.55	0.55	0.55	0.54	0.51	0.51	0.51
2	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
3	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
4	0.65	0.64	0.62	0.61	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
5	0.65	0.64	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.58	0.54	0.54	0.54
6	0.65	0.64	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.58	0.54	0.54	0.54
7	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.58	0.58	0.58
8	0.75	0.73	0.71	0.70	0.69	0.69	0.68	0.68	0.67	0.67	0.67	0.62	0.62	0.62
9	0.75	0.73	0.71	0.70	0.69	0.68	0.68	0.67	0.67	0.67	0.67	0.62	0.62	0.62
10	2.45	2.35	2.28	2.25	2.22	2.20	2.19	2.17	2.17	2.16	2.15	2.00	2.00	2.00
11	9.75	9.21	8.94	8.82	8.71	8.63	8.56	8.51	8.48	8.45	8.41	7.84	7.84	7.84
12	0.80	0.77	0.75	0.74	0.73	0.72	0.72	0.71	0.71	0.71	0.71	0.66	0.66	0.66
13	0.75	0.73	0.71	0.70	0.69	0.68	0.68	0.68	0.67	0.67	0.67	0.62	0.62	0.62
14	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.58	0.58	0.58
15	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.58	0.58	0.58
16	0.65	0.64	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.58	0.54	0.54	0.54
17	0.65	0.64	0.62	0.61	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
18	0.65	0.64	0.62	0.61	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
19	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
20	0.60	0.59	0.58	0.57	0.56	0.56	0.55	0.55	0.55	0.54	0.54	0.51	0.51	0.51

C-111 100-YR STORM FOR 13 RAINFALL BASINS

	POINT	AREALLY REDUCED RAINFALL IN INCHES FOR 13 RAINGAGE BASINS AS NUMBERED											
DAY	RAINFALL	7	6	10	4	1	8	3	2	5	9	11	13	12
1	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
2	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
3	0.70	0.69	0.67	0.66	0.65	0.65	0.64	0.64	0.64	0.63	0.63	0.59	0.59	0.59
4	0.70	0.69	0.67	0.66	0.65	0.65	0.64	0.64	0.64	0.63	0.63	0.59	0.59	0.59
5	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.64	0.63	0.63	0.63	0.59	0.59	0.59
6	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.58	0.58	0.58
7	0.75	0.73	0.71	0.70	0.69	0.69	0.68	0.68	0.68	0.67	0.67	0.63	0.63	0.63
8	0.75	0.73	0.71	0.70	0.69	0.69	0.68	0.68	0.67	0.67	0.67	0.62	0.62	0.62
9	0.80	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71	0.66	0.66	0.66
10	2.70	2.59	2.52	2.48	2.45	2.43	2.41	2.39	2.39	2.38	2.37	2.21	2.21	2.21
11	11.00	10.40	10.09	9.96	9.82	9.74	9.66	9.60	9.57	9.54	9.49	8.84	8.84	8.84
12	0.80	0.77	0.75	0.74	0.73	0.72	0.72	0.71	0.71	0.71	0.71	0.66	0.66	0.66
13	0.75	0.73	0.71	0.70	0.69	0.68	0.68	0.68	0.67	0.67	0.67	0.62	0.62	0.62
14	0.75	0.73	0.71	0.70	0.69	0.69	0.68	0.68	0.68	0.67	0.67	0.62	0.62	0.62
15	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.63	0.63	0.63	0.63	0.58	0.58	0.58
16	0.70	0.69	0.67	0.66	0.65	0.64	0.64	0.64	0.63	0.63	0.63	0.59	0.59	0.59
17	0.70	0.69	0.67	0.66	0.65	0.65	0.64	0.64	0.64	0.63	0.63	0.59	0.59	0.59
18	0.70	0.69	0.67	0.66	0.65	0.65	0.64	0.64	0.64	0.63	0.63	0.59	0.59	0.59
19	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55
20	0.65	0.64	0.62	0.62	0.61	0.60	0.60	0.59	0.59	0.59	0.59	0.55	0.55	0.55

TABLE A-3

STORM CATEGORIES
HOMESTEAD EXPERIMENT STATION

Number of Days with Rainfall Greater or Equal to Values Shown During Period of Record (1914 - 1977)

MONTH	3"	4"	5"	6"	7"	8"
JAN	-	-	-	-	-	-
FEB	-	-	-	-	-	-
MAR	3	2	-	-	-	-
APR	6	3	2	1	-	-
MAY	15	8	4	2	1	-
JUN	21	13	7	4	-	-
JUL	7	1	-	-	-	-
AUG	4	2	-	-	-	-
SEP	25	10	3	2	2	-
OCT	22	10	8	1	1	1
NOV	2	1	1	-	-	-
DEC	-	-	-	-	-	-

Number of 5-Day Total Rainfall Depths Greater Than or Equal to Values Shown (1914 - 1977)

MONTH	5"	6"	7"	8"	9"	10"	11"
JAN	-	-	-	-	-	-	-
FEB	-	-	-	-	-	-	-
MAR	2	-	-	-	-	-	-
APR	5	3	2	1	-	-	-
MAY	24	15	13	8	7	7	4
JUN	27	14	8	7	5	3	1
JUL	11	1	1	1	1	-	-
AUG	7	2	1	-	-	-	-
SEP	22	15	11	6	4	2	1
OCT	22	14	5	3	3	2	1
NOV	2	1	-	-	-	-	-
DEC	-	-	-	-	-	-	-

STRUCTURES MANAGED IN ROUTE SUBROUTINE

STRUCTURE	S-176							
PARAMETER	AUTHORIZED PROJECT	BASE CONDITION	ALTERNATIVE #1	ALTERNATIVE #2	ALTERNATIVE #3	ALTERNATIVE #4	ALTERNATIVE #5	ALTERNATIVE #6
Discharge	630 cfs	630 cfs	630 cfs	630 cfs	<100 cfs	Rating	Rating	Rating
Headwater	6.0 ft	6.6 ft	6.0 ft	6.0 ft	6.0 ft	Curve	Curve	Curve
Tailwater	5.5 ft	6.1 ft	5.5 ft	5.5 ft	5.9 ft			
Optimum	5.7 ft	5.7 ft	5.7 ft	5.7 ft	5.7 ft			
STRUCTURE	S-174							
Discharge	500 cfs	500 cfs	1500 cfs	500 cfs	500 cfs	500 cfs	500 cfs	500 cfs
Headwater	6.0 ft	6.0 ft	6.0 ft	6.0 ft	6.0 ft	6.0 ft	6.0 ft	6.0 ft
Tailwater	5.5 ft	5.5 ft	5.5 ft	5.5 ft	5.5 ft	5.5 ft	5.5 ft	5.5 ft
Optimum	5.3 ft	5.3 ft	5.3 ft	5.3 ft	5.3 ft	5.3 ft	5.3 ft	5.3 ft
STRUCTURE	S-175							
Discharge	500 cfs	500 cfs	500 cfs	500 cfs	---	500 cfs	---	500 cfs
Headwater	5.0 ft	5.0 ft	5.0 ft	3.5 ft	---	5.0 ft	---	5.0 ft
Tailwater	4.5 ft	4.5 ft	4.5 ft	3.0 ft	---	4.5 ft	---	4.5 ft
Optimum	4.5 ft	4.5 ft	4.5 ft	4.5 ft	---	4.5 ft	---	4.5 ft
PUMP STA.	S-332							
Discharge	165 cfs	165 cfs	1000 cfs	---	---	165 cfs	---	165 cfs
Headwater	4.5 ft	4.5 ft	4.5 ft	---	---	4.5 ft	---	4.5 ft
Tailwater	4.5–5.5	4.5 ft	5.5 ft	---	---	5.5 ft	---	5.5 ft
Optimum	---	---	---	---	---	---	---	---

TABLE A-5

STRUCTURES MANAGED IN ROUTE SUBROUTINE

PUMP STA.	S-332A	At S-174						
PARAMETER	AUTHORIZED PROJECT	BASE CONDITION	ALTERNATIVE #1	ALTERNATIVE #2	ALTERNATIVE #3	ALTERNATIVE #4	ALTERNATIVE #5	ALTERNATIVE #6
Discharge	---	---	---	1000 cfs	1630 cfs	---	1000 cfs	---
Headwater	---	---	---	4.5 ft	5.5 FT	---	5.5 ft	---
Tailwater	---	---	---	5.5 ft	8.0 ft	---	8.0 ft	---
Optimum	---	---	---	---	---	---	---	---
PUMP STA.	S-332B	At Context Road						
Discharge	---	---	50 cfs	50 cfs	---	---	---	---
Headwater	---	---	---	---	---	---	---	---
Tailwater	---	---	8.5 ft	8.5 ft	---	---	---	---
Optimum	---	---	---	---	---	---	---	---
PUMP STA.	S-332B, C, E	At the Spreader Canal						
			C	C	B	E	B	E
Discharge	---	---	50 cfs	50 cfs	500 cfs	500 cfs	500 cfs	500 cfs
Headwater	---	---	3.0 ft	3.0 ft	3.0 ft	3.0 ft	3.0 ft	3.0 ft
Tailwater	---	---	4.0 ft	4.0 ft	4.0 ft	4.0 ft	4.0 ft	4.0 ft
Optimum	---	---	---	---	---	---	---	---
PUMP STA.	S-332A	At Rocky Glades						
Discharge	---	---	---	---	---	300 cfs	---	300 cfs
Headwater	---	---	---	---	---	5.5 ft	---	5.5 ft
Tailwater	---	---	---	---	---	8.0 ft	---	8.0 ft
Optimum	---	---	---	---	---	---	---	---

TABLE A-5
(Continued)

STRUCTURES MANAGED IN ROUTE SUBROUTINE

PARAMETER	AUTHORIZED PROJECT	BASE CONDITION	ALTERNATIVE #1	ALTERNATIVE #2	ALTERNATIVE #3	ALTERNATIVE #4	ALTERNATIVE #5	ALTERNATIVE #6
PUMP STA. S-332B At the west end of the northern connector canal from L-31N to NEW L-31W								
Discharge	---	---	---	---	---	300 cfs	---	300 cfs
Headwater	---	---	---	---	---	5.5 ft	---	5.5 ft
Tailwater	---	---	---	---	---	8.0 ft	---	8.0 ft
Optimum	---	---	---	---	---	---	---	---
PUMP STA. S-332C At the west end of the connector canal from L-31N to NEW L-31W, near C-103								
Discharge	---	---	---	---	---	300 cfs	---	300 cfs
Headwater	---	---	---	---	---	5.5 ft	---	5.5 ft
Tailwater	---	---	---	---	---	8.0 ft	---	8.0 ft
Optimum	---	---	---	---	---	---	---	---
PUMP STA. S-332D At the west end of the connector canal from S-174 to New L-31W								
Discharge	---	---	---	---	---	300 cfs	---	300 cfs
Headwater	---	---	---	---	---	5.5 ft	---	5.5 ft
Tailwater	---	---	---	---	---	8.0 ft	---	8.0 ft
Optimum	---	---	---	---	---	---	---	---
STRUCTURE S-175A At the north end of L-31W Extension								
Discharge	---	---	---	500 cfs	---	---	---	---
Headwater	---	---	---	4.5 ft	---	---	---	---
Tailwater	---	---	---	4.0 ft	---	---	---	---
Optimum	---	---	---	5.0 ft	---	---	---	---

TABLE A-5
(Continued)

C-111 ALTERNATIVES PERCENT CHANCE EXCEEDANCE 1965-1989 SIMULATIONS ELEVATIONS IN FEET NGVD									
NODE	PLAN	10%	50%	90%	NODE	PLAN	10%	50%	90%
2 44	BASE	2.09	1.71	0.28	7 51	BASE	2.55	1.90	0.47
GRND	ALT 1	2.11	1.73	0.28	GRND	ALT 1	2.61	1.88	0.40
ELEV	ALT 2	2.13	1.74	0.25	ELEV	ALT 2	2.68	1.88	0.44
1.13	ALT 3	2.09	1.73	0.25	1.85	ALT 3	2.47	1.84	0.19
	ALT 4	2.11	1.73	0.26		ALT 4	2.48	1.83	0.19
	ALT 5	2.09	1.71	0.24		ALT 5	2.49	1.79	0.47
	ALT 6	2.10	1.73	0.27		ALT 6	2.61	1.86	0.52
4 43	BASE	2.43	1.86	0.38	7 55	BASE	2.39	1.72	0.23
GRND	ALT 1	2.45	1.88	0.38	GRND	ALT 1	2.29	1.47	0.08
ELEV	ALT 2	2.47	1.87	0.37	ELEV	ALT 2	2.29	1.48	0.13
1.52	ALT 3	2.43	1.86	0.36	0.83	ALT 3	2.12	1.45	-0.22
	ALT 4	2.45	1.87	0.39		ALT 4	1.95	1.37	-0.30
	ALT 5	2.42	1.84	0.36		ALT 5	1.95	1.33	0.12
	ALT 6	2.45	1.87	0.39		ALT 6	2.27	1.46	0.17
4 53	BASE	1.42	0.93	-0.43	8 44	BASE	2.96	2.27	1.03
GRND	ALT 1	1.42	0.92	-0.55	GRND	ALT 1	3.02	2.28	1.05
ELEV	ALT 2	1.44	0.95	-0.52	ELEV	ALT 2	3.09	2.26	1.02
0.20	ALT 3	1.49	0.93	-0.67	1.40	ALT 3	2.96	2.25	1.02
	ALT 4	1.45	0.91	-0.72		ALT 4	3.01	2.27	1.05
	ALT 5	1.45	0.92	-0.54		ALT 5	2.96	2.23	1.02
	ALT 6	1.41	0.90	-0.50		ALT 6	3.02	2.26	1.05
4 55	BASE	1.30	0.84	-0.35	8 47	BASE	3.08	2.42	0.89
GRND	ALT 1	1.36	0.86	-0.51	GRND	ALT 1	3.13	2.44	0.89
ELEV	ALT 2	1.37	0.88	-0.44	ELEV	ALT 2	3.25	2.39	0.84
0.05	ALT 3	1.37	0.83	-0.74	1.44	ALT 3	3.06	2.37	0.79
	ALT 4	1.34	0.75	-0.84		ALT 4	3.13	2.40	0.83
	ALT 5	1.39	0.89	-0.45		ALT 5	3.07	2.36	0.80
	ALT 6	1.35	0.85	-0.41		ALT 6	3.13	2.40	0.85
5 47	BASE	2.20	1.72	0.25	8 53	BASE	2.48	1.82	0.69
GRND	ALT 1	2.24	1.73	0.26	GRND	ALT 1	2.39	1.68	0.58
ELEV	ALT 2	2.30	1.72	0.23	ELEV	ALT 2	2.39	1.69	0.62
1.32	ALT 3	2.20	1.70	0.23	1.63	ALT 3	2.38	1.69	0.22
	ALT 4	2.23	1.71	0.26		ALT 4	2.20	1.66	0.18
	ALT 5	2.18	1.69	0.21		ALT 5	2.11	1.65	0.70
	ALT 6	2.22	1.71	0.27		ALT 6	2.37	1.67	0.69
5 50	BASE	1.78	1.24	-0.16	8 58	BASE	1.94	1.35	-0.03
GRND	ALT 1	1.79	1.25	-0.17	GRND	ALT 1	2.00	1.35	-0.08
ELEV	ALT 2	1.84	1.25	-0.19	ELEV	ALT 2	2.01	1.35	-0.06
1.05	ALT 3	1.85	1.22	-0.24	1.10	ALT 3	2.01	1.38	-0.15
	ALT 4	1.82	1.24	-0.23		ALT 4	1.95	1.34	-0.22
	ALT 5	1.78	1.23	-0.20		ALT 5	1.92	1.31	-0.12
	ALT 6	1.78	1.24	-0.17		ALT 6	2.00	1.34	-0.09
5 58	BASE	1.81	1.12	-0.09	8 61	BASE	1.50	1.06	-0.14
GRND	ALT 1	1.91	1.17	-0.14	GRND	ALT 1	1.51	1.08	-0.14
ELEV	ALT 2	1.92	1.18	-0.10	ELEV	ALT 2	1.52	1.08	-0.13
0.90	ALT 3	1.92	1.12	-0.42	1.00	ALT 3	1.52	1.09	-0.14
	ALT 4	1.84	1.04	-0.46		ALT 4	1.51	1.07	-0.18
	ALT 5	1.81	1.07	-0.18		ALT 5	1.51	1.06	-0.17
	ALT 6	1.90	1.15	-0.05		ALT 6	1.51	1.08	-0.15

TABLE A-6

C-111 ALTERNATIVES PERCENT CHANCE EXCEEDANCE 1965-1989 SIMULATIONS ELEVATIONS IN FEET NGVD									
NODE	PLAN	10%	50%	90%	NODE	PLAN	10%	50%	90%
10 50	BASE	3.23	2.44	1.44	12 51	BASE	3.35	2.53	1.74
GRND	ALT 1	3.23	2.44	1.42	GRND	ALT 1	3.37	2.53	1.71
ELEV	ALT 2	3.47	2.42	1.41	ELEV	ALT 2	3.45	2.57	1.71
3.45	ALT 3	3.45	2.43	1.30	5.30	ALT 3	3.53	2.77	1.78
	ALT 4	3.21	2.43	1.40		ALT 4	3.39	2.63	1.77
	ALT 5	3.45	2.38	1.35		ALT 5	3.43	2.64	1.75
	ALT 6	3.22	2.42	1.44		ALT 6	3.34	2.53	1.74
10 55	BASE	2.46	1.81	0.52	13 47	BASE	4.40	4.14	2.42
GRND	ALT 1	2.47	1.82	0.55	GRND	ALT 1	4.83	4.19	2.44
ELEV	ALT 2	2.46	1.85	0.58	ELEV	ALT 2	4.48	3.63	2.17
1.65	ALT 3	2.78	2.10	0.51	3.95	ALT 3	4.69	3.92	2.25
	ALT 4	2.55	2.02	0.51		ALT 4	4.54	3.82	2.11
	ALT 5	2.44	1.81	0.60		ALT 5	4.46	3.81	2.11
	ALT 6	2.45	1.82	0.61		ALT 6	4.55	3.77	2.11
11 44	BASE	4.52	3.45	1.89	13 52	BASE	3.79	2.68	1.59
GRND	ALT 1	4.55	3.48	1.90	GRND	ALT 1	3.80	2.69	1.58
ELEV	ALT 2	4.54	3.44	1.86	ELEV	ALT 2	3.85	2.70	1.60
4.40	ALT 3	4.54	3.48	1.90	6.00	ALT 3	4.05	2.94	1.69
	ALT 4	4.54	3.47	1.91		ALT 4	3.81	2.77	1.69
	ALT 5	4.53	3.47	1.89		ALT 5	3.90	2.79	1.63
	ALT 6	4.54	3.47	1.90		ALT 6	3.74	2.69	1.62
11 47	BASE	3.61	2.70	1.75	13 55	BASE	3.84	2.22	0.82
GRND	ALT 1	3.72	2.72	1.76	GRND	ALT 1	3.86	2.20	0.84
ELEV	ALT 2	3.93	2.67	1.64	ELEV	ALT 2	3.88	2.22	0.86
1.95	ALT 3	3.63	2.64	1.65	3.80	ALT 3	4.05	2.43	0.88
	ALT 4	3.73	2.69	1.67		ALT 4	3.95	2.34	0.86
	ALT 5	3.65	2.61	1.58		ALT 5	3.90	2.22	0.88
	ALT 6	3.72	2.68	1.66		ALT 6	3.85	2.21	0.87
11 53	BASE	2.53	2.08	1.07	14 44	BASE	5.78	4.37	2.62
GRND	ALT 1	2.58	2.07	1.02	GRND	ALT 1	5.86	4.42	2.63
ELEV	ALT 2	2.59	2.09	1.06	ELEV	ALT 2	5.82	4.44	2.59
2.19	ALT 3	2.99	2.27	1.06	6.40	ALT 3	5.92	4.61	2.65
	ALT 4	2.74	2.23	1.06		ALT 4	5.89	4.54	2.61
	ALT 5	2.63	2.10	1.06		ALT 5	5.93	4.67	2.62
	ALT 6	2.57	2.07	1.07		ALT 6	5.89	4.53	2.60
11 58	BASE	2.51	1.62	0.11	14 58	BASE	2.85	1.61	0.37
GRND	ALT 1	2.49	1.62	0.15	GRND	ALT 1	2.85	1.60	0.37
ELEV	ALT 2	2.53	1.64	0.17	ELEV	ALT 2	2.86	1.62	0.38
2.20	ALT 3	2.65	1.83	0.19	2.80	ALT 3	2.90	1.71	0.42
	ALT 4	2.55	1.72	0.15		ALT 4	2.88	1.65	0.39
	ALT 5	2.52	1.63	0.16		ALT 5	2.87	1.61	0.38
	ALT 6	2.49	1.61	0.17		ALT 6	2.85	1.60	0.38
11 61	BASE	2.15	1.29	-0.27	14 61	BASE	2.22	1.14	0.00
GRND	ALT 1	2.16	1.29	-0.26	GRND	ALT 1	2.21	1.13	0.00
ELEV	ALT 2	2.19	1.30	-0.26	ELEV	ALT 2	2.21	1.14	0.00
1.50	ALT 3	2.25	1.32	-0.23	2.00	ALT 3	2.24	1.20	0.03
	ALT 4	2.21	1.29	-0.27		ALT 4	2.22	1.17	0.01
	ALT 5	2.19	1.27	-0.27		ALT 5	2.22	1.14	0.00
	ALT 6	2.16	1.29	-0.26		ALT 6	2.21	1.13	0.01

TABLE A-6
(Continued)

C-111 ALTERNATIVES PERCENT CHANCE EXCEEDANCE 1965-1989 SIMULATIONS ELEVATIONS IN FEET NGVD									
NODE	PLAN	10%	50%	90%	NODE	PLAN	10%	50%	90%
15 47	BASE	5.32	3.88	2.77	18 55	BASE	3.67	2.41	1.29
GRND	ALT 1	5.40	3.90	2.80	GRND	ALT 1	3.65	2.41	1.28
ELEV	ALT 2	5.44	4.30	2.67	ELEV	ALT 2	3.62	2.43	1.31
5.17	ALT 3	6.08	4.66	2.82	9.00	ALT 3	3.65	2.51	1.40
	ALT 4	5.78	4.40	2.55		ALT 4	3.61	2.47	1.40
	ALT 5	5.81	4.71	2.56		ALT 5	3.64	2.48	1.35
	ALT 6	5.77	4.39	2.54		ALT 6	3.60	2.44	1.33
15 49	BASE	5.08	3.75	2.38	19 47	BASE	6.16	4.85	3.21
GRND	ALT 1	5.10	3.77	2.38	GRND	ALT 1	6.24	4.90	3.21
ELEV	ALT 2	5.17	3.84	2.43	ELEV	ALT 2	6.19	5.00	3.28
5.50	ALT 3	6.65	4.25	2.43	5.71	ALT 3	6.32	5.14	3.31
	ALT 4	4.70	3.69	2.45		ALT 4	6.55	5.29	3.32
	ALT 5	5.52	4.12	2.34		ALT 5	6.60	5.42	3.26
	ALT 6	4.68	3.67	2.40		ALT 6	6.55	5.27	3.31
15 53	BASE	4.22	2.82	1.53	19 49	BASE	5.79	4.49	3.16
GRND	ALT 1	4.25	2.83	1.53	GRND	ALT 1	6.12	4.49	3.16
ELEV	ALT 2	4.26	2.87	1.55	ELEV	ALT 2	5.90	4.68	3.22
1.30	ALT 3	4.48	3.07	1.63	5.72	ALT 3	5.74	4.80	3.22
	ALT 4	4.22	2.89	1.62		ALT 4	5.56	4.86	3.29
	ALT 5	4.30	2.98	1.59		ALT 5	6.22	4.89	3.19
	ALT 6	4.18	2.83	1.59		ALT 6	5.55	4.83	3.27
16 51	BASE	4.80	3.49	2.16	19 50	BASE	5.69	4.57	3.26
GRND	ALT 1	4.82	3.51	2.15	GRND	ALT 1	5.68	4.57	3.26
ELEV	ALT 2	4.83	3.54	2.18	ELEV	ALT 2	5.35	4.61	3.27
7.20	ALT 3	5.18	3.83	2.23	6.75	ALT 3	5.42	4.76	3.29
	ALT 4	4.71	3.54	2.21		ALT 4	5.31	4.74	3.31
	ALT 5	4.95	3.73	2.19		ALT 5	5.48	4.81	3.27
	ALT 6	4.69	3.50	2.18		ALT 6	5.31	4.73	3.29
17 44	BASE	6.00	4.91	3.04	20 44	BASE	6.37	5.30	3.46
GRND	ALT 1	6.03	4.94	3.04	GRND	ALT 1	6.38	5.34	3.46
ELEV	ALT 2	6.06	5.02	3.04	ELEV	ALT 2	6.40	5.35	3.45
6.45	ALT 3	6.20	5.18	3.08	6.58	ALT 3	6.46	5.44	3.48
	ALT 4	6.25	5.21	3.08		ALT 4	6.60	5.59	3.49
	ALT 5	6.32	5.37	3.10		ALT 5	6.56	5.56	3.49
	ALT 6	6.25	5.20	3.07		ALT 6	6.60	5.57	3.49
17 47	BASE	5.76	4.31	2.94	20 54	BASE	4.30	3.05	1.85
GRND	ALT 1	5.79	4.34	2.95	GRND	ALT 1	4.27	3.06	1.83
ELEV	ALT 2	5.92	4.71	3.00	ELEV	ALT 2	4.19	3.03	1.86
5.65	ALT 3	6.28	4.95	3.02	10.00	ALT 3	4.21	3.07	2.13
	ALT 4	6.29	4.90	2.94		ALT 4	4.19	3.05	2.13
	ALT 5	6.65	5.28	2.95		ALT 5	4.20	3.07	1.90
	ALT 6	6.28	4.85	2.93		ALT 6	4.19	3.04	1.88
18 48	BASE	5.80	4.38	3.02	21 47	BASE	6.55	5.13	3.50
GRND	ALT 1	5.92	4.37	3.02	GRND	ALT 1	6.58	5.17	3.50
ELEV	ALT 2	6.00	4.69	3.09	ELEV	ALT 2	6.51	5.19	3.54
5.43	ALT 3	6.29	4.86	3.06	6.58	ALT 3	6.56	5.29	3.58
	ALT 4	6.40	4.86	3.12		ALT 4	6.96	5.48	3.60
	ALT 5	6.67	5.13	3.02		ALT 5	6.64	5.41	3.56
	ALT 6	6.40	4.85	3.10		ALT 6	6.96	5.46	3.57

TABLE A-6
(Continued)

C-111 ALTERNATIVES PERCENT CHANCE EXCEEDANCE 1965–1989 SIMULATIONS ELEVATIONS IN FEET NGVD									
NODE	PLAN	10%	50%	90%	NODE	PLAN	10%	50%	90%
21 49	BASE	5.90	4.67	3.33	18 52	BASE	4.78	3.62	2.13
GRND	ALT 1	5.87	4.67	3.32	GRND	ALT 1	4.77	3.62	2.12
ELEV	ALT 2	5.48	4.75	3.34	ELEV	ALT 2	4.72	3.68	2.15
6.29	ALT 3	5.51	4.86	3.37	8.75	ALT 3	4.80	3.86	2.21
	ALT 4	5.49	4.90	3.43		ALT 4	4.71	3.69	2.22
	ALT 5	5.60	4.90	3.35		ALT 5	4.77	3.82	2.16
	ALT 6	5.51	4.90	3.42		ALT 6	4.69	3.65	2.16
22 51	BASE	5.95	4.50	2.97	24 53	BASE	6.05	4.42	2.78
GRND	ALT 1	5.90	4.49	2.97	GRND	ALT 1	6.01	4.42	2.77
ELEV	ALT 2	5.58	4.51	2.98	ELEV	ALT 2	5.80	4.38	2.78
8.75	ALT 3	5.58	4.57	3.02	8.50	ALT 3	5.81	4.44	2.82
	ALT 4	5.64	4.61	3.02		ALT 4	5.87	4.48	2.82
	ALT 5	5.60	4.61	2.99		ALT 5	5.83	4.49	2.79
	ALT 6	5.60	4.58	2.99		ALT 6	5.83	4.47	2.79
23 49	BASE	6.05	4.78	3.43	22 56	BASE	5.78	3.30	1.61
GRND	ALT 1	6.01	4.78	3.42	GRND	ALT 1	5.78	3.27	1.61
ELEV	ALT 2	5.64	4.85	3.43	ELEV	ALT 2	5.72	3.26	1.62
6.30	ALT 3	5.64	4.96	3.47	8.00	ALT 3	5.71	3.31	1.76
	ALT 4	5.61	4.98	3.48		ALT 4	5.72	3.31	1.75
	ALT 5	5.70	5.01	3.45		ALT 5	5.73	3.28	1.68
	ALT 6	5.60	4.98	3.47		ALT 6	5.72	3.27	1.65
24 47	BASE	6.69	5.57	3.73	6 41	BASE	2.71	2.19	0.60
GRND	ALT 1	6.69	5.57	3.73	GRND	ALT 1	2.73	2.21	0.61
ELEV	ALT 2	6.65	5.56	3.74	ELEV	ALT 2	2.75	2.20	0.61
6.16	ALT 3	6.67	5.62	3.78	1.88	ALT 3	2.71	2.20	0.61
	ALT 4	7.10	5.98	3.79		ALT 4	2.73	2.20	0.63
	ALT 5	6.68	5.64	3.76		ALT 5	2.69	2.19	0.60
	ALT 6	7.10	5.97	3.76		ALT 6	2.73	2.20	0.62
26 50	BASE	6.87	5.37	3.77	13 41	BASE	5.55	4.12	2.25
GRND	ALT 1	6.86	5.37	3.76	GRND	ALT 1	5.56	4.15	2.25
ELEV	ALT 2	6.58	5.35	3.77	ELEV	ALT 2	5.56	4.15	2.26
6.85	ALT 3	6.56	5.40	3.79	5.50	ALT 3	5.57	4.19	2.31
	ALT 4	7.00	5.75	3.82		ALT 4	5.57	4.18	2.31
	ALT 5	6.59	5.42	3.79		ALT 5	5.57	4.22	2.32
	ALT 6	7.00	5.73	3.81		ALT 6	5.57	4.18	2.30
29 52	BASE	6.20	5.37	4.10					
GRND	ALT 1	6.21	5.37	4.09					
ELEV	ALT 2	6.20	5.34	4.10					
6.78	ALT 3	6.20	5.35	4.13					
	ALT 4	6.03	5.22	4.13					
	ALT 5	6.20	5.35	4.10					
	ALT 6	6.02	5.22	4.11					
32 51	BASE	7.20	6.63	5.03					
GRND	ALT 1	7.21	6.63	5.03					
ELEV	ALT 2	7.21	6.63	5.04					
5.92	ALT 3	7.21	6.63	5.10					
	ALT 4	7.25	6.64	5.11					
	ALT 5	7.21	6.63	5.06					
	ALT 6	7.25	6.64	5.05					

TABLE A-6
(Continued)

C-111 ALTERNATIVES
FLOOD EVENT PEAK STAGES vs. EXCEEDANCE FREQUENCY
ELEVATIONS IN FEET NGVD

NODE	PLAN	50%	10%	2%	SPF	NODE	PLAN	50%	10%	2%	SPF
14 51	BASE	5.59	6.00	6.53	6.95	15 49	BASE	5.68	6.17	6.51	7.20
GRND	ALT 1	5.60	5.97	6.48	6.93	GRND	ALT 1	5.88	6.31	6.63	7.24
ELEV	ALT 2	5.61	5.99	6.40	6.94	ELEV	ALT 2	6.01	6.42	6.77	7.39
5.50	ALT 3	5.68	6.12	6.65	7.32	5.50	ALT 3	8.07	9.07	9.82	10.68
	ALT 4	5.56	6.07	6.69	7.12		ALT 4	5.26	5.53	5.86	6.72
	ALT 5	5.62	5.99	6.41	6.95		ALT 5	5.98	6.34	6.71	7.35
	ALT 6	5.55	5.94	6.45	6.85		ALT 6	5.24	5.52	5.69	6.48
16 51	BASE	5.90	6.64	7.22	7.63	12 53	BASE	3.85	3.95	4.09	4.63
GRND	ALT 1	5.93	6.64	7.23	7.62	GRND	ALT 1	3.86	3.94	4.23	4.82
ELEV	ALT 2	5.93	6.64	7.23	7.62	ELEV	ALT 2	3.86	3.94	4.24	4.82
7.20	ALT 3	6.24	7.08	7.32	7.82	3.80	ALT 3	4.25	4.80	5.26	5.97
	ALT 4	5.83	6.59	7.23	7.64		ALT 4	3.89	4.58	5.05	5.79
	ALT 5	6.00	6.72	7.26	7.65		ALT 5	3.89	4.34	4.77	5.39
	ALT 6	5.81	6.53	7.20	7.55		ALT 6	3.86	3.95	4.21	4.80
19 51	BASE	6.20	6.49	7.09	7.93	17 53	BASE	5.94	7.06	7.77	8.33
GRND	ALT 1	6.16	6.39	6.87	7.84	GRND	ALT 1	5.95	7.07	7.77	8.32
ELEV	ALT 2	6.03	6.[illegible]	6.76	7.82	ELEV	ALT 2	5.94	7.05	7.77	8.32
7.80	ALT 3	5.97	6.[illegible]	6.86	7.74	7.50	ALT 3	6.05	7.30	7.82	8.38
	ALT 4	6.05	6.36	6.85	7.86		ALT 4	5.89	7.01	7.76	8.32
	ALT 5	6.06	6.40	6.83	7.87		ALT 5	5.97	7.11	7.78	8.34
	ALT 6	6.03	6.32	6.73	7.82		ALT 6	5.87	6.97	7.75	8.29
21 51	BASE	6.72	7.20	7.58	8.27	19 53	BASE	5.36	5.82	6.26	6.98
GRND	ALT 1	6.68	7.12	7.49	7.98	GRND	ALT 1	5.33	5.77	6.16	6.88
ELEV	ALT 2	6.45	6.97	7.46	7.93	ELEV	ALT 2	5.22	5.69	6.11	6.81
7.50	ALT 3	6.38	6.89	7.39	7.88	10.00	ALT 3	5.24	5.76	6.30	7.08
	ALT 4	6.47	6.97	7.51	8.02		ALT 4	5.23	5.72	6.26	7.06
	ALT 5	6.47	6.98	7.50	8.08		ALT 5	5.26	5.72	6.14	6.86
	ALT 6	6.47	6.97	7.45	7.98		ALT 6	5.22	5.68	6.09	6.77
23 51	BASE	7.73	8.04	8.38	8.90	22 53	BASE	7.41	8.76	9.10	9.56
GRND	ALT 1	7.70	8.03	8.33	8.74	GRND	ALT 1	7.38	8.73	9.08	9.52
ELEV	ALT 2	7.63	7.98	8.28	8.74	ELEV	ALT 2	7.15	8.60	9.02	9.49
7.50	ALT 3	7.61	7.97	8.28	8.70	8.75	ALT 3	7.14	8.60	9.02	9.48
	ALT 4	7.64	7.99	8.30	8.78		ALT 4	7.16	8.61	9.02	9.49
	ALT 5	7.62	7.98	8.30	8.81		ALT 5	7.14	8.59	9.01	9.49
	ALT 6	7.64	7.99	8.30	8.75		ALT 6	7.15	8.60	9.02	9.49

TABLE A-7

TABLE A-8
Optimum Stages in ENP-South Dade Conveyance System

Canal	Reach	Elevation
Levee 29 Borrow Canal	S-333 to S-334	5.0
Levee 30 Borrow Canal	S-32A to S-335	6.0
Levee 30 Borrow Canal	S-335 to U.S. 41	5.0
Levee 31(N) Borrow Canal	U.S. 41 to S-331	5.0
Levee 31(N) Rem. Borrow Canal	S-331 to S-176	5.5
Canal 111	S-176 to S-177	4.5
Canal 111	S-177 to S-18C	2.0
Levee 31(W) Borrow Canal	S-174 to S-175	4.5
Canal 103	L-31(N) Rem. to S-167	5.5
Canal 103	S-167 to S-179	3.5
Canal 103	S-179 to S-20F	2.0
Canal 102	L-31(N) Rem to S-165	5.5
Canal 102	S-165 to S-21A	2.0
Canal 1	L-31(N) to S-148	5.0
Canal 1	S-148 to S-21	2.0

TABLE A-9
Minimum Monthly Delivery Schedule to Taylor Slough at S-332

	Percent of Annual Flow	Monthly Flow Acre-Feet	Average Daily Flow Cubic Feet per Second
Jan	2.0	740	12.0
Feb	1.0	370	6.7
Mar	0.5	185	3.0
Apr	0.5	185	3.1
May	1.0	370	6.0
Jun	18.0	6,600	112.0
Jul	20.0	7,400	120.0
Aug	8.0	2,960	48.0
Sep	16.0	5,920	100.0
Oct	21.0	7,770	126.0
Nov	10.0	3,700	62.0
Dec	2.0	740	12.0
Total	100.0	37,000	

Note: All elevations are in feet, NGVD

TABLE A-10
Minimum Monthly Delivery Schedule to Eastern Panhandle
As delivered at S-18C

Month	Acre-Feet
Jan	1,540
Feb	630
Mar	290
Apr	110
May	110
Jun	340
Jul	510
Aug	860
Sep	2,690
Oct	4,630
Nov	4,060
Dec	2,230

TABLE A-11
Hydraulic Design Data
Pump Station S-332A

Total Discharge	300 cfs
Number of pumps	4
Pump No. 1 discharge	75 cfs
Pump No. 2 discharge	75 cfs
Pump No. 3 discharge	75 cfs
Pump No. 4 discharge	75 cfs
Intake Water Surface Elevation	
Maximum Pumping	8.8 ft
Maximum Non-Pumping	5.7 ft
Start Pumping	5.7 ft
Normal Drawdown Pumping	5.7 ft
Minimum Non-Pumping	2.0 ft
Discharge Water Surface Elevation	
Maximum Pumping	10.3 ft
Normal Pumping	8.0 ft
Minimum Pumping	6.0 ft
Minimum Non-Pumping	5.0 ft

Note: All elevations are in feet, NGVD

TABLE A-12
Hydraulic Design Data
Pump Station S-332B

Total Discharge	300 cfs
Number of pumps	4
Pump No. 1 discharge	75 cfs
Pump No. 2 discharge	75 cfs
Pump No. 3 discharge	75 cfs
Pump No. 4 discharge	75 cfs
Intake Water Surface Elevation	
Maximum Pumping	6.5 ft
Maximum Non-Pumping	6.5 ft
Start Pumping	3.0 to 6.5 ft
Normal Drawdown Pumping	4.0 ft
Minimum Non-Pumping	3.0 ft
Discharge Water Surface Elevation	
Maximum Pumping	10.3 ft
Normal Pumping	8.0 ft
Minimum Pumping	6.0 ft
Minimum Non-Pumping	5.0 ft

TABLE A-13
Hydraulic Design Data
Pump Station S-332C

Total Discharge	300 cfs
Number of pumps	4
Pump No. 1 discharge	75 cfs
Pump No. 2 discharge	75 cfs
Pump No. 3 discharge	75 cfs
Pump No. 4 discharge	75 cfs
Intake Water Surface Elevation	
Maximum Pumping	6.5 ft
Maximum Non-Pumping	6.5 ft
Start Pumping	3.0 to 6.5 ft
Normal Drawdown Pumping	4.0 ft
Minimum Non-Pumping	3.0 ft
Discharge Water Surface Elevation	
Maximum Pumping	9.8 ft
Normal Pumping	8.0 ft
Minimum Pumping	6.0 ft
Minimum Non-Pumping	4.5 ft

Note: All elevations are in feet, NGVD

TABLE A-14
Hydraulic Design Data
Pump Station S-332D

Total Discharge	300 cfs
Number of pumps	4
Pump No. 1 discharge	75 cfs
Pump No. 2 discharge	75 cfs
Pump No. 3 discharge	75 cfs
Pump No. 4 discharge	75 cfs
Intake Water Surface Elevation	
Maximum Pumping	6.5 ft
Maximum Non-Pumping	6.5 ft
Start Pumping	3.0 to 6.5 ft
Normal Drawdown Pumping	4.0 ft
Minimum Non-Pumping	3.0 ft
Discharge Water Surface Elevation	
Maximum Pumping	9.3 ft
Normal Pumping	8.0 ft
Minimum Pumping	6.0 ft
Minimum Non-Pumping	4.5 ft

TABLE A-15
Hydraulic Design Data
Pump Station S-332E

Total Discharge	50 cfs
Number of pumps	1
Intake Water Surface Elevation	
Maximum Pumping	5.0 ft
Maximum Non-Pumping	5.0 ft
Start Pumping	2.5 to 3.5 ft
Normal Drawdown Pumping	3.5 ft
Minimum Non-Pumping	2.0 ft
Discharge Water Surface Elevation	
Maximum Pumping	5.0 ft
Normal Pumping	4.5 ft
Minimum Pumping	4.0 ft
Minimum Non-Pumping	2.0 ft
Tieback levee	
Crest Elevation at Pump Station	6.3 ft
Width of Levee Crest	10.0 ft
Side Slope 1 on	3
Natural Grade, at the Pump	3.5 ft

Note: All elevations are in feet, NGVD

TABLE A-16
Hydraulic Design Data
C-111 North

Comments	Station (ft)	Discharge (cfs)	W.S. Elev. (ft, NGVD)	Btm. Width (ft)	Invert (ft, NGVD)	Side Slope 1 on
at S-178	0+00	50.0	4.00	15	-1.2	1
Intake at S-332E	2+00	50.0	4.00	15	-1.2	1
Discharge at S-332E	2+50	50.0	4.50	15	-1.2	1
	26+50	50.0	4.37	15	-1.2	1
	101+70	25.0	4.25	10	-1.2	1
	101+71	25.0	4.25	10	-0.625	1
	152+55	12.5	4.13	10	-0.625	1
End of Channel	203+40	0.0	4.00	10	-0.625	1

TABLE A-17
Hydraulic Design Data
L-31W Tieback
LOCATED ABOUT 1 MILE WEST OF L-31N, RUNNING NORTH TO SOUTH

LOCATION	STATION	TOP ELEVATION	EXISTING GROUND
NEAR S-332B	0+00	10.5	7.0
NEAR S-332C	55+00	9.8	6.5
NEAR S-332D (TIE-IN TO NORTH END OF EXISTING L-31W)	187+00	9.3	6.5
TIE-IN TO SOUTH END OF EXISTING L-31W	277+00	9.0	6.0
NEAR S-175	435+00	9.0	5.0
C-111	488+00	7.0	5.5

TABLE A-18
Hydraulic Design Data
S-332D Tieback
LOCATED ABOUT 0.5 MILE WEST OF L-31N, RUNNING NORTH TO SOUTH

LOCATION	STATION	TOP ELEVATION	GROUND ELEVATION
NEAR S-332A	0+00	10.5	7.5
NEAR S-332B	190+00	10.5	7.0
NEAR S-332C	296+00	9.8	6.5
L-31W	428+00	9.3	6.5
TIE-IN TO EXISTING L-31N	450+00	9.3	6.5

Note: All elevations are in feet, NGVD

TABLE A-19
Hydraulic Design Data
Retention/Detention Area Culverts

Design Conditions	
Discharge	17.3 cfs
Headwater Elevation	8.3 ft varies
Tailwater Elevation	7.8 ft varies
Optimum Conditions	
Headwater Elevation	7.0 ft
Tailwater Elevation	6.5 ft
Culvert Size	
Number of Pipes	1
Diameter (CMP)	36 inches
Invert Elevation	3.5 ft
Length	50 ft
Riser Diameter	48 inches
Type of Control	Stop Log

TABLE A-20
Hydraulic Design Data
Culvert from C-111 connector canal to S-332

Design Conditions	
Discharge	165 cfs
Headwater Elevation	5.5 ft
Tailwater Elevation	5.0 ft
Optimum Conditions	
Headwater Elevation	4.5 ft
Tailwater Elevation	4.5 ft
Culvert Size	
Number of Pipes	3
Diameter (CMP)	84 inches
Invert Elevation	-3.0 ft
Length	66 ft
Type of Control	flap-gate

Note: All elevations are in feet, NGVD

TABLE A-21
Hydraulic Design Data
Existing Channel Dimensions

C-111

Location	Station (ft)	Invert (ft, NGVD)	Btm. Width (ft)
Structure S-18C	481+70	-12.0	100
Junction C-111E	481+70 to 594+94 (STA. 0+00)	-12.0	100
Structure S-177	594+94 to 791+00	-10.0	70
Structure S-176	793+67 to 1080+34	-12.0	40

C-111E

From Junction C-111E	0+00 to 60+00	-12.0	20
	60+00 to 120+00	-12.0	20
To Structure S-178	1[illegible]+00 to 180+00	-9.0	20

L-31N Borrow Canal

From Junction C-111	532+00	-12.0	35
Junction C-103	532+00 to 720+00	-12.0	35
Junction C-102	720+00 to 980+00	-10.0	20
To Junction S-173 (S-331)	980+00 to 1113+34	-3.5	10

TABLE A-22
Existing Structure Hydraulic Data

Item Type	S-174 Gated Spillway	S-175 Gated Culvert	S-176 Gated Spillway	S-177 Gated Spillway	S-18C Gated Spillway	S-197 Gated Culvert	S-332 Pump Station
Design Condition							
Discharge (cfs)	500.0	500.0	630.0	1400.0	2100.0	2400.0	Varies 5.0 to 165
Headwater Elev.	6.0	5.0	6.0	4.3	2.6	1.4	3.0
Tailwater Elev.	5.5	4.5	5.5	3.7	2.1	0.6	Below 5.8
Optimum Condition							
Headwater Elev.	4.3 to 4.8	4.5	4.3 to 4.8	3.9	None	None	
Tailwater Elev.	None	None	None	None	Tidal	None	
SPF Condition (est.)							
Discharge (cfs)	850.0	500.0	1100.0	2900.0	3200.0	None	
Headwater Elev.	7.5	6.0	7.5	6.0	3.8	None	
Tailwater Elev.	6.5	5.5	6.3	4.0	2.8	None	
Minimum Condition (est.)							
Headwater Elev.	3.0	2.0	3.0	2.0	1.0	-0.5	
Tailwater Elev.	2.0	-1.0	2.0	1.0	-2.0	-1.0	
Gates							
Number	1.0	3.0	1.0	1.0	2.0	10.0	6.0
Width by Height (ft)	16.0 x 8.0	84" dia	20.0 x 8.5	22.0 x 12.6	22.0 x 11.0	4.0 x 12.0	
Type of Controls	Auto. Vertical Lift	Manual Slide Gate	Auto. Vertical Lift	Auto. Vertical Lift	Vert. lift w/ Slide Gat	Manual Slide Gat	Flapgates
Apron							
Elevation	-3.5		-2.0	-8.0	-8.0		
Length	20.0		20	20	20		
End Sill Elev.	-2.5		-1.0	-7.0	-7.0		
Culvert Type		CMP					
Number/Size of Barrels		3 - 84"				13 - 84"	
Invert Elev.							

C-111
GENERAL REEVALUATION REPORT
Appendix A
Hydrology and Hydraulic Analysis

PHOTOGRAPHS

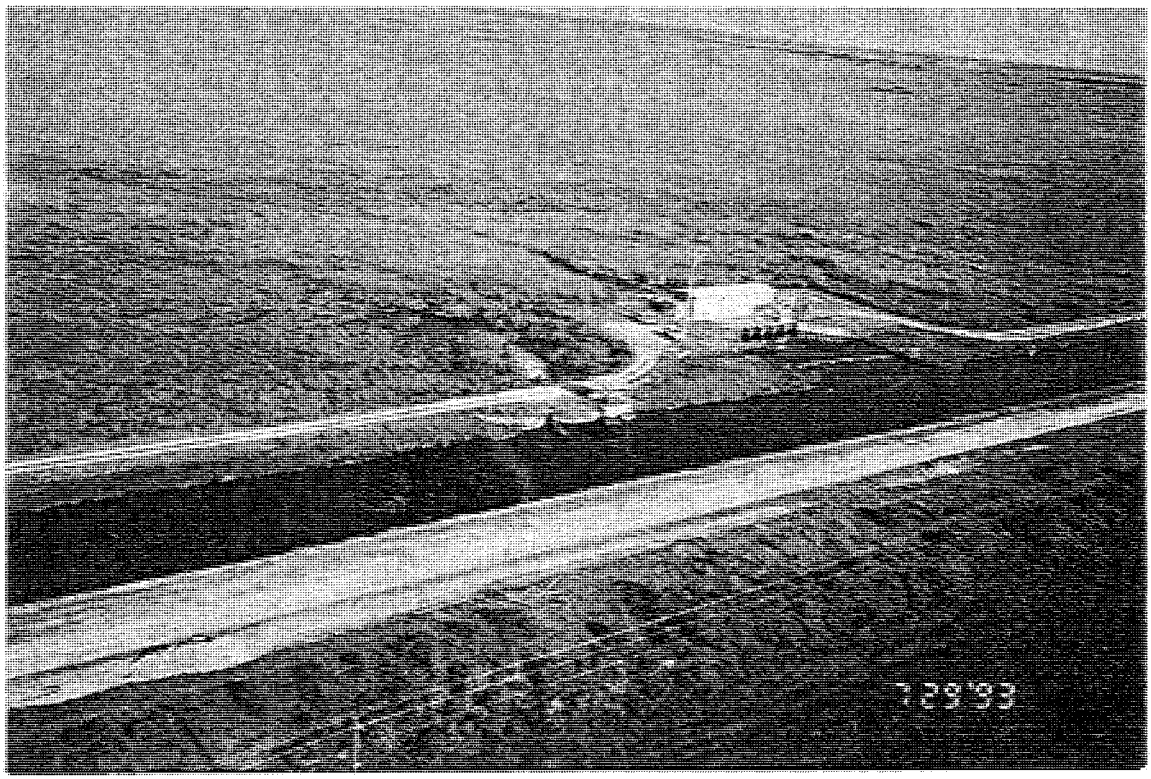


PHOTO A-1. AERIAL VIEW OF PUMP STATION S-332 ON L-31W BORROW CANAL. TAYLOR SLOUGH FLOWS RIGHT TO LEFT ACROSS THE MIDDLE OF THIS VIEW.

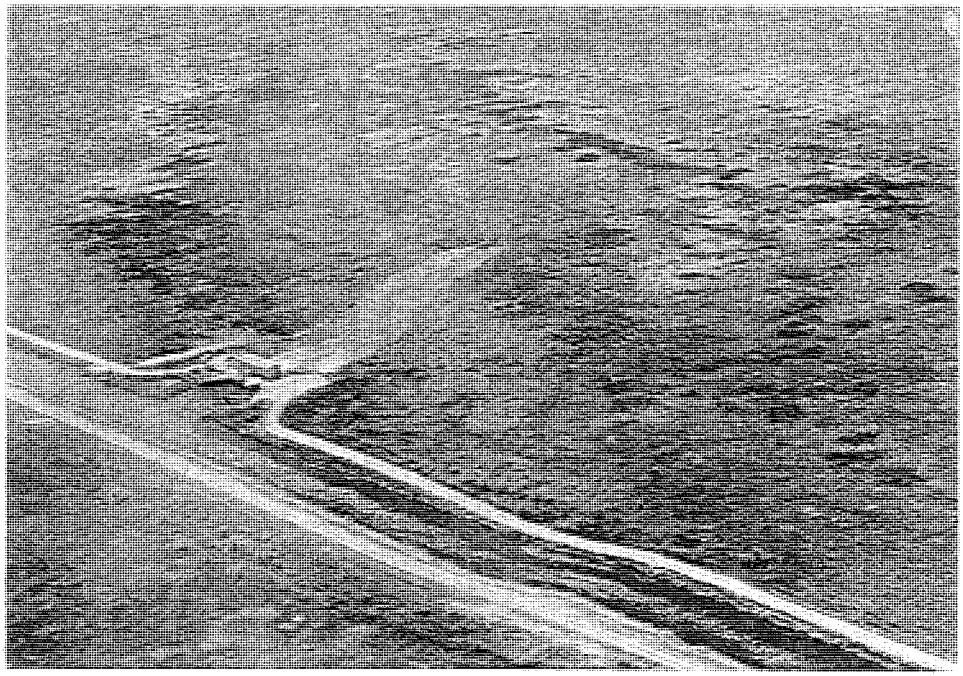


PHOTO A-2. AERIAL VIEW OF PUMP STATION S-332 ON L-31W BORROW CANAL. MORE RECENT PHOTO SHOWS ADDITIONAL PUMP INTAKE ON NORTH SIDE OF INTAKE. TAYLOR SLOUGH FLOWS RIGHT TO LEFT ACROSS THE MIDDLE/TOP OF THIS VIEW.

PHOTO A-3. LOOKING EASTERLY AT TAYLOR SLOUGH, WITH STATE ROAD 9336 (FORMERLY SR 27) AND SHALLOW BOX CULVERT TYPE BRIDGE, 60 FEET LONG.

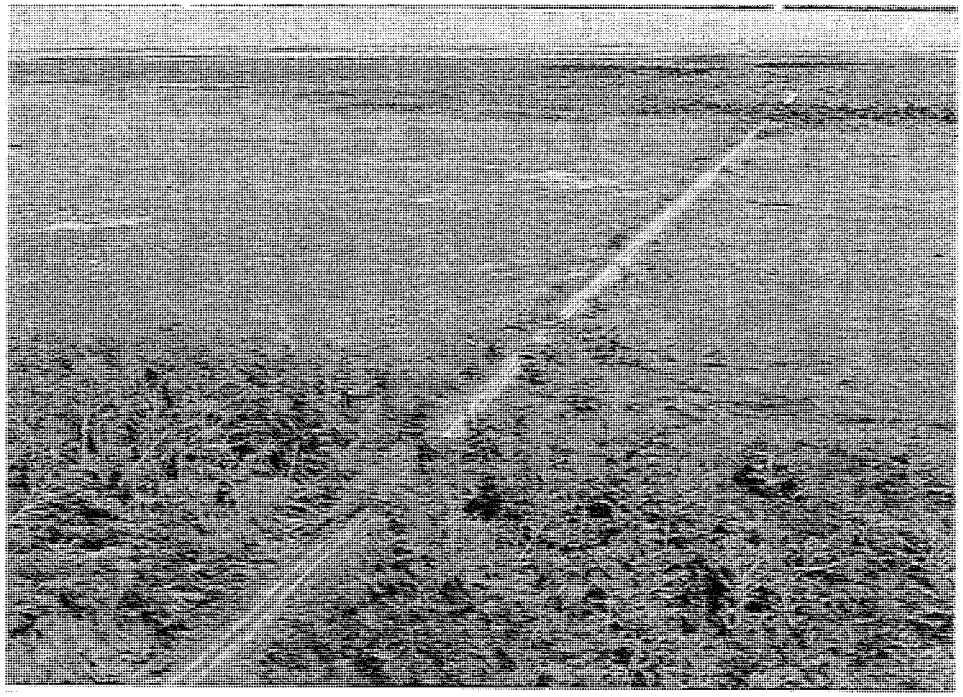


PHOTO A-4. AERIAL VIEW LOOKING EAST AT OLD INGRAHAM HIGHWAY. AN UNPAVED ROAD THAT WAS THE ORIGINAL ACCESS IN TO THE AREA, IT WAS BUILT IN 1916. IT CROSSES TAYLOR SLOUGH WHICH FLOWS FROM LEFT TO RIGHT IN THIS VIEW.

PHOTO A-5. LOOKING NORTH ALONG L-31N BORROW CANAL, JUST UPSTREAM OF S-176. THE JUNCTION WITH L-31W BORROW CANAL CAN BE SEEN AT LEFT, S-174 IS OUT OF FRAME TO THE LEFT.

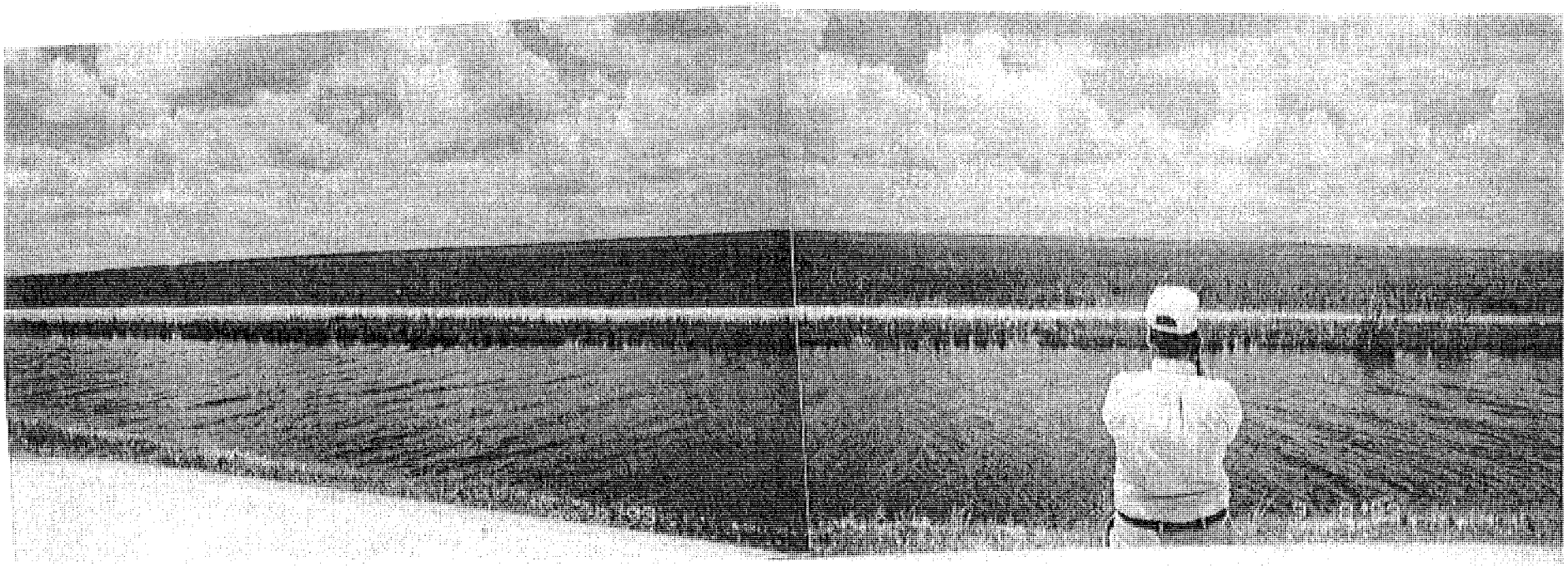


PHOTO A-6 LOOKING WEST ACROSS L-31W BORROW CANAL INTO EVERGLADES NATIONAL PARK, ABOUT 2000 FEET NORTH OF PUMP STATION S-332.

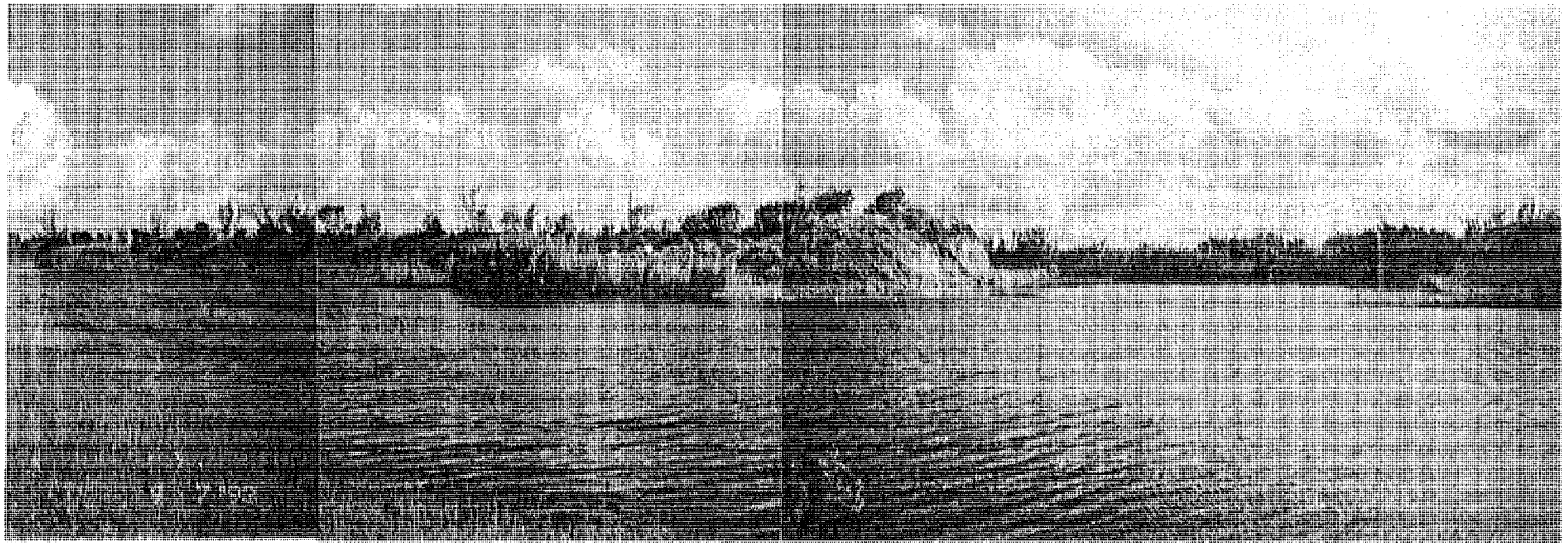


PHOTO A-7. LOOKING EAST ALONG THE SOUTHERN LEG OF C-111, WITH THE SPOIL MOUNDS ON THE SOUTHERN BANK ON THE RIGHT. NOTE THE RECENTLY CLEANED OUT GAP AT FAR RIGHT, THAT WILL ALLOW OVERLAND FLOW TOWARD THE EASTERN PANHANDLE OF EVERGLADES NATIONAL PARK.

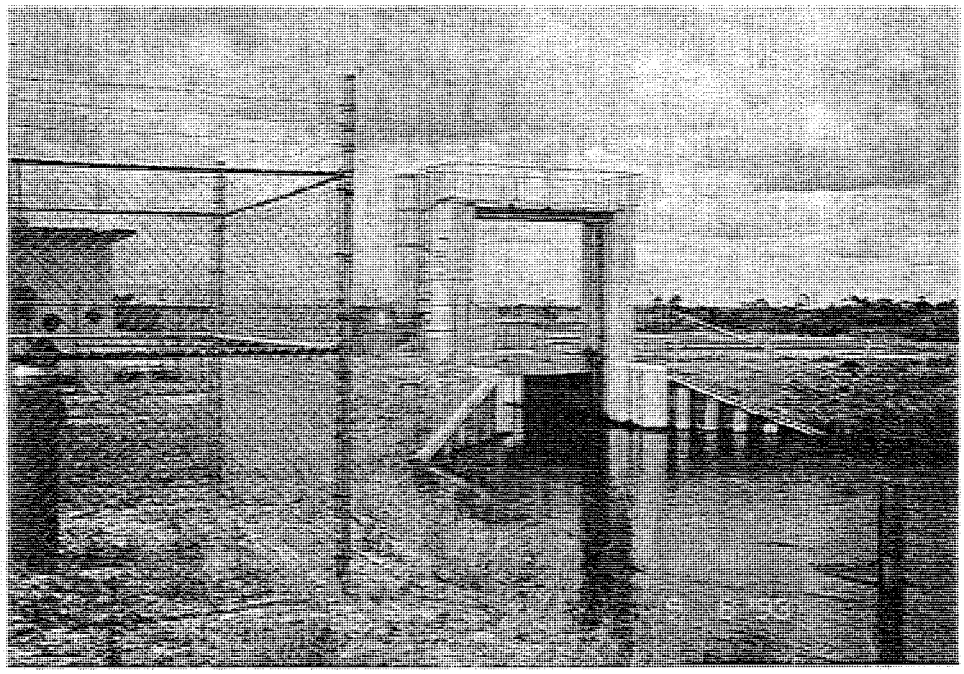


PHOTO A-8. LOOKING WEST AT S-174, ON L-31W.

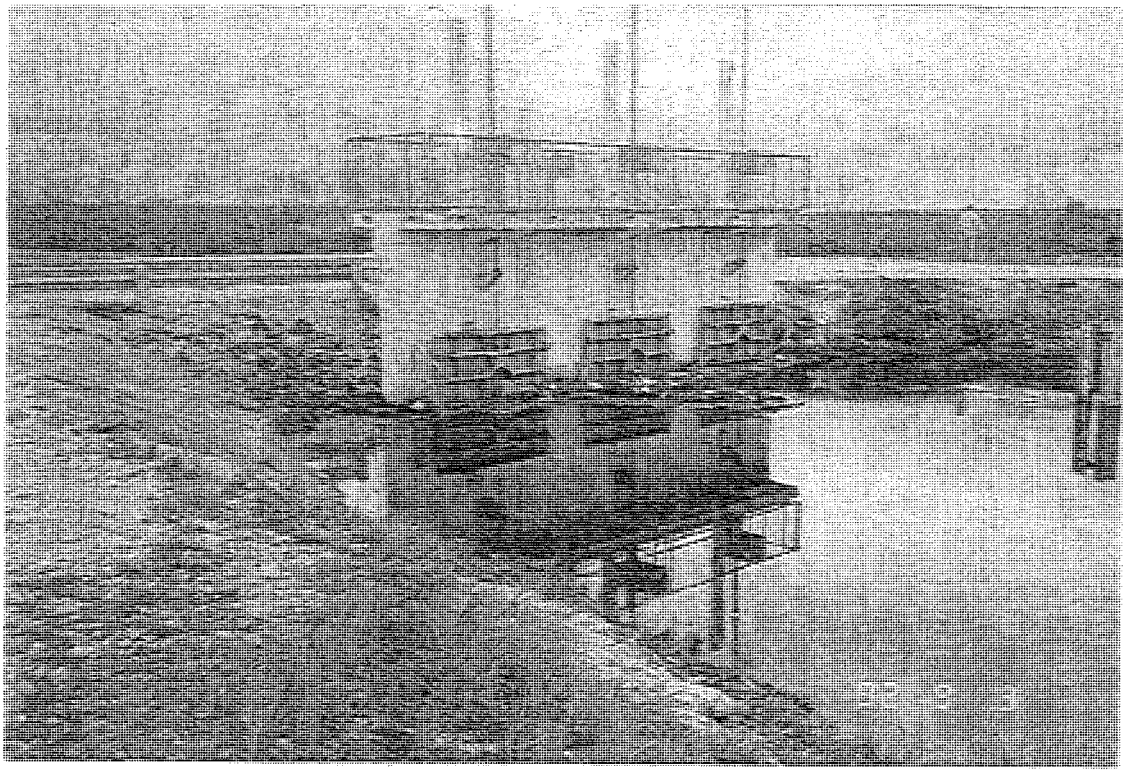


PHOTO A-9. LOOKING AT THE UPSTREAM SIDE OF S-175 ON L-31W.

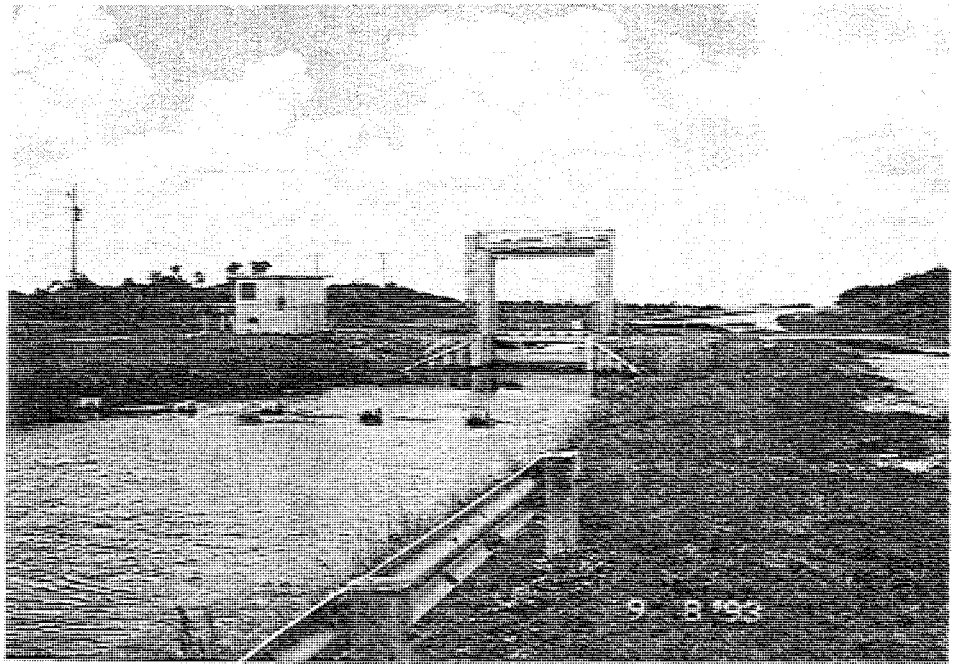


PHOTO A-10. LOOKING SOUTH AT S-176, WHERE THE "CANAL" CHANGES NAME FROM L-31N BORROW CANAL UPSTREAM TO C-111 DOWNSTREAM OF S-176.

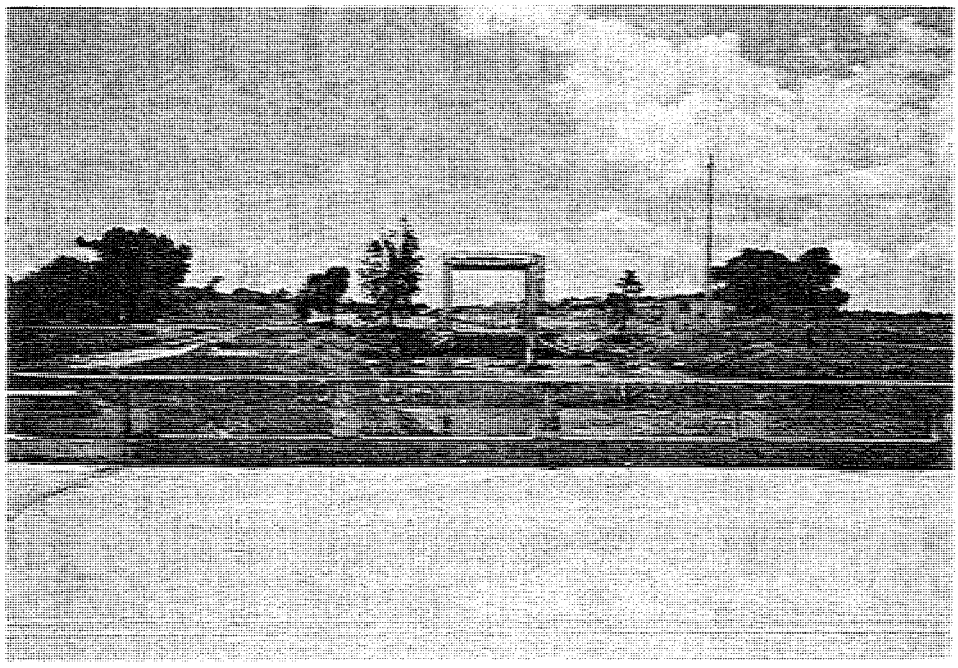


PHOTO A-11. LOOKING DOWNSTREAM AT S-177, ON C-111.

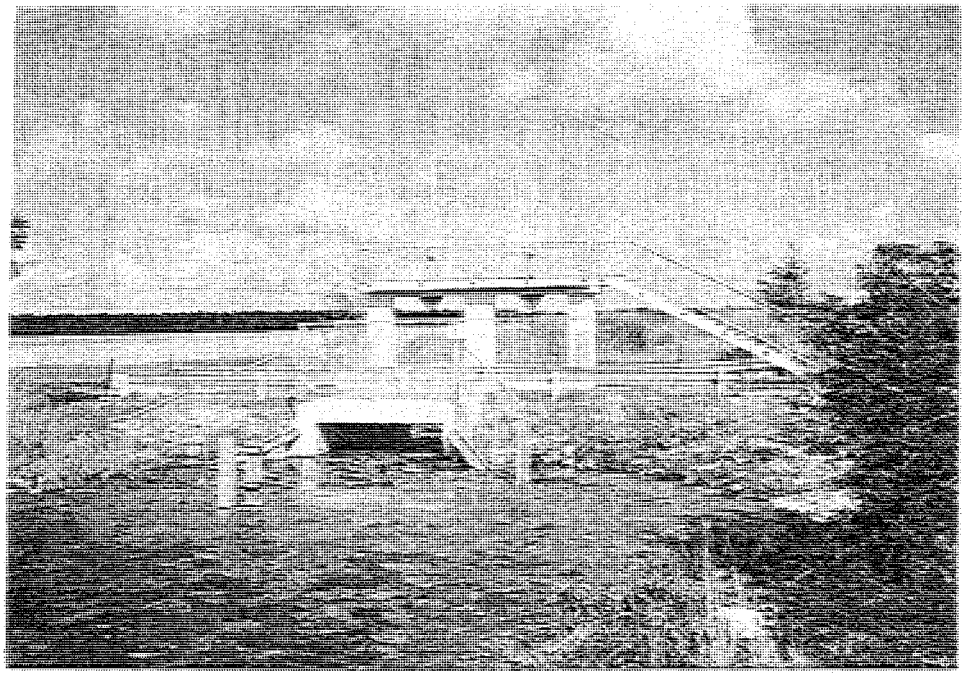


PHOTO A-12. LOOKING UPSTREAM AT S-178 ON C-111E.

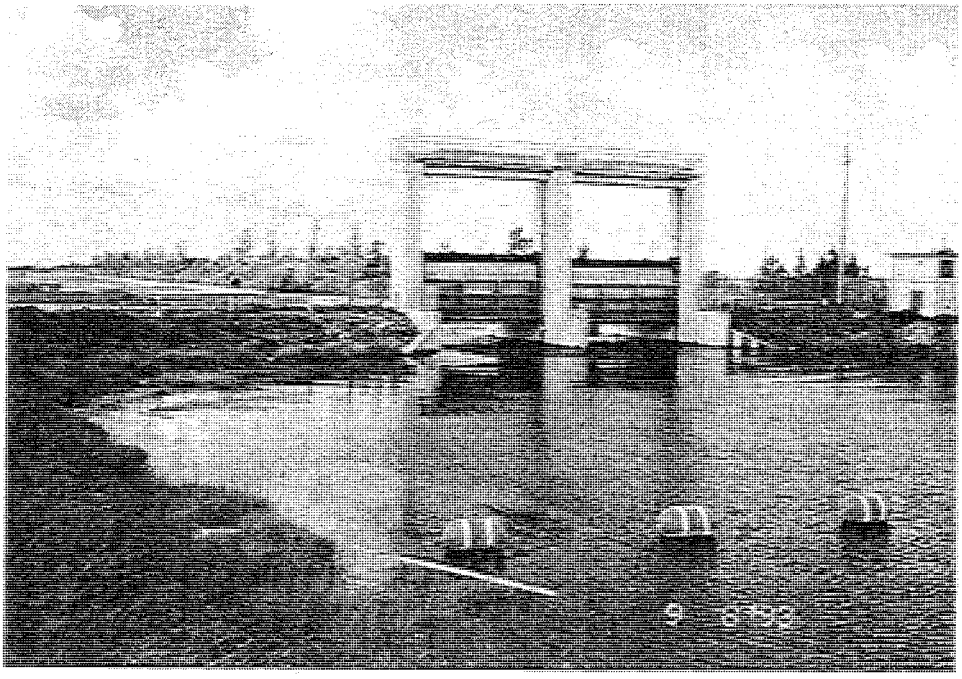
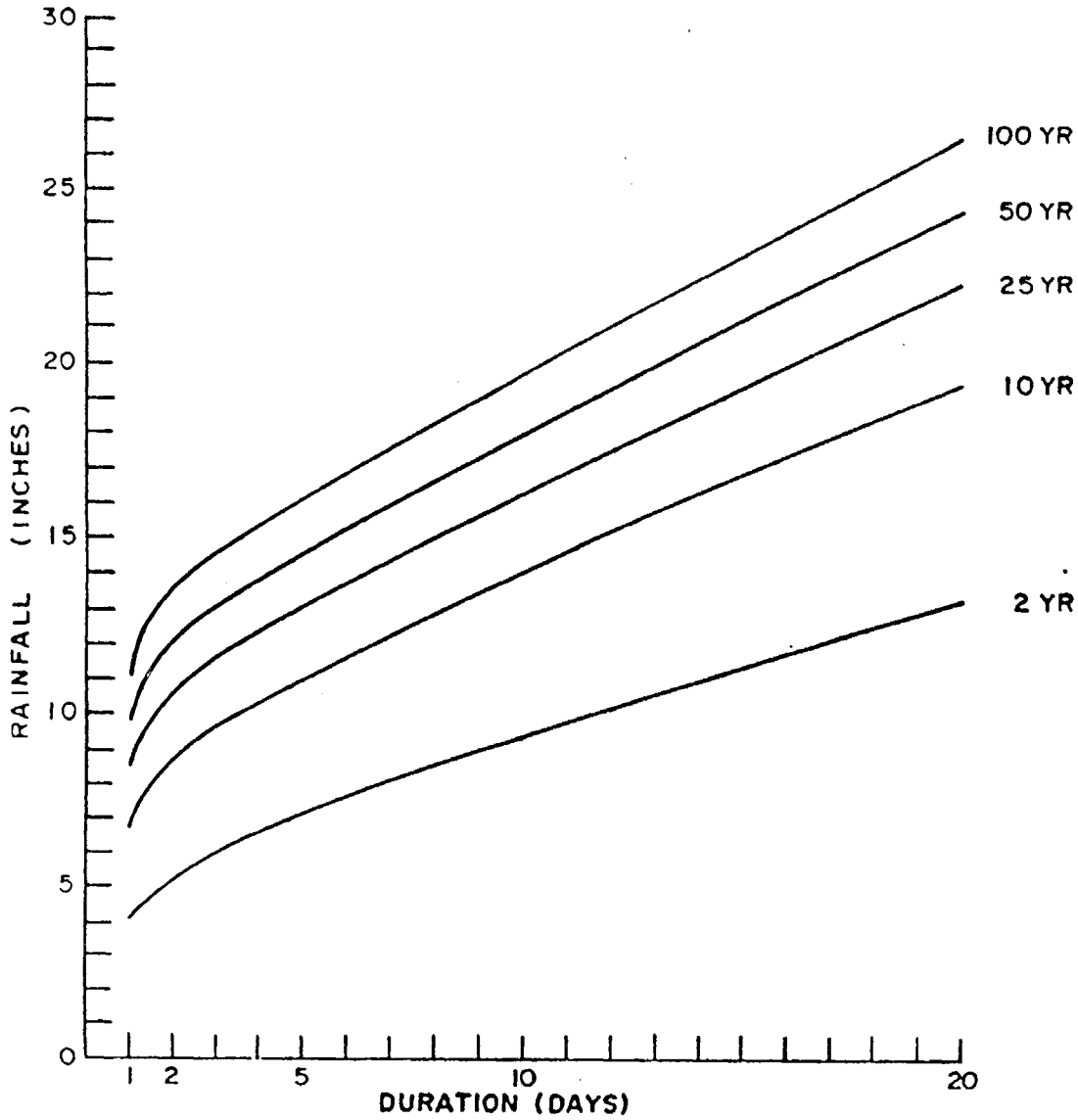


PHOTO A-13. LOOKING DOWNSTREAM AT S-18C ON C-111.

PHOTO A-14. LOOKING AT THE UPSTREAM SIDE OF S-197, THE THREE ORIGINAL CULVERTS AT LEFT, AND THE TEN ADDITIONAL INSTALLED BY THE LOCAL SPONSOR AT RIGHT.

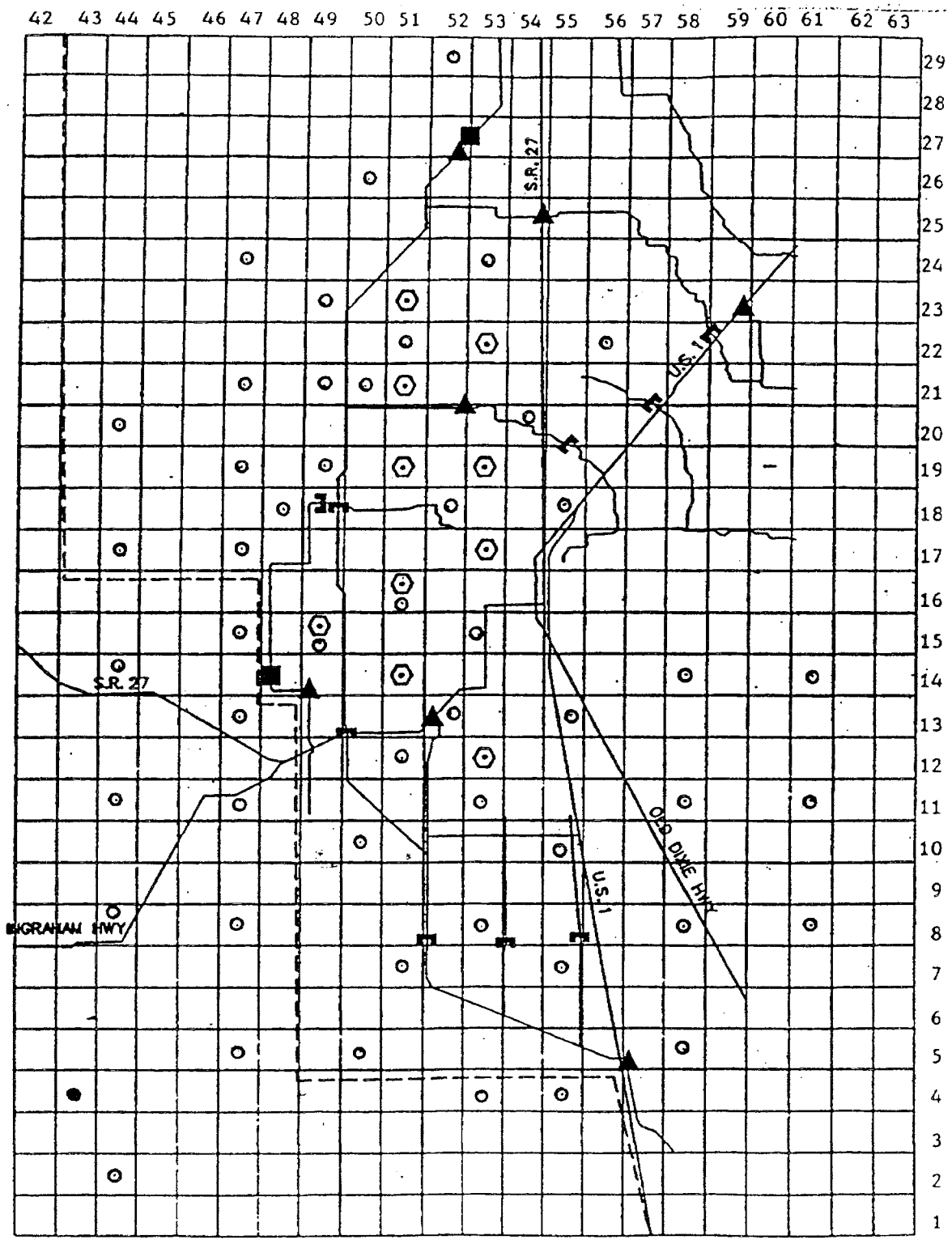
C-111
GENERAL REEVALUATION REPORT
Appendix A
Hydrology and Hydraulic Analysis

FIGURES



HOMESTEAD EXPERIMENT STATION
ANNUAL RAINFALL
(Expected Probability)

FIGURE A-1

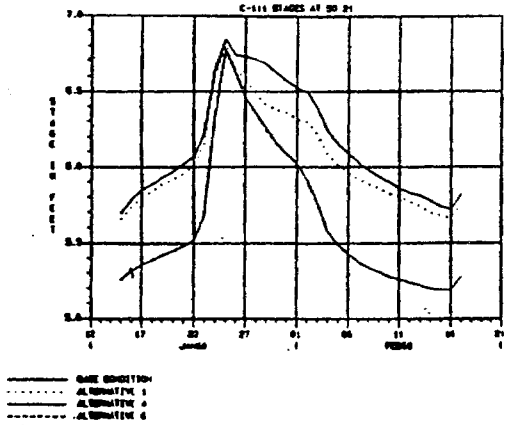


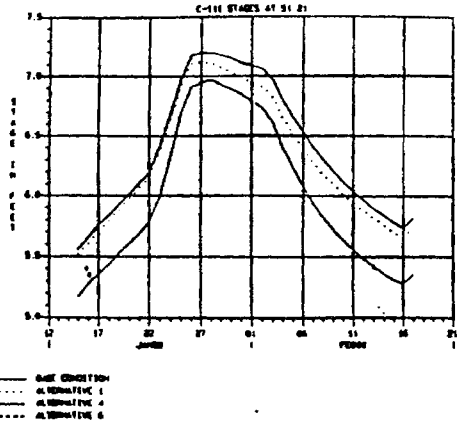
ONE BY ONE GRID

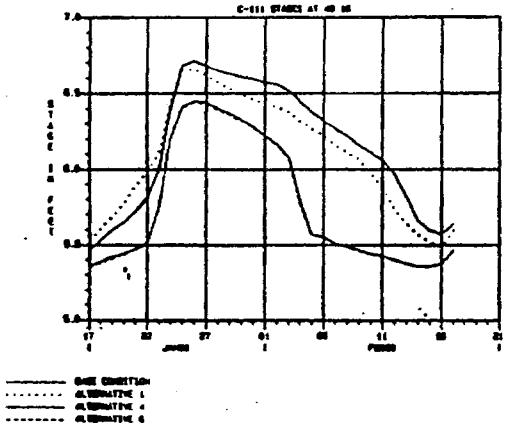
Period of Record Cells ○

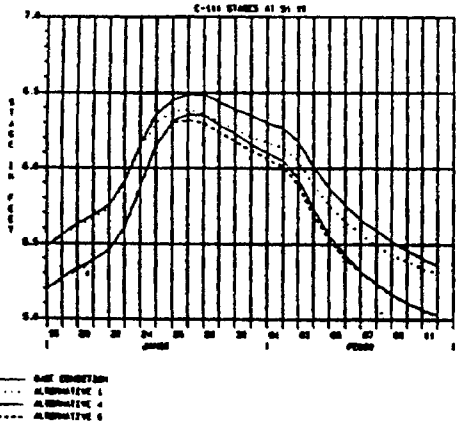
Flood Stage Cells ⊙

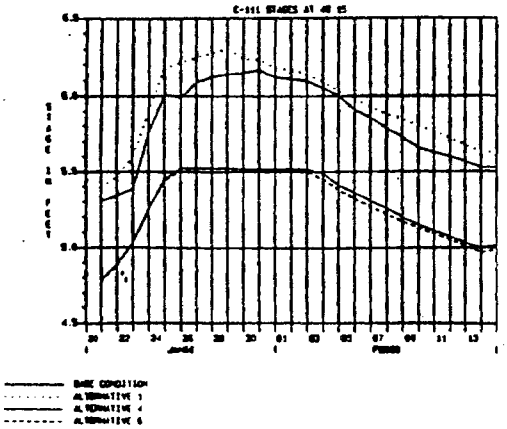
FIGURE A-2











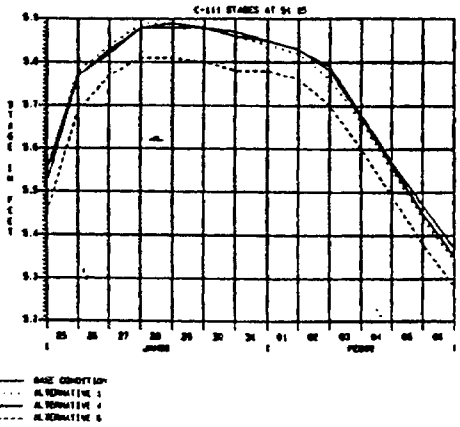
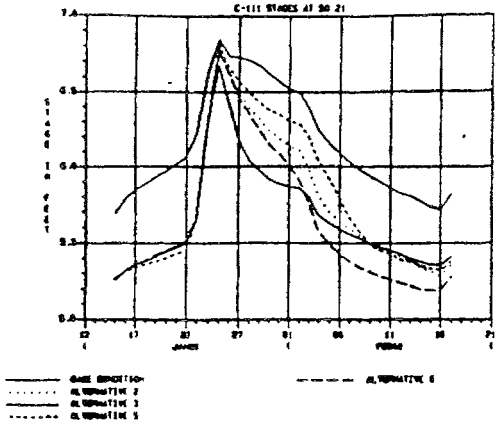
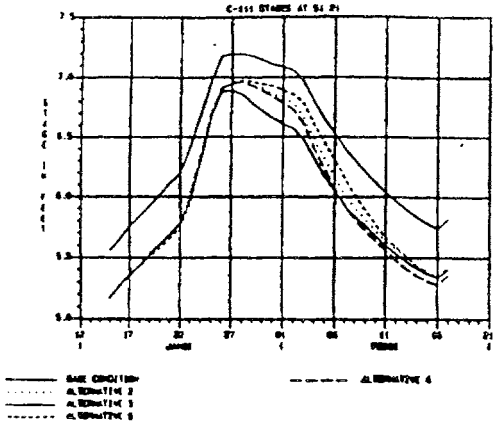
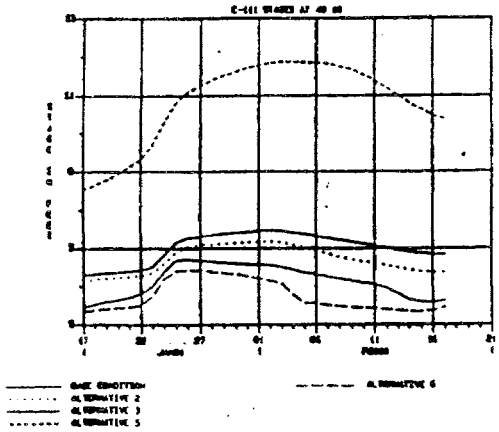
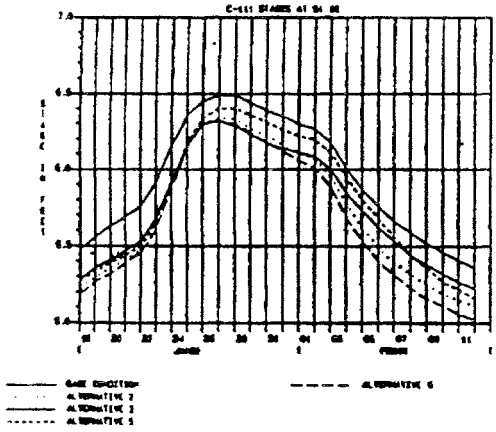


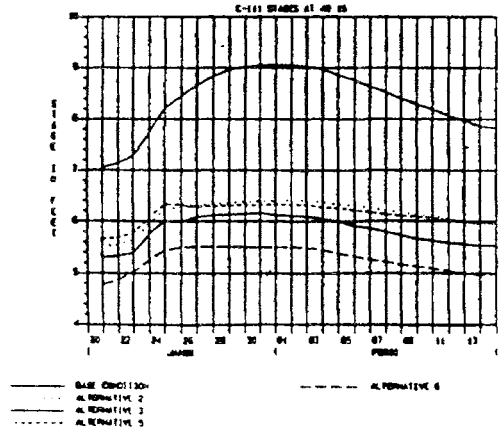
FIGURE A-3











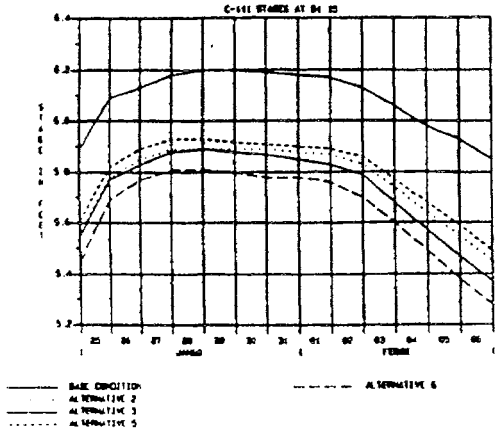
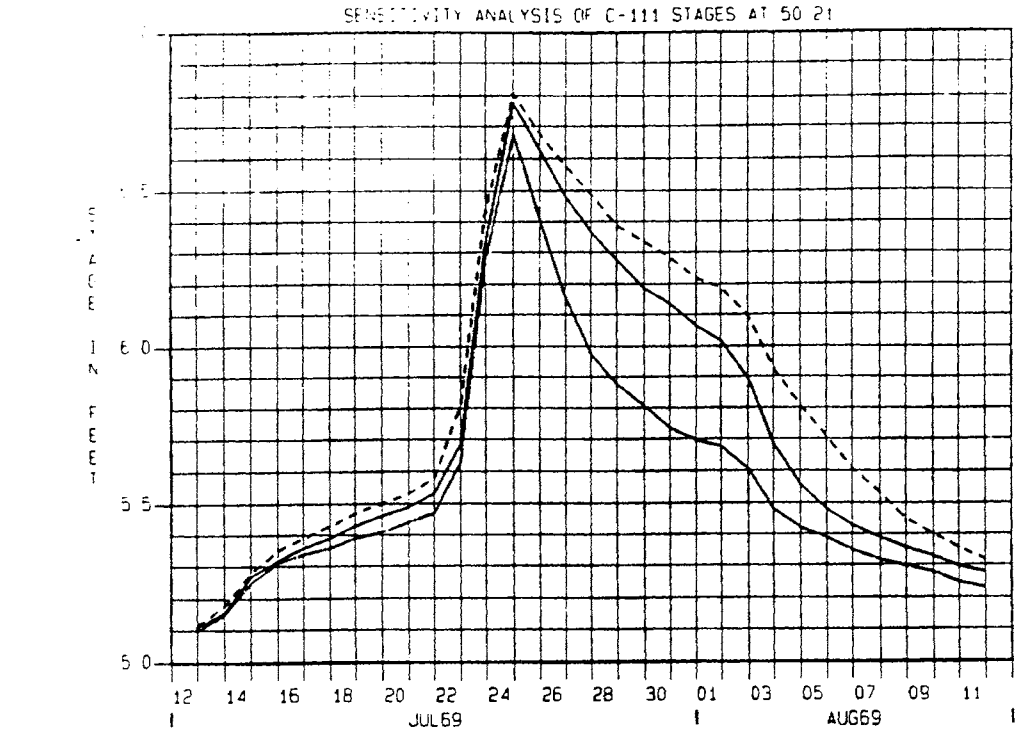


FIGURE A-3
(Continued)


SENSITIVITY ANALYSIS OF C-111 STAGES AT 50 21
STAGE IN FEET
6 0
5 5
5 0
12 14 16 18 20 22 24 26 28 30 01 03 05 07 09 11
JUL69
AUG69
ALTERNATIVE (1200 CFS PUMP STATION)
ALTERNATIVE (2000 CFS PUMP STATION)
ALTERNATIVE (800 CFS PUMP STATION)

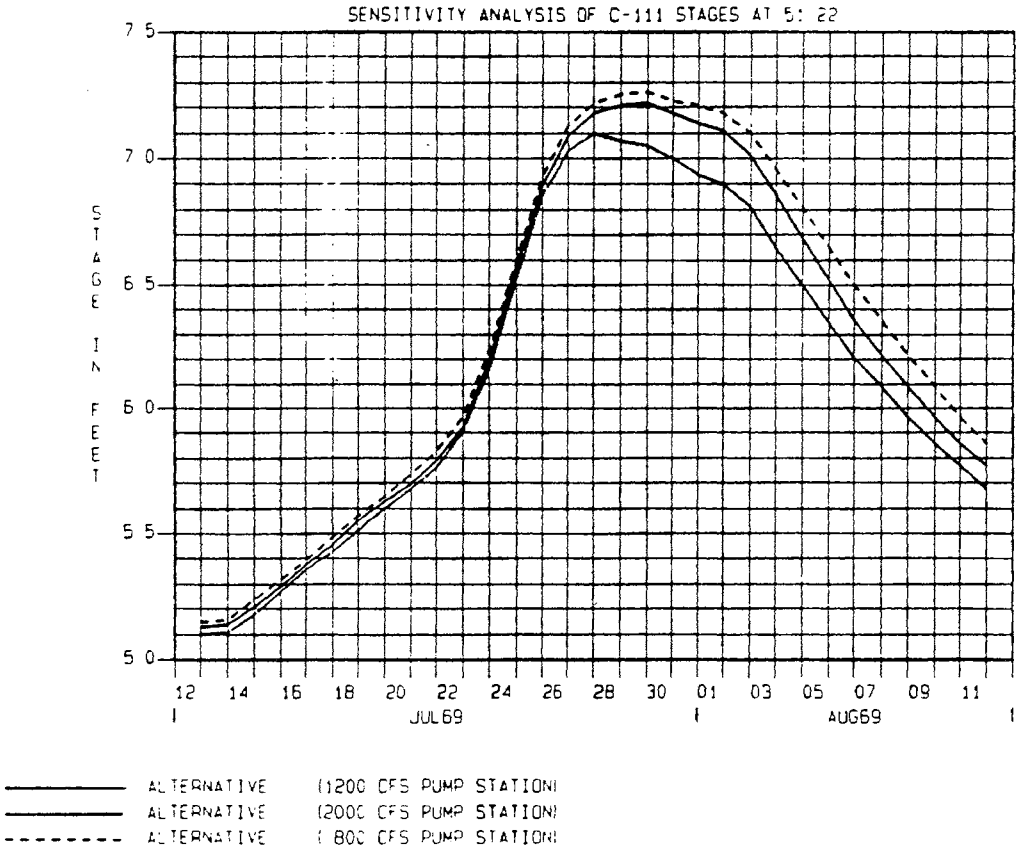

SENSITIVITY ANALYSIS OF C-111 STAGES AT 5: 22
STAGE IN FEET
7 5
7 0
6 5
6 0
5 5
5 0
12 14 16 18 20 22 24 26 28 30 01 03 05 07 09 11
JUL69
AUG69
ALTERNATIVE (1200 CFS PUMP STATION)
ALTERNATIVE (2000 CFS PUMP STATION)
ALTERNATIVE (800 CFS PUMP STATION)

FIGURE A-4

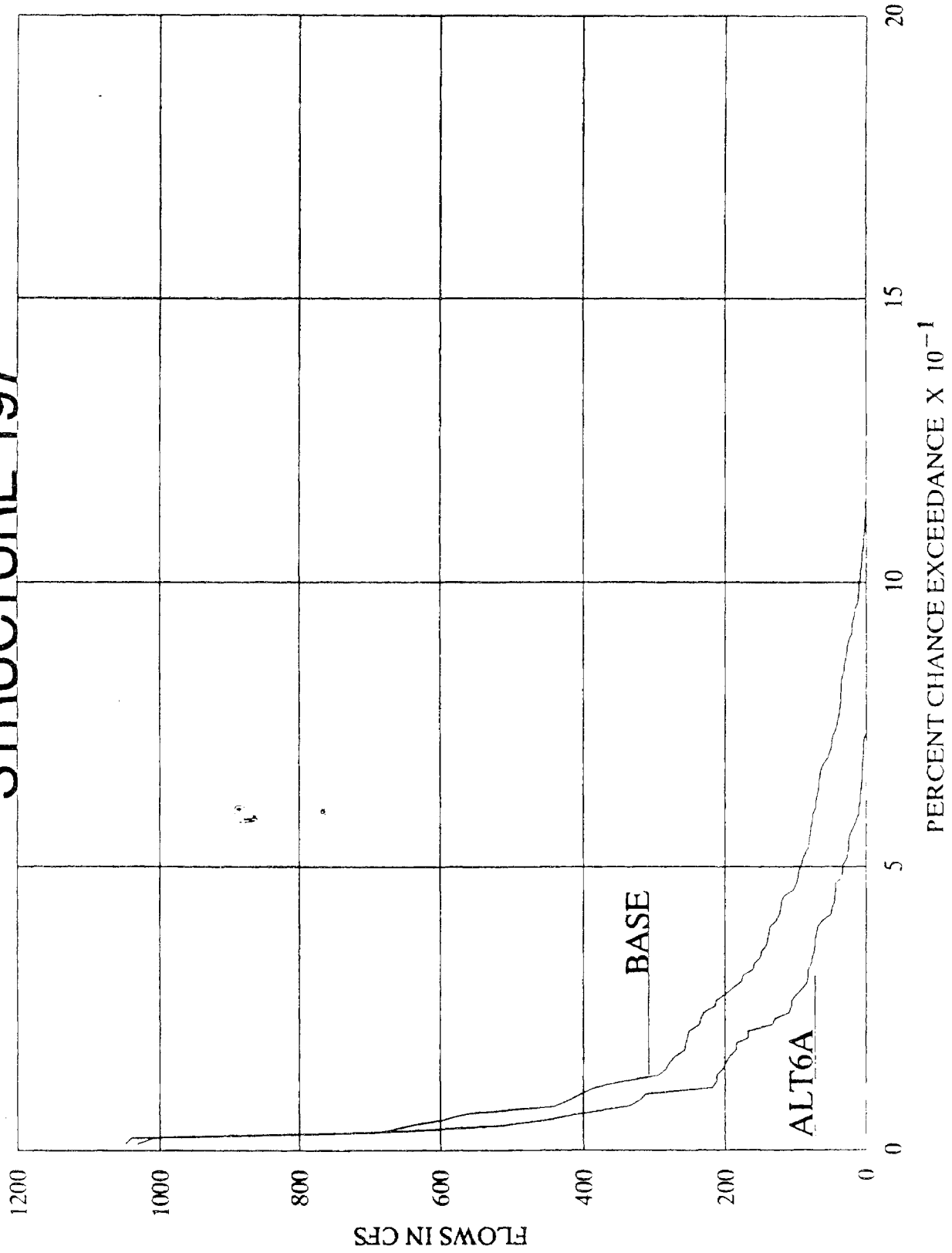
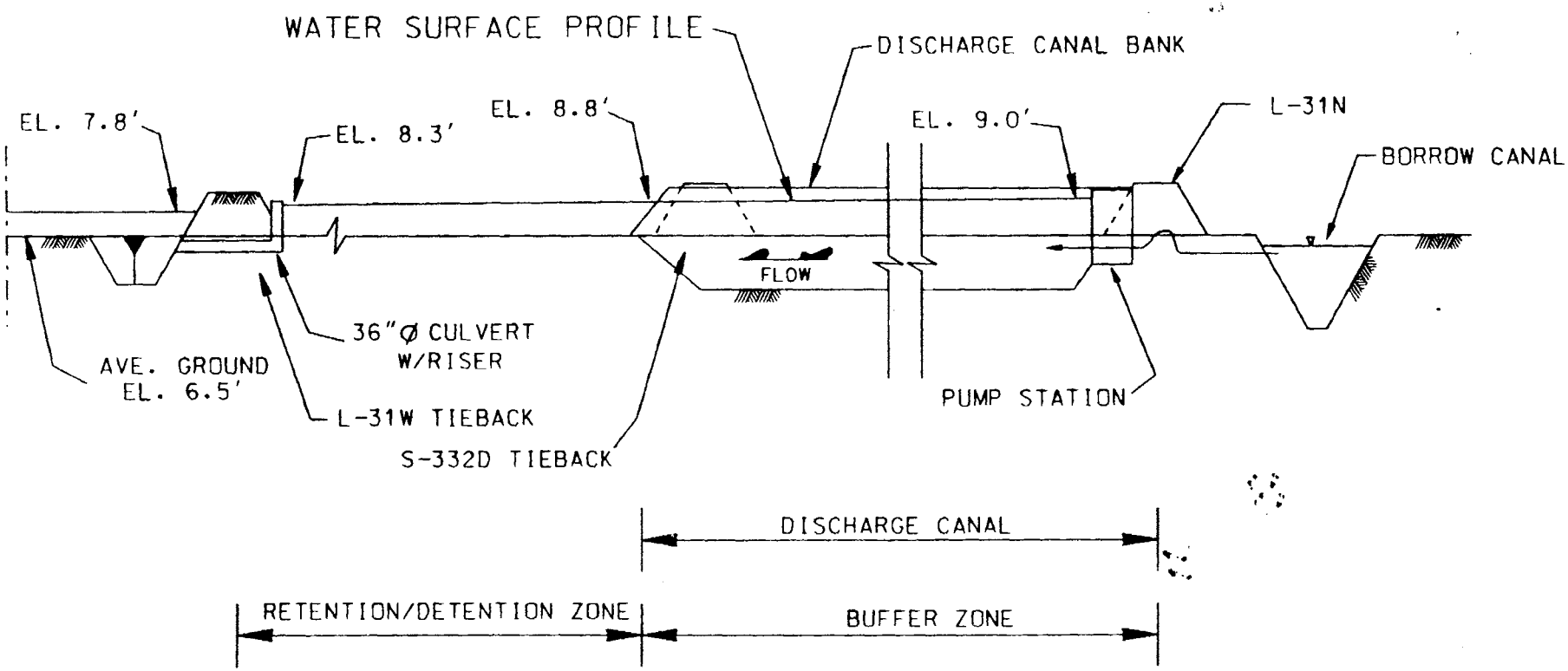

STRUCTURE 197
FLOWS IN CFS
1200
1000
800
600
400
200
0
0
5
10
15
20
PERCENT CHANCE EXCEEDANCE X 10^{-1}
BASE
ALT6A

FIGURE A-5

FIGURE A-6

HYDRAULIC PROFILE
TYPICAL FROM PUMP STATION ACROSS RETENTION/DETENTION
AREA THROUGH CULVERT/RISER

ALTERNATIVE 6A, RECOMMENDED PLAN

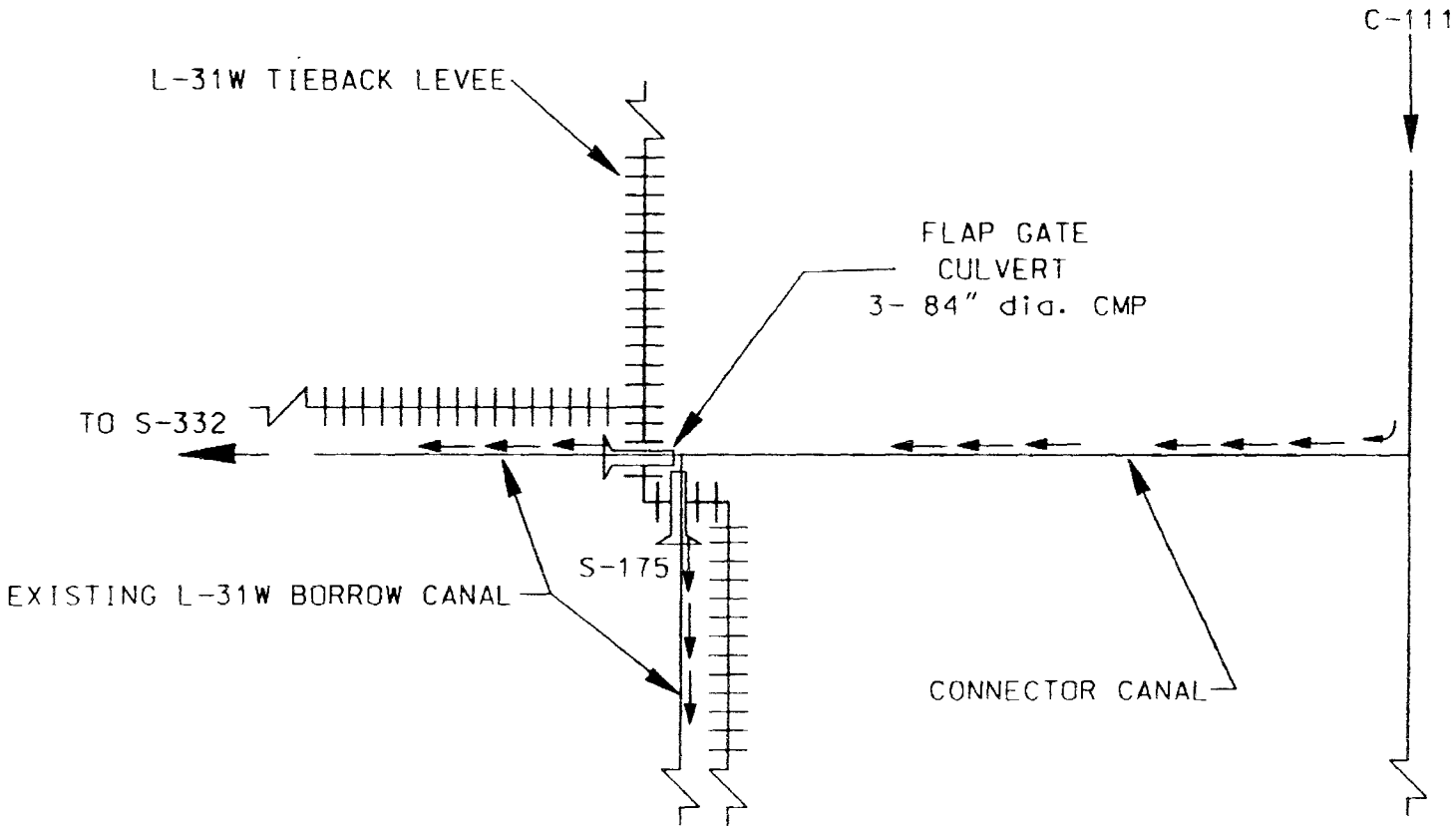


NOT TO SCALE

SCHEMATIC PLAN LAYOUT

CONNECTOR CANAL, CONTROLLED CULVERTS, AND TEE-CONNECTION FOR S-332 & S-175

ALTERNATIVE 6A, RECOMMENDED PLAN

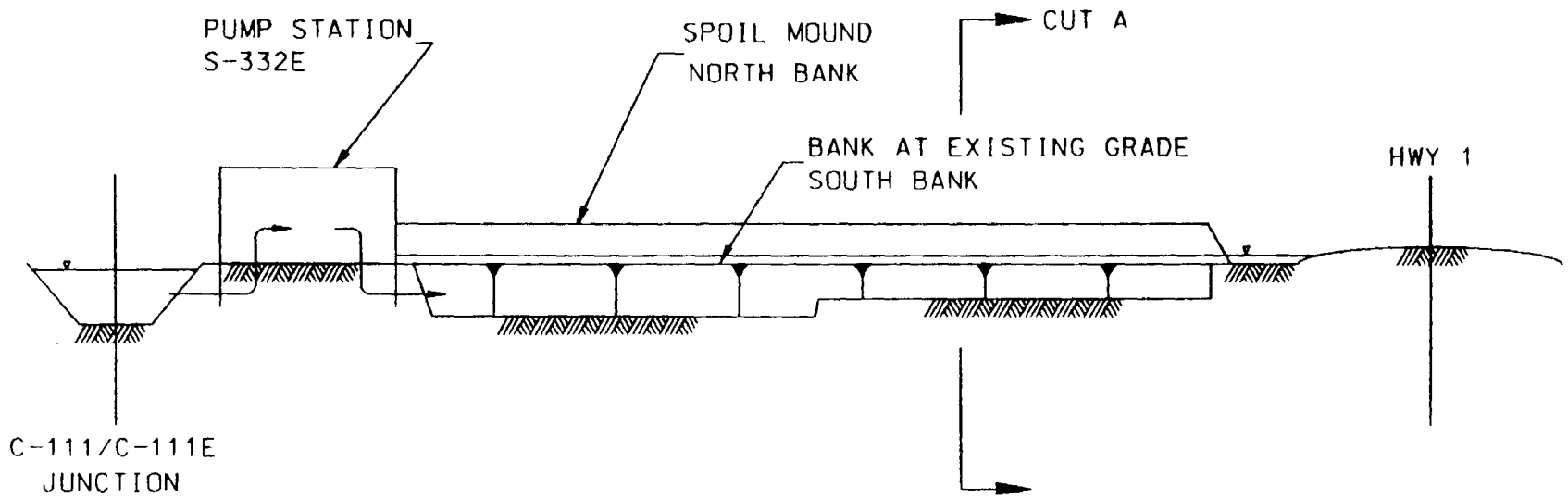


NOT TO SCALE

FIGURE A-7

FIGURE A-8

SCHEMATIC PROFILE
CANAL 111 NORTH
ALTERNATIVE 6A. RECOMMENDED PLAN

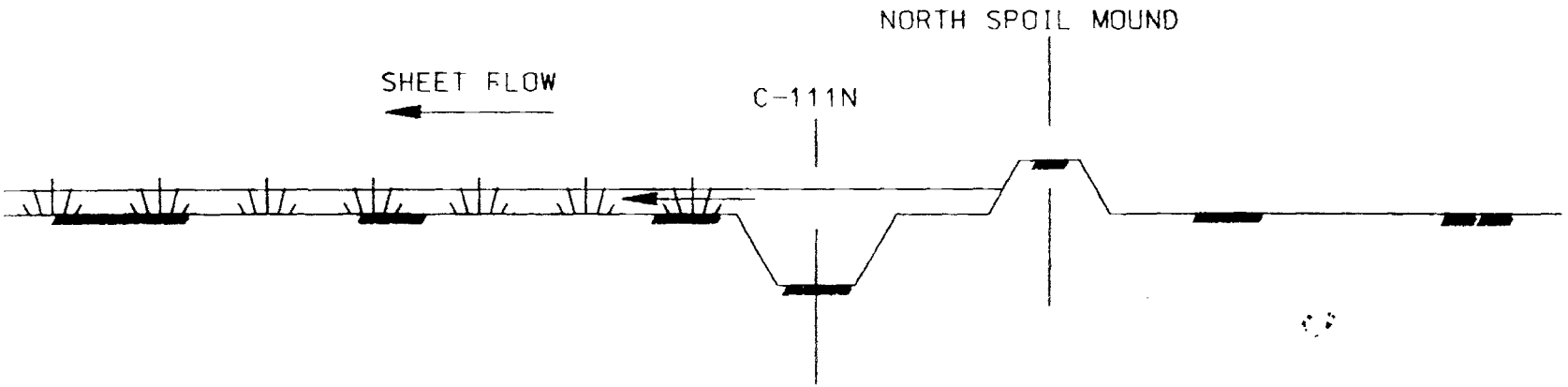


NOT TO SCALE

CUT A

CANAL 111 NORTH

ALTERNATIVE 6A. RECOMMENDED PLAN

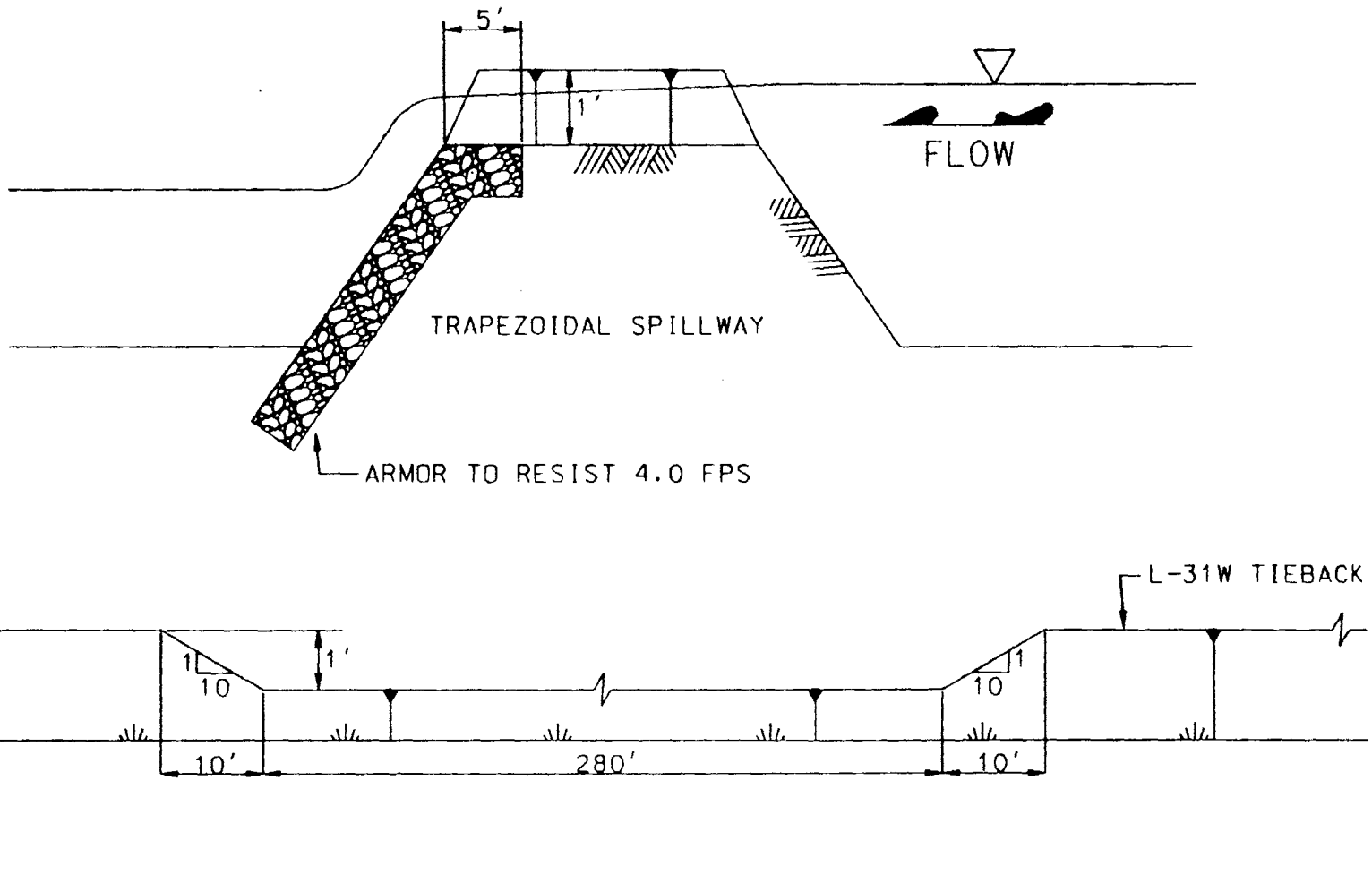


NOT TO SCALE

FIGURE A-9

FIGURE A-10

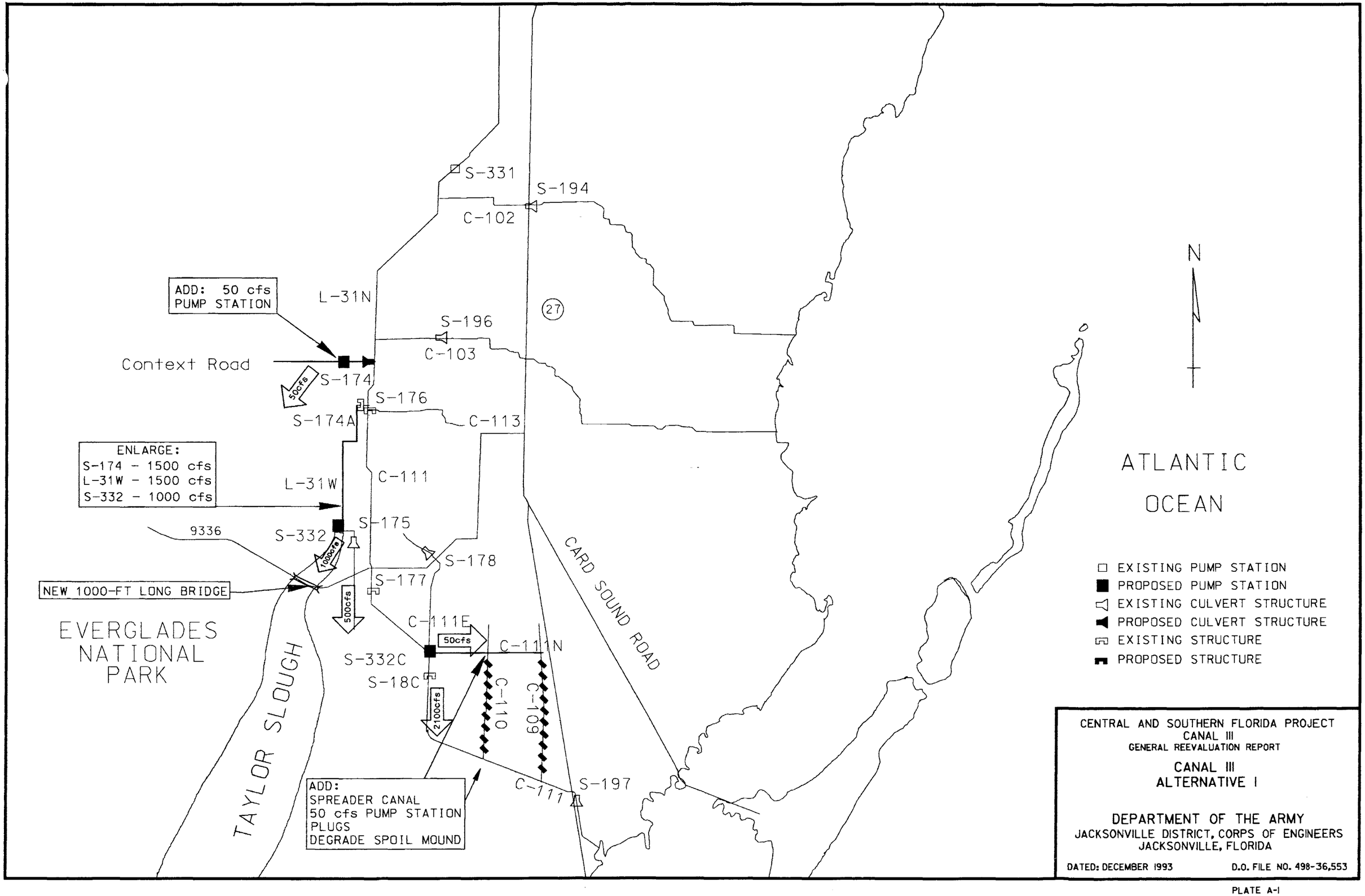
300' LONG OVERFLOW SPILLWAY
L-31W TIEBACK



NOT TO SCALE

C-111
GENERAL REEVALUATION REPORT
Appendix A
Hydrology and Hydraulic Analysis

PLATES



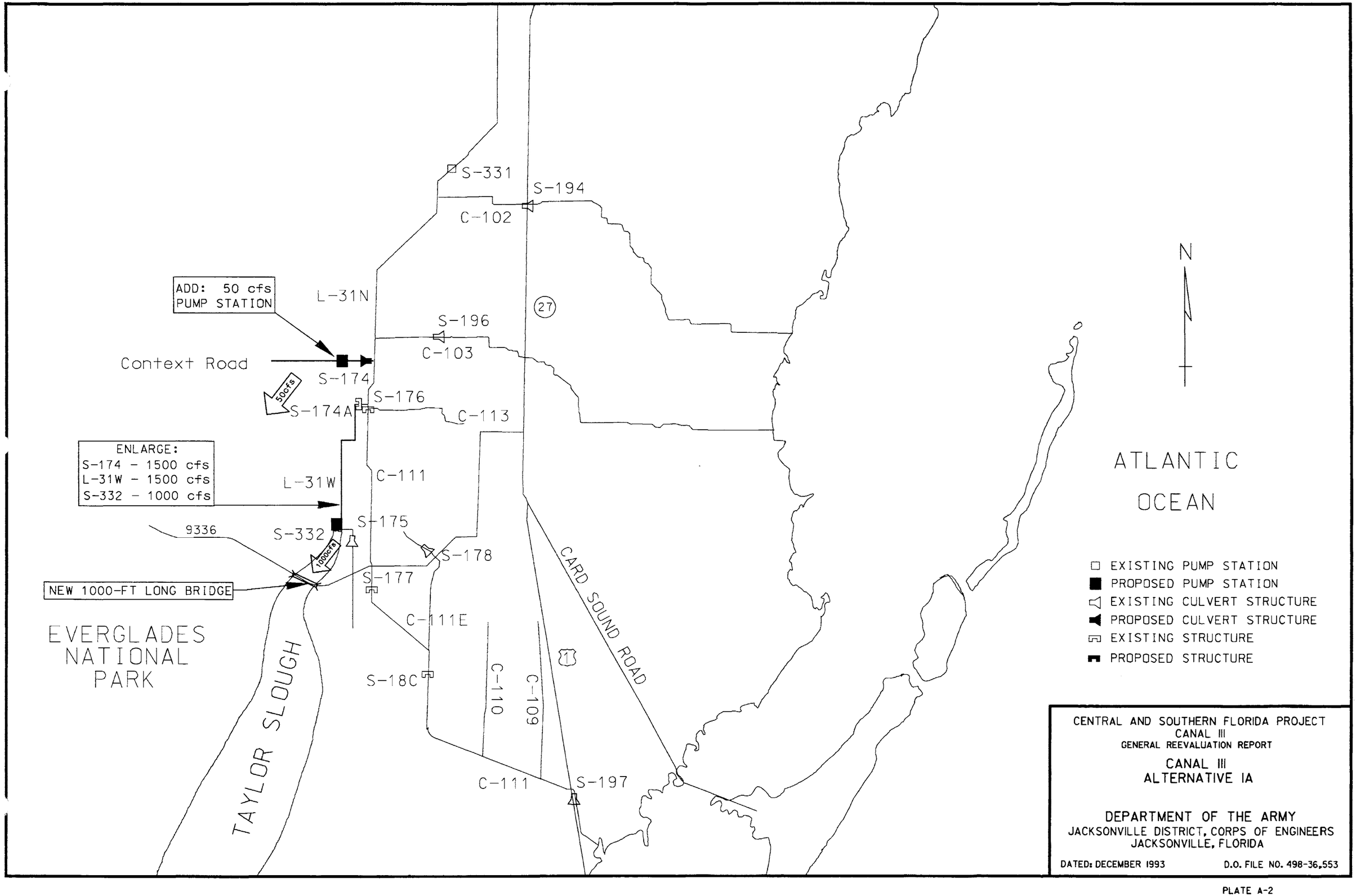
CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

CANAL III
ALTERNATIVE I

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

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553

PLATE A-1



CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

CANAL III
ALTERNATIVE IA

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

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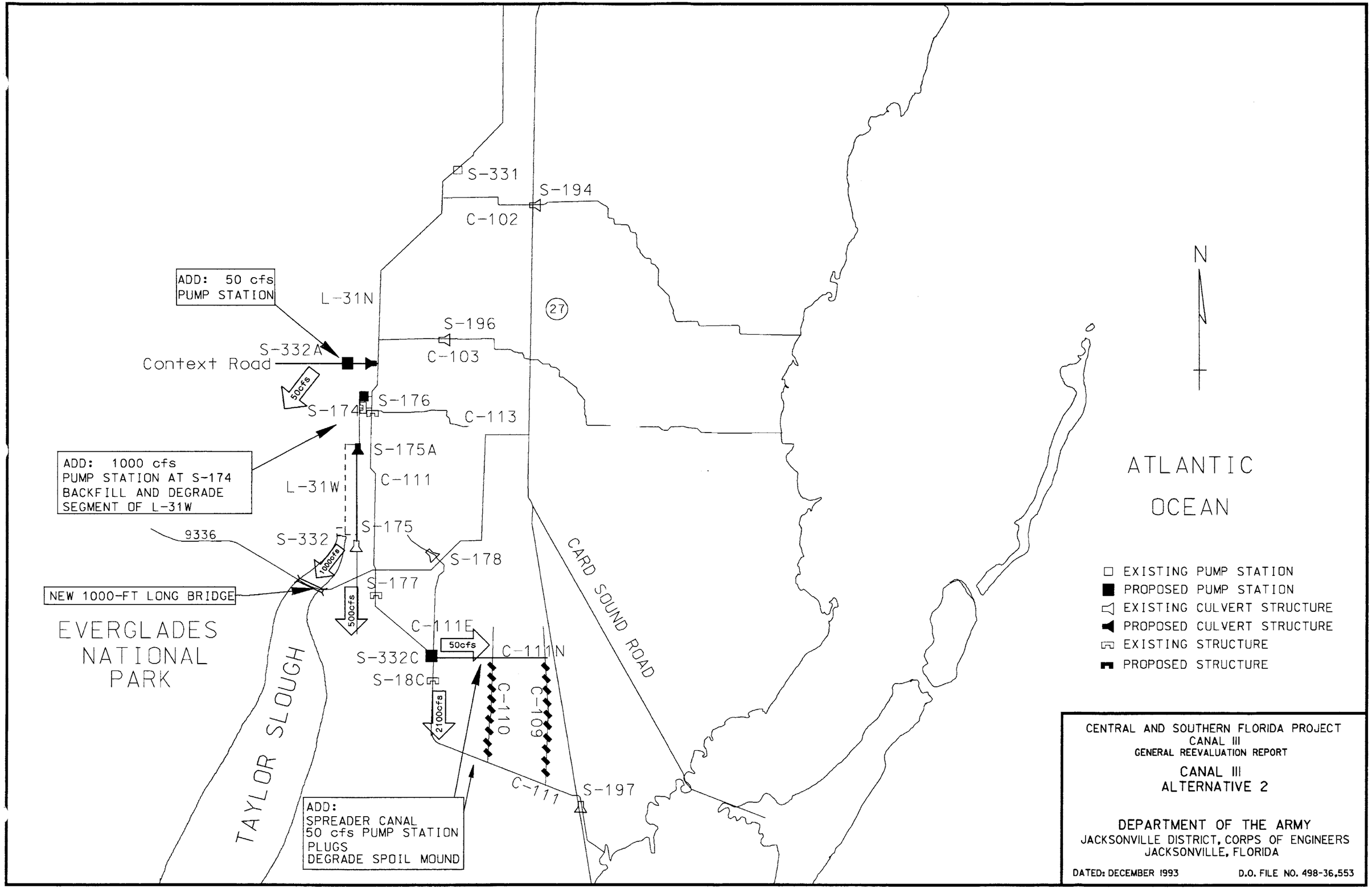
PLATE A-2



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CANAL III
GENERAL REEVALUATION REPORT

CANAL III
ALTERNATIVE 2

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

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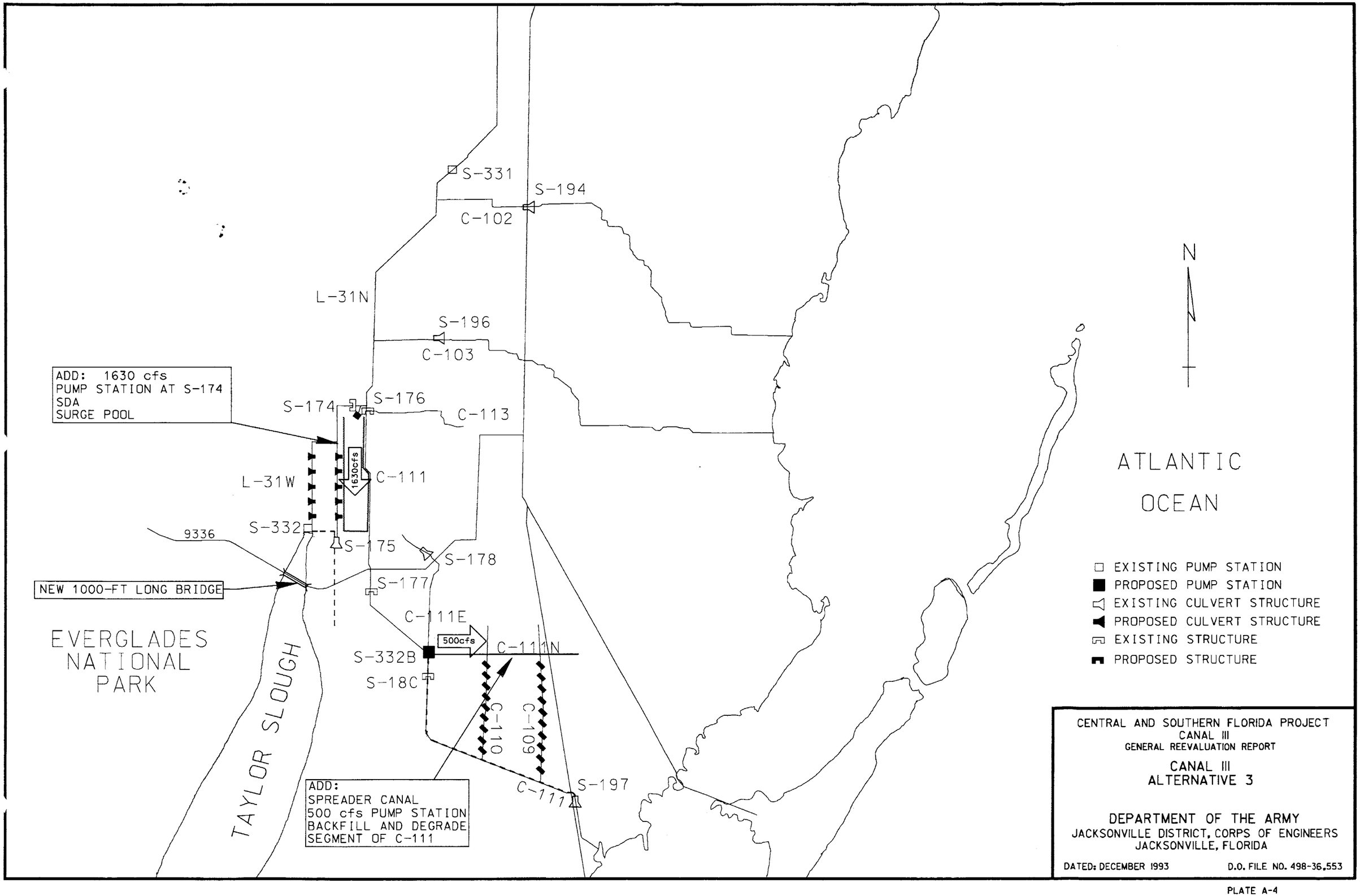
PLATE A-3



CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

CANAL III
ALTERNATIVE 3

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

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PLATE A-4

S-357

PUMP STATION AND SEEPAGE CANAL PROPOSED UNDER "MODIFIED WATER DELIVERIES" PLAN

S-332A

300cfs

S-331

S-194

C-102

S-332B

300cfs

L-31N

27

S-196

S-332C

300cfs

C-103

ADD:
L-31N TIEBACK
4 - 300 cfs PUMP STATIONS
BACKFILL AND DEGRADE
SEGMENT OF L-31W

S-332D

S-174

S-176

C-113

300cfs

L-31W

C-111

S-332

9336

185cfs

S-175

S-178

S-177

NEW 1000-FT LONG BRIDGE

500cfs

C-111E

500cfs

C-111N

S-332E

S-18C

1

EVERGLADES NATIONAL PARK

TAYLOR SLOUGH

CARD SOUND ROAD

C-110

C-109

C-111

S-197

ADD:
SPREADER CANAL
500 cfs PUMP STATION
BACKFILL AND DEGRADE
SEGMENT OF C-111

N

ATLANTIC OCEAN

- EXISTING PUMP STATION
- PROPOSED PUMP STATION
- EXISTING CULVERT STRUCTURE
- PROPOSED CULVERT STRUCTURE
- EXISTING STRUCTURE
- PROPOSED STRUCTURE

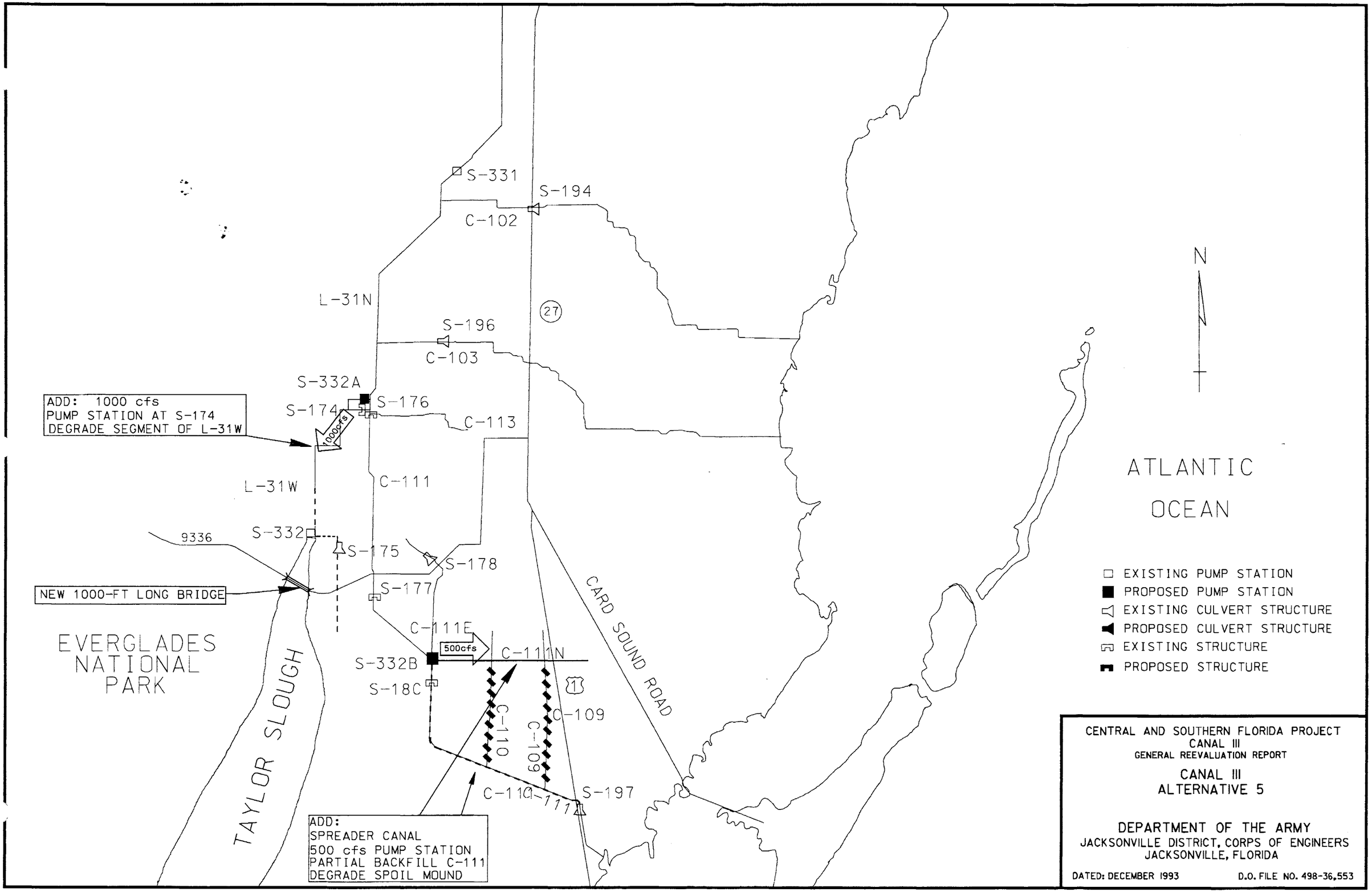
CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

CANAL III
ALTERNATIVE 4

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

DATED: DECEMBER 1993 D.O. FILE NO. 498-36.553

PLATE A-5



CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

CANAL III
ALTERNATIVE 5

DEPARTMENT OF THE ARMY
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JACKSONVILLE, FLORIDA

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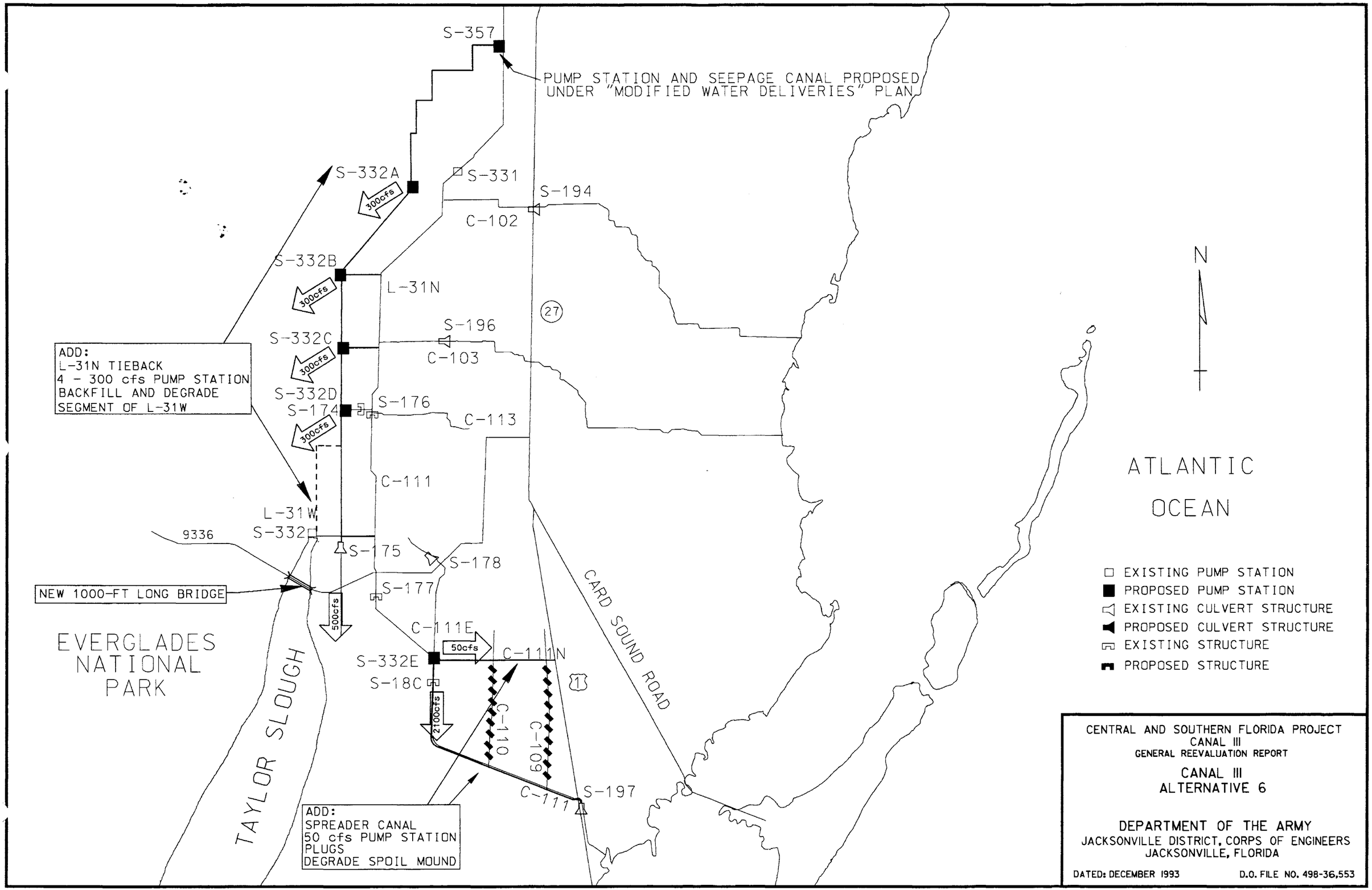
PLATE A-6



CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

CANAL III
ALTERNATIVE 6

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

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PLATE A-7

STRUCTURE	DISCHARGE
S-332A	300 cfs
S-332B	300 cfs
S-332C	300 cfs
S-332D	300 cfs
S-332E	50 cfs

S-357

PUMP STATION AND SEEPAGE CANAL PROPOSED UNDER "MODIFIED WATER DELIVERIES" PLAN

S-331

S-332A

300cfs

S-194

C-102

S-332D TIEBACK

S-332B

L-31N

300cfs

L-31W TIEBACK WITH 24 36" CULVERT RISERS

27

S-332C

S-196

300' OVERFLOW WEIR

C-103

300cfs

S-174

300cfs

S-332D

S-176

C-113

C-111

L-31W BORROW CANAL, BACKFILL AND DEGRADE SEGMENT OF L-31W

L-31W

S-332

9336

165cfs

S-175

S-178

S-177

NEW 1000-FT LONG BRIDGE

500cfs

C-111E

50cfs

C-111N

EVERGLADES NATIONAL PARK

S-332E

S-18C

1

2100cfs

C-110

C-109

C-111

S-197

TAYLOR SLOUGH

CARD SOUND ROAD

ADD:
SPREADER CANAL
50 cfs PUMP STATION
PLUGS
DEGRADE SPOIL MOUND

N

ATLANTIC OCEAN

- EXISTING PUMP STATION
- PROPOSED PUMP STATION
- EXISTING CULVERT STRUCTURE
- PROPOSED CULVERT STRUCTURE
- EXISTING STRUCTURE
- PROPOSED STRUCTURE

CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

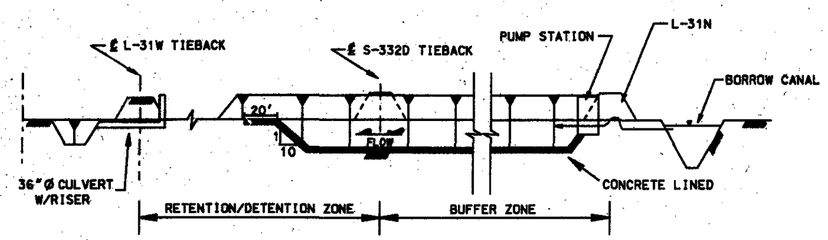
CANAL III
ALTERNATIVE 6A

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

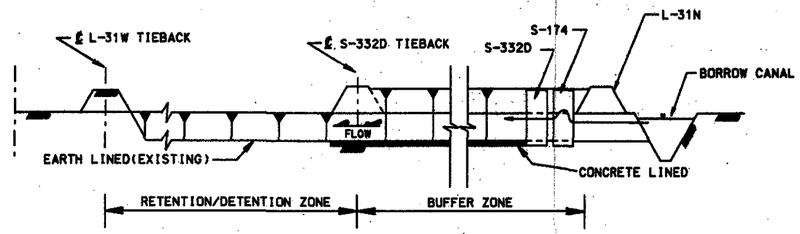
DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553

PLATE A-8

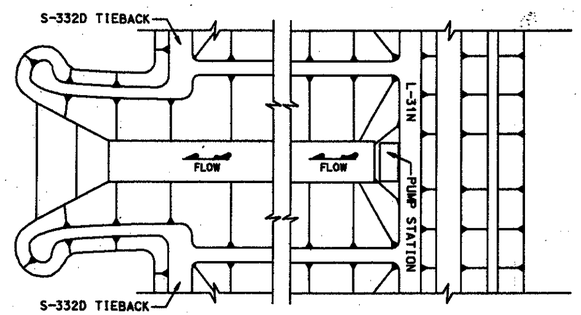
SCHEMATIC PROFILE
TYPICAL FOR DISCHARGE CANAL
FROM S-332A, S-332B, & S-332C
ALTERNATIVE 6A



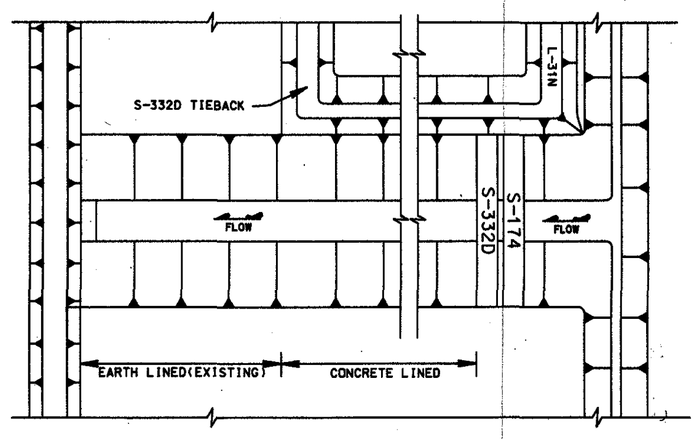
SCHEMATIC PROFILE
DISCHARGE CANAL FROM S-332D
ALTERNATIVE 6A



SCHEMATIC PLAN
TYPICAL FOR DISCHARGE CANAL
FROM S-332A, S-332B, & S-332C
ALTERNATIVE 6A



SCHEMATIC PLAN
DISCHARGE CANAL FROM S-332D
ALTERNATIVE 6A



NOT TO SCALE

CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

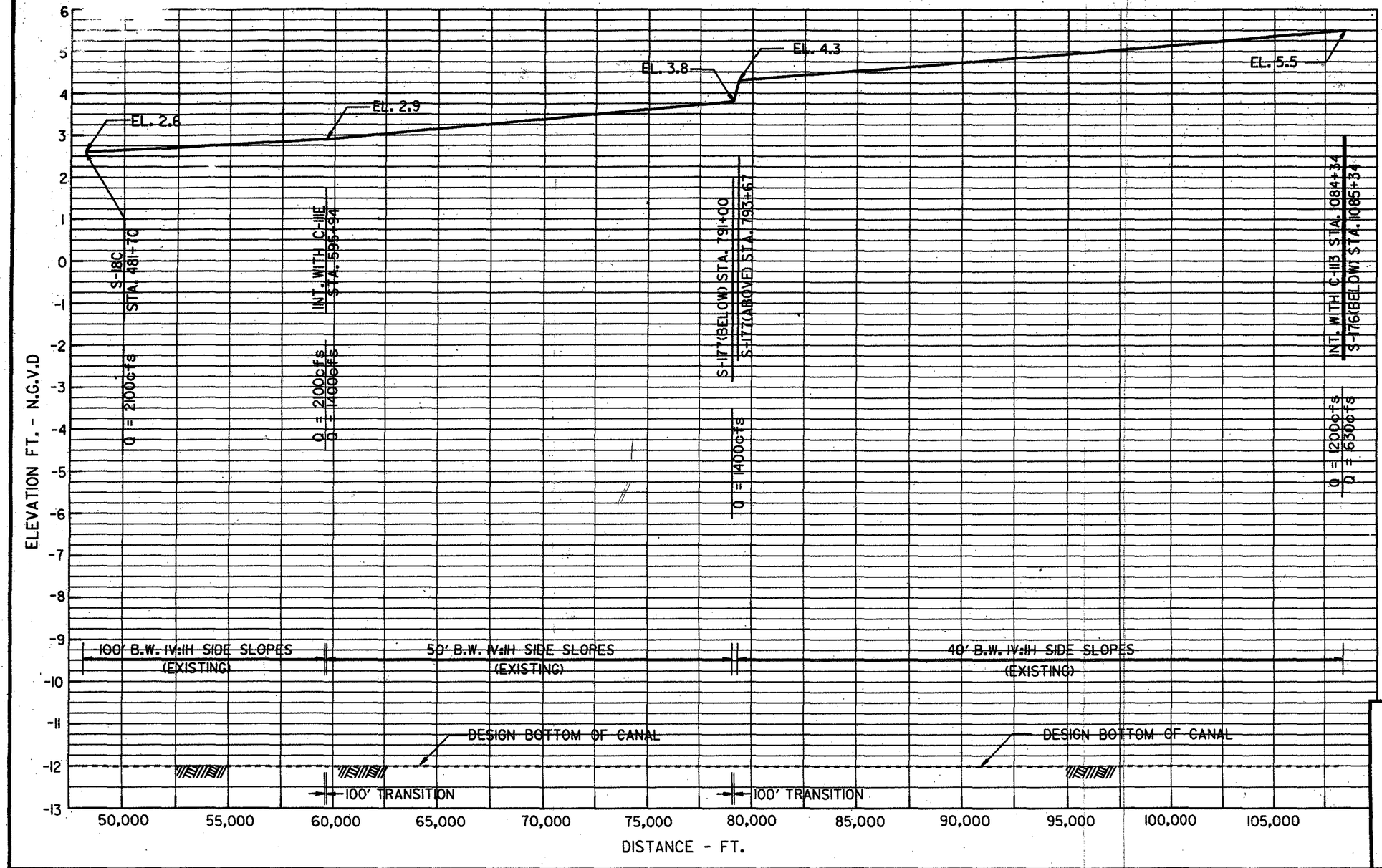
SCHEMATIC PLAN AND PROFILE

PUMP STATION DISCHARGE CANAL
AND CULVERT/RISERS

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

DATED: MARCH 1994 D.O. FILE NO. 498-36,553

PLATE A-9



LEGEND

EXISTING BOTTOM OF CANAL

WATER SURFACE

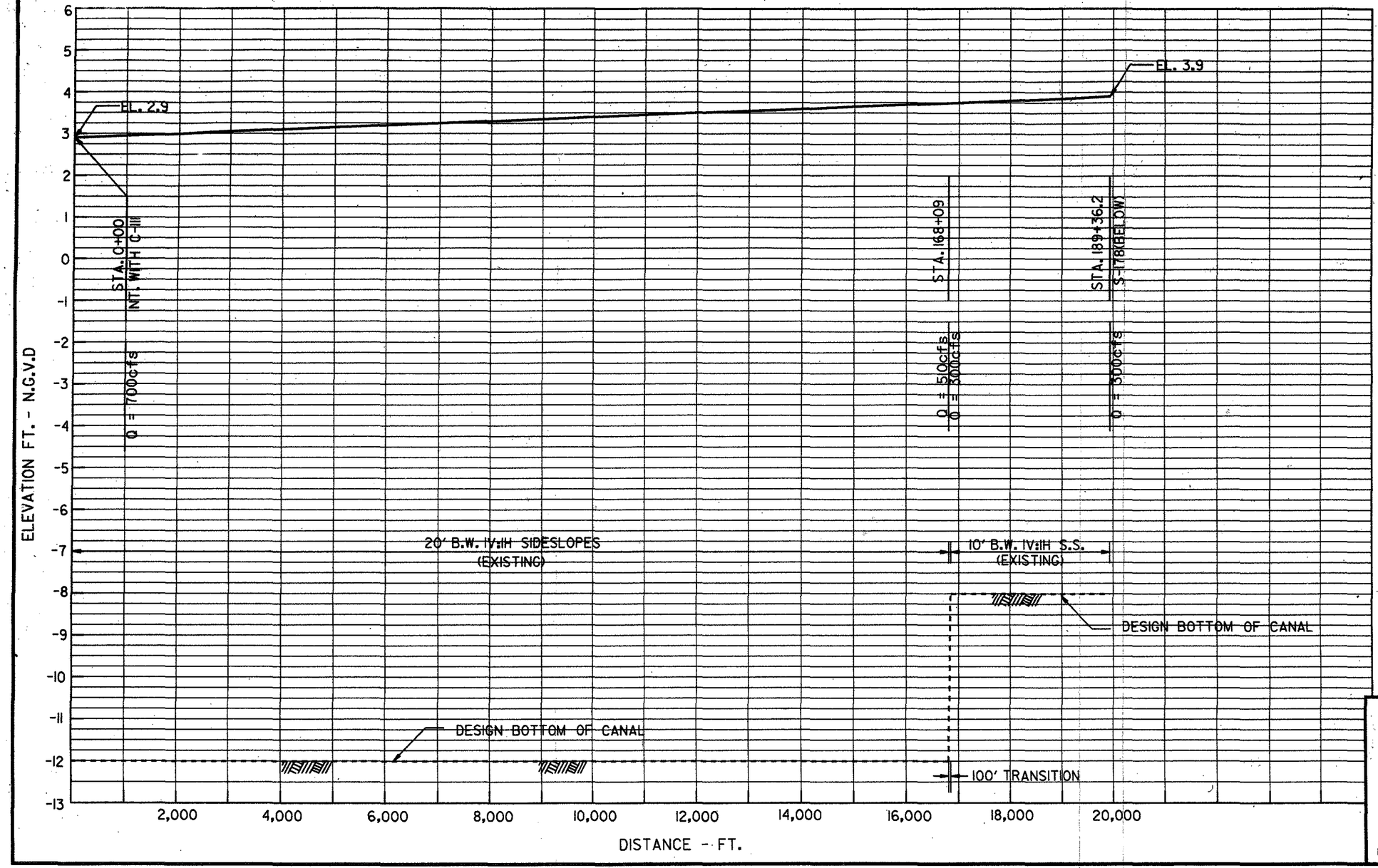
CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

CANAL III
FROM S-18C TO S-176
HYDRAULIC PROFILE

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

DATED: MARCH 1994 D.O. FILE NO. 498-36,553

PLATE A-10



LEGEND

EXISTING BOTTOM OF CANAL

WATER SURFACE

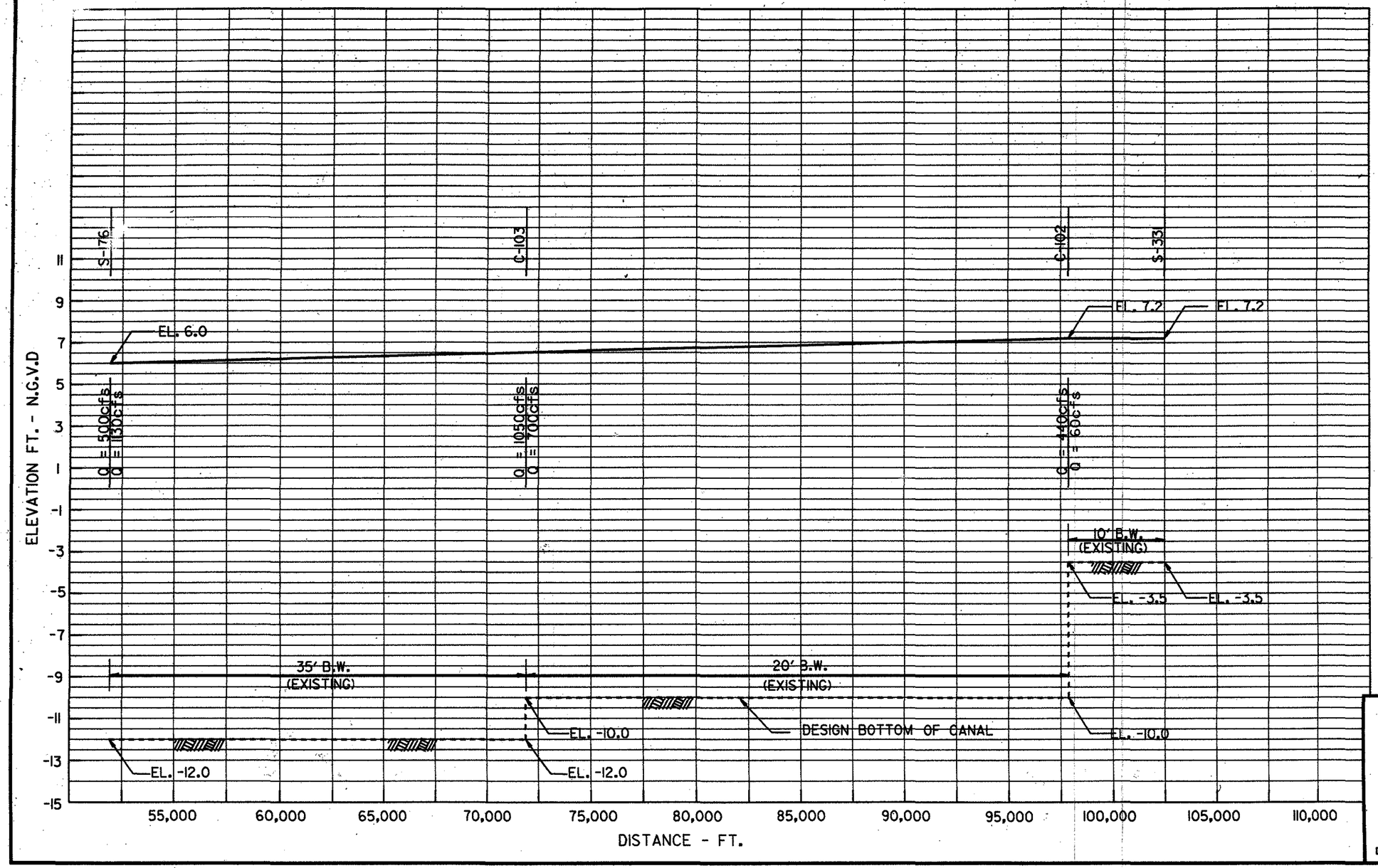
CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

CANAL IIIE
HYDRAULIC PROFILE

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

DATED: MARCH 1994 D.O. FILE NO. 498-36,553

PLATE A-II



LEGEND

EXISTING BOTTOM OF CANAL

WATER SURFACE

CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT
LEVEE 31(N) BORROW CANAL
FROM S-176 TO S-331
HYDRAULIC PROFILE

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

DATED: MARCH 1994 D.O. FILE NO. 96-36,553

PLATE A-12

C-111
GENERAL REEVALUATION REPORT
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Appendix B
Geotechnical Investigations

1. Investigations Performed. No new subsurface investigations were performed for this report. However, during the 1960's and 1970's, numerous core borings were obtained along the alignments of L-31W, C-111, C-111E, C-109, and C-110. Refer to Plates B-1 through B-6 for the geologic sections. Also during the 1960's and 1970's, core borings were obtained for the C-111 basin structures. The core boring logs for S-332, S-174, S-175, and S-18C are included in this section. Core borings and laboratory tests will be conducted for the detailed design phase.

2. Materials Encountered. The materials in the vicinity of the proposed features are anticipated to be characteristic of the general geology of the area. A layer of soft, unconsolidated material is underlain by medium-hard limestone. The overburden material varies in thickness and composition. The material is silty in some areas and highly organic along other reaches. The medium-hard limestone overlies a hard, sometimes cavernous, limestone formation. Penetration of the rock during drilling occasionally resulted in a highly fractured sample with poor recovery.

3. Excavation. The surficial materials can be removed using conventional methods. Excavation of the underlying rock will require blasting. Presplit blasting will be required for rock excavation adjacent to existing structures. Production blasting will be allowed for all other excavation.

4. Fill Material. The fill materials to be used for canal backfilling and levee construction will be limestone obtained from excavation operations and existing spoil mounds. Test pits will be used to determine the range of particle sizes in the existing spoil. It is anticipated that 70 percent of the blast material will be less than three inches in diameter; however, during blasting operations, occasionally dense slabs of limestone are encountered which will produce boulders three feet or greater in size. The boulders will be segregated from the suitable fill material.

5. Foundation Conditions and Settlement. The elevations for the structure foundations will be determined during the detail design phase. The structures will be founded on medium-hard to hard limestone which will provide adequate support. For the proposed levees, some settlement is expected where the levees are founded on the unconsolidated overburden. Settlement calculations will be performed in the detailed design phase to determine if overbuild is required.

6. Structure Dewatering. Dewatering for the five pump stations will be accomplished using a sheetpile cofferdam, a tremie concrete seal, and sump pumps. Due to the hardness of the rock, driving sheetpile will not be possible. Therefore, presplit blasting will be required along the sheetpile wall alignment. Based on past experience in the area, predrilling will be necessary for every third sheetpile location to facilitate installation. The culvert structures

will be constructed in the wet.

7. Stability Analysis. Based on existing canals in the C-111 basin, the canal side slopes (in rock) will be 1V:1H. The side slopes for the proposed levees will be 1V:3H. A detailed slope stability analysis will be conducted in the detailed design phase to determine if steeper embankment slopes will be stable. The critical factor will be the thickness of the unconsolidated overburden material.

8. Stone Protection. Based on the low exit velocities for all of the proposed culverts, riprap will not be required.

9. Proposed Cutoff Wall. Alternative 9 consists of an impermeable cutoff west of the agricultural areas. To evaluate the curtain wall alternative, an impervious barrier was modeled using the 2-dimensional finite element program ***FASTSEEP***. This program was used to calculate the quantity of seepage beneath a fully and partially penetrating cutoff barrier. The following assumptions were used in the analysis:

a) The geology of the area was assumed to consist of 45 feet of highly pervious limestone underlain by the much less permeable Tamiami Formation. This cross-section was assumed to be representative of the entire 16 mile length of wall.

b) The water level in ENP was assumed to be at ground level and the water level in the agricultural areas was assumed to be three feet below ground. This would be fairly representative of average daily conditions if this alternative were used.

c) The flow was assumed to be steady-state. Since average daily conditions were evaluated, this assumption would be accurate.

d) The horizontal permeability of the limestone aquifer was assumed to be 0.15 fps, which is 50% of the observed permeabilities in the C-111 area. The vertical permeability was assumed to be 0.015 fps which is 10% of the horizontal permeability. Both of these permeabilities are very low compared to the permeabilities observed in the field.

e) The wall was assumed to be imbedded 10 feet into the less permeable formation underlying the aquifer.

The seepage quantities from the finite element model were computed for the entire 16 mile length of wall. The results of the analysis are shown below:

Depth of Cutoff Wall (feet)	*Flow (cfs)*
55	7
40	4,250
30	6,250

From this analysis, it is apparent that an impermeable cutoff must extend the full depth of the aquifer to be effective. If the cutoff partially penetrates the aquifer, additional pump stations would be required to handle the resulting backseepage. This additional cost would make a partially penetrating cutoff much more expensive than a fully penetrating one.

It is important to note that the purpose of this model study was ***only*** to determine the necessary depth of imbedment for the cutoff and not to determine actual seepage rates. The results of this analysis agree with similar analyses done by the South Florida Water Management District. A 3-Dimensional groundwater model of the C-111 area is currently being developed to fully evaluate the water level impacts of this alternative during the detailed design phase. From an engineering standpoint, this alternative is very feasible. The most difficult and potentially expensive portion of this work is the excavation of a trench through the 45 to 50 feet of limestone to the base of the aquifer. Once the trench is open, any type of impermeable liner can be placed in the trench to produce the desired cutoff effect (except for a bentonite slurry wall which would not be feasible due to the cavernous nature of the limestone).

Since the cost of blasting a trench to this depth for such a great length is prohibitive, some type of rock excavating machinery would have to be used. Although the technology for this type of excavation currently exists, the cost for this type of equipment is extremely variable. Estimates from various contractors involved with this type of work range from $15 to $20 per square foot of wall placed. However, all of the contractors contacted during this study stated that trenches have not been excavated to the depths required by this project in rock materials.

The Little Rock District has recently attempted to use some of these trenching technologies to excavate rock at Beaver Dam. The first contractor tried using a trenching excavator but defaulted on the contract due to poor production rates. The second contractor is currently drilling the trench using a large diameter drill bit, but production is slow and he has already filed a claim against the Government. The final cost of the wall is expected to be about $150 per square foot of installed wall, not including claims.

10. Future Subsurface Investigations. A subsurface investigation will be performed during the detailed design phase to supplement existing data. A minimum of two holes per pump station and one hole per culvert structure will be obtained. Core borings will be acquired where needed for the proposed canals and levees.

C-111
GENERAL REEVALUATION REPORT
Appendix B
Geotechnical Investigations

CORE BORING LOGS

Appendix B
Geotechnical Investigations

CORE BORING LOGS

Structure	Hole Number
S-332	CB-S332-7 CB-S332-8 CB-S332-9 CB-S332-10 CB-S332-11
S-174	CB-1 CB-2 CB-3
S-175	CB-S175-1 CB-S175-2 CB-S175-3
S-18C	CB-S18C-1 CB-S18C-2 CB-S18C-3 CB-S18C-4

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~~15~~

Hole No. CB-S332-7

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2 SHEETS
1. PROJECT: C&SF Structure 332		10. SIZE AND TYPE OF BIT: See Remarks	
2. LOCATION (Coordinates or Station): Sta. 280+74.16; Rge. 1110 X 633,117 Y 395,631		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40-C	
4. HOLE NO. (As shown on drawing title and file number): CB-S332-7		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: C. Mason & R. Randall		14. TOTAL NUMBER CORE BOXES: 3	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: +2.3	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED 6-27-74 / COMPLETED 6-28-74	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE: +4.1	
9. TOTAL DEPTH OF HOLE: 34.7'		18. TOTAL CORE RECOVERY FOR BORING: 85 %	
		19. GEOLOGIST: T. NOVAK	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
+4.1	0.0					BIT OR BARREL +4.1 Bls/0.5 ft
+2.9	1.2		SILT, soft, calcareous, gray (ML)	30	1	SPLIT SPOON Pushed Pushed +2.6 55
			LIMESTONE, hard, porous, open solution holes, fossiliferous, buff to gray with yellow stains	100		DIAMOND 4 x 5-1/2 D.T. 23 min. H.P. 75 psi. +0.4
				96		" " " DIAMOND 4 x 5-1/2 D.T. 15 min. H.P. 75 psi. -1.4
				100		" " " DIAMOND 4 x 5-1/2 D.T. 25 min. H.P. 75 psi. -6.4
				100		DIAMOND 4 x 5-1/2 D.T. 35 min. H.P. 75 psi. -11.4

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE +4.1 | **Hole No.** CB-S332-7

PROJECT: C&SF Structure 332 | INSTALLATION: Jacksonville District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
						-11.4 Bls/0.5 ft
				100		DIAMOND 4 x 5-1/2 D.T. 35 min. H.P. 75 psi.
						-16.4
				100		DIAMOND 4 x 5-1/2 D.T. 17 min. H.P. 75 psi.
			Open solution holes from -18.9 to -20.2			
-20.4	24.5		Medium hard from -20.4 to -25.6			-20.4
				53		SPLIT SPOON 3 3 -21.9 9
				82		" " 8 15 -23.4 23
				86		" " 21 33 -24.9 23
-25.6	29.7			74		" " 8 -25.6 50
				100		DIAMOND 4 x 5-1/2 D.T. 45 min. H.P. 75 psi.
-30.6	34.7					-30.6
			NOTES: 1. Set 6" casing to -24.9 2. Hole grouted upon completion with 7 bags of Sakrete.			140# hammer with 30" drop used on 2.0' split spoon (1-3/8" I.D. X 2" O.D.)

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Hole No. CB-S332-8

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2 SHEETS
1. PROJECT: C&SF Structure 332		10. SIZE AND TYPE OF BIT: See Remarks	
2. LOCATION (Coordinates or Station): Sta. 280+44.16, Rge. 1150	X 635,083 Y 336,980	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40-C	
4. HOLE NO. (As shown on drawing title and file number): CB-S332-8		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: C. Mason		14. TOTAL NUMBER CORE BOXES: 4	
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: +3.8	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED 7-1-74 / COMPLETED 7-2-74	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE: +4.1	
9. TOTAL DEPTH OF HOLE: 35.0'		18. TOTAL CORE RECOVERY FOR BORING: 92.5 %	
		19. [redacted] GEOLOGIST: T. NOVAK	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
+4.1	0.0					BIT OR BARREL +4.1 Bls/0.5 ft
+2.8	1.3		SILT, soft, calcareous, gray (ML)	40	1	SPLIT SPOON Pushed +2.6 43
			LIMESTONE, hard, porous, solution holes, fossiliferous, slightly weathered, buff with yellow stains	100		DIAMOND 4 x 5-1/2 D.T. 13 min. H.P. 75 psi. +0.6
				100		DIAMOND 4 x 5-1/2 D.T. 15 min. H.P. 75 psi. -1.4
				100		DIAMOND 4 x 5-1/2 D.T. 25 min. H.P. 75 psi. -6.4
				100		DIAMOND 4 x 5-1/2 D.T. 35 min. H.P. 75 psi. -11.4

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE +4.1 | Hole No. CB-S332-8

PROJECT: C&SF Structure 332 | INSTALLATION: Jacksonville District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
						-11.4
				100		DIAMOND 4 x 5-1/2 D.T. 37 min. H.P. 75 psi.
						-16.4
				98		DIAMOND 4 x 5-1/2 D.T. 16 min. H.P. 75 psi.
						-21.3
			zones of open solution holes and badly broken from -21.3 to -26.3	95		DIAMOND 4 x 5-1/2 D.T. 28 min. H.P. 75 psi.
						-26.3
				100		DIAMOND 4 x 5-1/2 D.T. 43 min. H.P. 75 psi.
-30.9	35.0					-30.9
			NOTE: 1. Hole grouted upon completion.			140# hammer with 30" drop used on 2.0' split spoon (1-3/8" I.D. X 2" O.D.)

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PROJECT: C&SF Structure 332 | HOLE NO: CB-S332-8

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Hole No. CB-S332-9

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2 SHEETS
1. PROJECT C&SF Structure 332		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station) Sta. 280+44.16, Rge. 1110	X 633 723 Y 995 600	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood 40-C	
4. HOLE NO. (As shown on drawing title and file number) CB-S332-9		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED	UNDISTURBED
5. NAME OF DRILLER F. Crawford		14. TOTAL NUMBER CORE BOXES 2	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER +3.6	
		16. DATE HOLE STARTED 7-3-74	COMPLETED 7-8-74
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE +3.7	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING 51.7 %	
9. TOTAL DEPTH OF HOLE 34.0'		19. GEOLOGIST: T. NOVAK	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
+3.7	0.0					BIT OR BARPEL +3.7 B1s/0.5 ft
+2.5	1.2		SILT, soft, calcareous, gray (ML)	45	1	SPLIT SPOON Pushed Pushed +2.2 46
			LIMESTONE, hard, porous, solution holes, fossiliferous buff with yellow stains	30		DIAMOND NX D.T. 13 min. H.P. 75 psi. +0.2
				17		DIAMOND NX D.T. 18 min. H.P. 75 psi. -2.8
				8		DIAMOND NX D.T. 46 min. H.P. 75 psi. -7.8
				40		DIAMOND NX D.T. 16 min. H.P. 75 psi. -10.3

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE +3.7 **Hole No.** CB-S332-9

PROJECT C&SF Structure 332 | INSTALLATION Jacksonville District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
						-10.3 Bls/0.5 ft
			contains broken medium hard zones from -10.3 to -12.0	100		DIAMOND 4x5-1/2 D.T. 46 min. H.P. 75 psi.
						-15.3
				98		DIAMOND 4 x 5-1/2 D.T. 23 min. H.P. 75 psi.
						-20.3
				28		DIAMOND 4 x 5-1/2 D.T. 1 Hr. 2 min. H.P. 75 psi.
						-23.8
				56		SPLIT SPOON 6/47/7
			void from -25.2 to -25.8			-25.3
				47		" " 2/67
						-26.3
				100		DIAMOND 4 x 5-1/2 D.T. 30 min. H.P. 75 psi.
-30.3	34.0					-30.3
			NOTE: 1. Hole grouted upon completion with 7 bags of Sakrete.			140# hammer with 30" drop used on 2.0' split spoon (1-3/8" ID. X 2" O.D.)

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PROJECT C&SF Structure 332 | HOLE NO CB-S332-9

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Hole No. CB-S332-10

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2 SHEETS
1. PROJECT: C&SF Structure 332		10. SIZE AND TYPE OF BIT: See Remarks	
2. LOCATION (Coordinates or Station): Sta. 280+74.16, Rge. 1150.42 X 635,078 Y 895,618		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40-C	
4. HOLE NO. (As shown on drawing title and file number): CB-S332-10		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: F. Crawford		14. TOTAL NUMBER CORE BOXES: 4	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: +3.8	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED 7-11-74 / COMPLETED 7-12-74	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE: +3.8	
9. TOTAL DEPTH OF HOLE: 33.0'		18. TOTAL CORE RECOVERY FOR BORING: 89.2 %	
		19. [redacted] GEOLOGIST: T. NOVAK	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
+3.8	0.0					+3.8 Bls/0.5 ft
			SILT, soft, calcareous, gray (ML)	40	1	SPLIT SPOON Pushed Pushed Pushed
+2.3	1.5					+2.3
			LIMESTONE, hard, porous, fossiliferous, solution holes buff to light gray	90		DIAMOND 4 x 5-1/2 D.T. 14 min. H.P. 75 psi.
						+0.3
				100		DIAMOND 4 x 5-1/2 D.T. 43 min. H.P. 75 psi.
						-4.7
				100		DIAMOND 4 x 5-1/2 D.T. 40 min. H.P. 75 psi.
						-9.2

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE +3.8 | Hole No. CB-S332-10

PROJECT: C&SF Structure 332 | INSTALLATION: Jacksonville District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
						-9.2
				92		DIAMOND 4 x 5-1/2 D.T. 50 min. H.P. 75 psi.
						-14.2
				100		DIAMOND 4 x 5-1/2 D.T. 45 min. H.P. 75 psi.
						-19.2
			Open solution holes with poorly cemented zones from -21.7 to -25.7	98		DIAMOND 4 x 5-1/2 D.T. 55 min. H.P. 75 psi.
						-24.2
				94		DIAMOND 4 x 5-1/2 D.T. 50 min. H.P. 75 psi.
-29.2	33.0					-29.2
			NOTE: 1. Hole grouted upon completion with 7 bags of Sakrete.			140# hammer with 30" drop used on 2.0' split spoon (1-3/8" I.D. X 2" O.D.)

Hole No. CB-S332-11

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2 SHEETS
1. PROJECT C&SF Structure 332		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station) Sta. 280+59, Rge. 1130	X 633 701 Y 395 613	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood 40-C	
4. HOLE NO. (As shown on drawing title and file number) CB-S332-11		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER F. Crawford		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER +4.4	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE STARTED 7-15-74	COMPLETED 7-17-74
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE +4.0	
9. TOTAL DEPTH OF HOLE 31.5'		18. TOTAL CORE RECOVERY FOR BORING Not Attempted	
		19. [illegible] GEOLOGIST: T. NOVAK	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) e
			Recharge Tests; GPM/Ft. Head		BIT OR BARREL
+4.0	0.0				+4.0 Bls/0.5 ft
			SILT, (ML)		SPLIT SPOON Pushed
+2.7	1.3				+2.5 26
			LIMESTONE, hard, porous, solution holes, fossiliferous, buff to gray.		DIAMOND NX D.T. 10 min. H.P. 75 psi.
				*	+0.5
			NOTE: Core recovery was not attempted; therefore, a detailed description is not available.		DIAMOND NX D.T. 23 min. H.P. 75 psi.
					-2.5
				*	DIAMOND NX D.T. 40 min. H.P. 75 psi.
					-7.5
				*	DIAMOND NX D.T. 40 min. H.P. 75 psi.
					-12.5

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE +4.0 | Hole No. CB-S332-11

PROJECT: C&SF Structure 332 | INSTALLATION: Jacksonville District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
					BIT OR BARREL
					-12.5
				*	DIAMOND NX D.T. 46 min. H.P. 75 psi.
					-17.5
				*	DIAMOND NX D.T. 40 min. H.P. 75 psi.
					-22.5
				*	DIAMOND NX D.T. 45 min. H.P. 75 psi.
-27.5	31.5				-27.5
			NOTES: 1. No core recovery was attempted. 2. NX casing set to -22.5 3. *No head could be maintained with pump operating at maximum capacity (50 GPM)		140# hammer with 30" drop used on 2.0' split spoon (1-3/8" I.D. X 2" O.D.)

ENG FORM 1836-A JUN 67

Hole No. CB-1

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 1 SHEETS
1. PROJECT: C&SF Structure 174		10. SIZE AND TYPE OF BIT: See Remarks	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C	
4. HOLE NO. (As shown on drawing title and file number): CB-1		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: D. L. Loadholtz		14. TOTAL NUMBER CORE BOXES: 1	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: +3.5	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED 12/14/65 COMPLETED 12/15/65	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE: +6.2	
9. TOTAL DEPTH OF HOLE: 37.0		18. TOTAL CORE RECOVERY FOR BORING: 74 %	
		19. [redacted] Geologist: G. J. Kraynak	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	Blows/Ft
			Recharge Test GPN/Ft. head			Bit & Barrel	
+6.2	0.0					+6.2	
			LIMESTONE, medium hard, white to buff, with silt in voids & solution channels	100		2" I.D.SPOON	42 24 22 26 28
						+1.2	
				100	0.7	" "	24 23 27 28 40
						-3.8	
				95	*	" "	28 23 119 26 33
						-8.8	
				45	*	" "	27 22 25 5 41
-13.8	20.0					-13.8	
-15.8	22.0		LIMESTONE, hard, dense, buff fossiliferous, with occasional solution channels	95	*	DIAMOND NX -15.8	
			LIMESTONE, medium hard, light gray with silt in voids & solution channels	100		2" I.D.SPOON -18.8	107 27 26
-20.3	26.5			100		-19.8 " "	78
			LIMESTONE, hard, slightly dense, fossiliferous, light gray, with occasional solution channels	50	*	DIAMOND NX -23.8	
-25.8	32.0			40	*	DIAMOND NX -25.8	
-27.8	34.0	C	PROBABLY silt filled cavity	0		-27.8	Pushed Core Barrel
-30.8	37.0		LIMESTONE, hard, dark gray, dense, fossiliferous, with occasional solution channels	87	*	DIAMOND NX -30.8	
			*Raised no head with pump operating at 30 GPM			300# Hammer with 18" drop used on 2" I.D.SPOON Grouted with 4 bags sakrete	

ENG FORM 1836 1 APR 63 — PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801) GPO 1965 O-772-775

PROJECT: C&SF Structure 174 — HOLE NO: CB-1

Hole No. CB-2

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

1. PROJECT C&SF Structure 174	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood 40C
4. HOLE NO. (As shown on drawing title and file number) CB-2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED; UNDISTURBED
5. NAME OF DRILLER D. L. Loadholtz	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER +3.1
7. THICKNESS OF OVERBURDEN	16. DATE HOLE STARTED 12/15/65 COMPLETED 12/16/65
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE +6.1
9. TOTAL DEPTH OF HOLE 36.5	18. TOTAL CORE RECOVERY FOR BORING 71 %
	19. [redacted] Geologist G. J. Kraynak

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOV.	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	Blows/Ft
			Recharge Test GPM/Ft. head			Bit & Barrel	
+6.1	0.0					+6.1	
			LIMESTONE, Medium hard, white with silt in voids & solution channels, hard in thin layers	90		2" I.D.SPOON	45
							26
							25
							25
						+1.1	28
				90	2.8	" "	30
							30
							28
							40
						-3.9	33
				70	*	" "	32
							34
							224
							53
						-8.9	77
				90	*	" "	64
							45
							42
-12.9	19.0					-12.9	45
			LIMESTONE, hard, dense, light gray, slightly fossiliferous with occasional solution channels	60	4.5	DIAMOND NX	
						-17.9	
-19.4	25.5			50		-19.4 " "	
			LIMESTONE, medium hard white, fossiliferous with silt in voids & solution channels, hard in thin layers	90	6.0	2" I.D.SPOON	92
							34
							75
-23.4	29.5					-23.4	30
			LIMESTONE, hard, dark gray dense, fossiliferous, with occasional solution channels	25	*	DIAMOND NX	
						-28.4	
-30.4	36.5			85		-30.4 " "	
			*Raised no head with pump operating at 30 GPM			300# Hammer with 18" drop used on 2" I.D. SPOON	
						Grouted with 4 bags sakrete	

ENG FORM 1836 1 APR 63 — PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801) SPO 1965 OF—718-273

PROJECT C&SF Structure 174 | HOLE NO CB-2

Hole No. CB-3

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 1 SHEETS
1. PROJECT: C&SF, Structure 174		10. SIZE AND TYPE OF BIT: See remarks	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague and Henwood 40C	
4. HOLE NO. (As shown on drawing title and file number): CB-3		13. TOTAL NO OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: D. L. Loadholtz		14. TOTAL NUMBER CORE BOXES: 1	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: +3.2	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED 12/17/65 COMPLETED 12/20/65	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE: +6.4	
9. TOTAL DEPTH OF HOLE: 37.8		18. TOTAL CORE RECOVERY FOR BORING: 52%	
		19. [redacted] Geologist: G. J. Kraynak	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	(f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)	Blows/Ft
			Recharge Tests; GPM/Ft.Head			BIT & BARREL	Bls/Ft
+6.4	0.0					+6.4	
			LIMESTONE, medium hard, white, fossiliferous, with silt in voids and solution channels	90		2" I.D. Spoon	48
							40
							35
							28
						+1.4	30
				100	0.84	" "	46
							36
							38
							41
						-3.6	42
				60	*	" "	30
							30
							61
							68
						-8.6	31
				70	4.5	" "	51
							55
							53
-19.3	12.9					-12.9	16
			LIMESTONE, hard, dense, light gray, fossiliferous with occasional solution channels	40	4.5	DIAMOND NX	55
						-17.9	
				36	*	DIAMOND NX	
						-22.9	
-24.4	30.8			23		DIAMOND NX	
						-24.9	
-26.4	32.8		NO RECOVERY, probably medium hard limestone	0		2" I.D. Spoon	6
						-26.4	30
			LIMESTONE, hard, dense, dark gray, fossiliferous with occasional solution channels	50	*	DIAMOND NX	
-31.4	37.8					-31.4	
			*Raised hd head with pump operating at 30 GPM Hole grouted upon completion			300# Hammer with 18" Drop used on 2" I.D. Spoon	

ENG FORM 1836 1 APR 63 — PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801) GPO 1963 OF-713-275

PROJECT: C&SF Structure 174 — HOLE NO: CB-3

Hole No. CB-S 175-1

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2 SHEETS
1. PROJECT: C&SF STRUCTURE 175		10. SIZE AND TYPE OF BIT: see remarks	
2. LOCATION (Coordinates or Station):		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	
4. HOLE NO. (As shown on drawing title and file number): CB-S175-1		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: R. Gordon		14. TOTAL NUMBER CORE BOXES: 1	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: +4.8	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED 10/7/66 COMPLETED 10/10/66	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE: +4.9	
9. TOTAL DEPTH OF HOLE: 35.1'		18. TOTAL CORE RECOVERY FOR BORING: 63 %	
		19. [redacted] Geologist: R. Dineen	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)	
			RECHARGE TESTS; GPM/Ft.head			BIT & BARREL Bls/ft.	
+4.9	0.0					+4.9	
			LIMESTONE, buff to white, medium hard, oolitic, fossiliferous, solution riddled	88		2" I.D.Spoon	18 39 26 27 22
						-0.1	
				64	*	" "	24 20 16 23 206
						-5.1	
				100	*	" "	55 63 78
-8.1	13.0					-8.1	
			LIMESTONE, buff to white, hard, fossiliferous, lenses of softer limestone, solution riddled	60		DIAMOND NX -10.1	
				10	*	" " -12.1	
-13.8	18.7			14		" " -14.1	
			LIMESTONE, medium hard, buff to white, fossiliferous, lenses of sand below -20.1	100		-15.1 2" I.D.Spoon	8
				75	*	" "	27 21 11 10 29
						-20.1	

ENG FORM 1836 1 APR 63 — PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801) GPO 1963 OF-712-273

PROJECT: C&SF STRUCTURE 175 — HOLE NO: CB-S175-1

Hole No. CB-S175-1

DRILLING LOG	DIVISION: SOUTH ATLANTIC	INSTALLATION: Jacksonville District	SHEET 2 OF 2 SHEETS
1. PROJECT: C&SF STRUCTURE 175		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number): CB-S175-1		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED / COMPLETED	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING: %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (f)
			RECHARGE TESTS; GPM/Ft. Head			BIT & BARREL Bls/ft.
						-20.1
-22.8	27.7			10	*	2" I.D. Spoon 16 52 124
						-22.8
			LIMESTONE, buff to white, hard, fossiliferous, solution riddled, bed of softer sandy limestone from -24.9 to -26.6	81		DIAMOND NX
						-25.1
				100	*	2" I.D. Spoon 71 101
						-26.6
				32		DIAMOND NX
						-28.1
-30.2	35.1			48		" "
						-30.2
			*COULD RAISE NO HEAD WITH PUMP OPERATING AT MAXIMUM CAPACITY OF 36 GPM			300# Hammer with 18" drop used on 2" I.D. x 2-1/2" O.D. Spoon
			HOLE GROUTED UPON COMPLETION			

Hole No. CB-S175-2

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

1. PROJECT: C&SF STRUCTURE 175	10. SIZE AND TYPE OF BIT: see remarks
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
4. HOLE NO. (As shown on drawing title and file number): CB-S175-2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: R. Gordon	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: +5.2
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 9/30/66 COMPLETED 10/3/66
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE: +5.0'
9. TOTAL DEPTH OF HOLE: 35.0'	18. TOTAL CORE RECOVERY FOR BORING: 76 %
	19. Geologist: R. Dineen

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	(f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
			RECHARGE TESTS; GPM/Ft. head			BIT & BARREL Bls/ft.
+5.0	0.0					+5.0
			LIMESTONE, buff to white, oolitic, fossiliferous, medium hard	92	*	2" I.D. Spoon 9, 22, 31, 31, 15
			weathered from +5.0 to +3.0; sandy from +5.0 to -10.0			0.0
				86	*	" " 35, 12, 20, 19, 62
						-5.0
				90	*	" " 56, 45, 66, 130
-8.5	13.5					-9.0
			hard from -8.5 to -12.3	100		-10.0 DIAMOND NX
-12.3	17.3			40	*	" "
			oolite sand, buff, from -12.3 to -13.5			-12.5
-13.5	18.5			100		2" I.D. Spoon 18, 36, 56
-15.0	20.0		oolite sand, buff, from -15.0 to -16.3			-15.0
-16.3	21.3			80	*	" " 31, 20, 12, 5, 1
-28.0	25.0					-20.0

ENG FORM 1836 APR 63 — PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801) GPO 1963 O-711-375

PROJECT: C&SF Structure 175 | HOLE NO: CB-S175-2

Hole No. CB-5175-2

DRILLING LOG

DIVISION	INSTALLATION
SHEET 2 OF 2 SHEETS	
1. PROJECT	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) CB-5175-2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			RECHARGE TESTS; GPM/Ft.Head			BIT & BARREL Bls/ft.
-20.0	25.0					-20.0
			oolite sand, buff, from -20.0 to -22.5	100	*	2" I.D.Spoon 39 / 226 / 148
-22.5	27.5					-23.0
			hard from -22.5 to -30.0	21		DIAMOND NX -25.0
				41	*	" " -27.5
-30.0	35.0			62		" " -30.0
			*Could raise no head with pump operating at maximum capacity of 35 GPM HOLE GROUTED UPON COMPLETION			300# Hammer with 18" drop used on 2" I.D. x 2-1/2" O.D. Spoon

ENG FORM 1836 1 APR 63 — PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801) — PROJECT C&SF STRUCTURE 175 — HOLE NO CB-S175-2

Hole No. CB-S175-3

DRILLING LOG

DIVISION: South Atlantic

INSTALLATION: Jacksonville District

SHEET 1 OF 2 SHEETS

1. PROJECT: C&SF Structure 175
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-S175-3
5. NAME OF DRILLER: R. Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 35.1'
10. SIZE AND TYPE OF BIT: see remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED ____ UNDISTURBED ____
14. TOTAL NUMBER CORE BOXES: 1
15. ELEVATION GROUND WATER: +5.2
16. DATE HOLE: STARTED 9/26/66 COMPLETED 9/29/66
17. ELEVATION TOP OF HOLE: +5.1
18. TOTAL CORE RECOVERY FOR BORING: 64 %
19. [redacted]: Geologist: R. Dineen

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	Blows/ft.
						BIT & BARREL	
			RECHARGE TESTS; GPM;Ft.head				
+5.1	0.0					+5.1	
+4.1	1.0		LIMESTONE,white to buff, oolitic,medium hard,with thin hard streaks,layer of silt, sandy,dark buff,calcareous, from +4.1 to +2.8			2" I.D.Spoon	3
+2.8	2.3						18
				90			29
							36
						+0.1	34
						" "	24
							14
				76	6.0		33
							28
						-4.9	58
						" "	82
				63			37
					6.0	-7.9	513
				25		DIAMOND NX	
-10.7	15.8					-9.9	
-12.1	17.2		layr of sand,silty,calcareous, buff (SP) from -10.7 to -12.1 and from -15.1 to -19.3			2" I.D.Spoon	11
				100	6.0		3
							426
							125
-15.1	20.2					-14.9	49
						" "	19
							8
				20	1.4		4
							2
-19.3	24.4					-19.9	30

ENG FORM 1836 1 APR 63 — PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801) GPO 1963 O—711-173

PROJECT: C&SF Structure 175 — HOLE NO: CB-S175-3

Hole No. CB-S175-3

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 2 OF 2 SHEETS
1. PROJECT: C&SF STRUCTURE 175		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number): CB-S175-3		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED / COMPLETED	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)		REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (f)
			RECHARGE TESTS: GPM/FT. HEAD			BIT & BARREL Bls/ft.
						-19.9
-21.5	26.6			50	6.0	2" I.D.Spoon 61 / 54 / 800
			LIMESTONE, hard, white to buff, silty, fossiliferous from -22.9 to -26.9			-22.9
				80		DIAMOND NX
						-24.9
				85	6.0	" "
						-26.9
				85		" "
						-28.4
-30.0	35.1			95		" "
						-30.0
			HOLE GROUTED UPON COMPLETION			300# Hammer with 18" drop used on 2" I.D. x 2-1/2" O.D. Spoon

ENG FORM 1836 1 APR 63 — PREVIOUS EDITIONS MAY BE USED (EM 1110-1-1801) GPO 1965 O-718-275

PROJECT: C&SF Structure 175 — HOLE NO: CB-S175-3

HOLE NO. CB-S18C-1

DEPARTMENT OF THE ARMY DIVISION Corps of Engineers INSTALLATION Jacksonville, Florida DRILLING LOG	1. PROJECT C&SF Structure 18C 2. LOCATION (Coordinates or Station) X=656,808 Y=362,538 3. DRILLING AGENCY Corps of Engineers	SHEET 1 OF 1
4. HOLE NO. (As shown on drawing title and file No.) CB-S18C-1	5. NAME OF DRILLER C. R. Mason	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED; DEGREES WITH VERTICAL	7. THICKNESS OF OVERBURDEN	8. DEPTH DRILLED INTO ROCK 9. TOTAL DEPTH OF HOLE 39'
10. SIZE AND TYPE OF BIT See remarks	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood 40C
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED; UNDISTURBED	14. TOTAL NO. CORE BOXES 2	15. ELEV. GROUND WATER +2.0 16. DATE HOLE: STARTED 12/10/63; COMPLETED 12/10/63
17. ELEV. TOP OF HOLE 0.0	18. TOTAL CORE RECOVERY FOR BORING (%) 78	19. [redacted] Geologist Robert G. Kretchman

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
						Bit & Barrel Bls/Ft
0.0	0.0					0.0
			LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes, layers of hard limestone from -6.6 to -8.0 and from -10.5 to -13.0	70		2" I.D. Spoon 6, 8, 12
						-3.0
				70		" " 15, 25, 25/54
						-6.6
				57		NX Diamond
						-8.0
				92		2" I.D. Spoon 48, 67, 74
						-10.5
				24		NX Diamond
						-13.0
-15.0	15.0			79		2" I.D. Spoon 21, 11, 106, 127/100
			LIMESTONE, hard, light gray, fossiliferous, porous, friable solution holes			
						-17.3
				50		-18.0 NX Diamond
				90		" "
						-20.0
				84		" "
						-22.5
				84		" "
						-25.0
				100		" "
						-27.5
				100		" "
						-30.0
				100		" "
						-32.0
				60		" "
-34.0	34.0					-34.0
			LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes	80		2" I.D. Spoon 20, 20, 50, 48, 12
-39.0	39.0					-39.0
						300# Hammer w/18" Drop Used on 2" I.D. Spoon

HOLE NO. CB-S18C-2

DEPARTMENT OF THE ARMY
DIVISION Corps of Engineers
INSTALLATION Jacksonville, Florida

DRILLING LOG

1. PROJECT C&SF Structure 18C — SHEET 1 OF 2
2. LOCATION (Coordinates or Station) X=656,848 Y=362,540
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file no.) CB-S18C-2
5. NAME OF DRILLER G. M. Lineberger
6. DIRECTION OF HOLE: VERTICAL ☑ INCLINED ☐ DEGREES WITH VERTICAL
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE 53.7'
10. SIZE AND TYPE OF BIT See remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood 40C
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED - UNDISTURBED
14. TOTAL NO. CORE BOXES 2
15. ELEV. GROUND WATER +2.0
16. DATE HOLE: STARTED 12/2/63 COMPLETED 12/4/63
17. ELEV. TOP OF HOLE +0.7
18. TOTAL CORE RECOVERY FOR BORING (%) 62
19. [illegible] Geologist Robert G. Kretchman

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (description)	% CORE RECOVERY		REMARKS (drilling time, water loss, depth of weathering, etc., if significant)
						Bit & Barrel Bls/Ft
+0.7	0.0					+0.7
			LIMESTONE, hard, light gray, sandy, fossiliferous, porous, friable, solution holes	50		NX Diamond -2.0
				10		-3.0 " "
				35	6.40	" " -5.5
				50		" " -8.0
				45		" " -10.5
				90	3.20	" " -13.0
-14.0	14.7			100		-14.0 " "
			Layer of medium hard limestone from -14.0 to -19.0	25	7.44	2" I.D. Spoon -18.0 — 20, 20, 70, 73
-19.0	19.7			50		" " -20.0 — 90, 170
				87	10.70	NX Diamond -23.0
				No Rec.		-23.8 2" I.D. Spoon 87
				100		NX Diamond -25.6
				100	10.70	" " -28.0
				100		" " -30.8
				100	0.625	" " -33.0

ENG FORM 1836 1 MAR 61 (EM 1110-1-1801) TRANSLUCENT — PREVIOUS EDITION MAY BE USED UNTIL EXHAUSTED.

PROJECT C&SF Structure 18C HOLE NO. CB-S18C-2

HOLE NO. CB-S18C-2

DEPARTMENT OF THE ARMY
DIVISION Corps of Engineers
INSTALLATION Jacksonville, Florida

DRILLING LOG

1. PROJECT C&SF Structure 18C	SHEET 2 OF 2
2. LOCATION (Coordinates or Station)	
3. DRILLING AGENCY	
4. HOLE NO. (As shown on drawing title and file No.)	5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED; DEGREES FROM VERTICAL	7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK	9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL	
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED; UNDISTURBED	14. TOTAL NO. CORE BOXES
15. ELEV. GROUND WATER	16. DATE HOLE: STARTED; COMPLETED
17. ELEV. TOP OF HOLE	18. TOTAL CORE RECOVERY FOR BORING (%)
19. SIGNATURE OF INSPECTOR	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (description)	% CORE RECOVERY		REMARKS (drilling time, water loss, depth of weathering, etc., if significant)	
						Bit & Barrel	Bls/Ft
						-33.0	
				15		NX Diamond	
						-35.5	
				30	7.44	" "	
-38.0	38.7					-38.0	
			LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes				8
							9
				70	32.00	2" I.D."Spoon	7
							44
						-43.0	34
							27
							24
				70	"	" "	19
							44
-48.0	48.7					-48.0	47
			SAND, medium to fine, quartz, light gray (SP)				11
							15
				80	4.60	" "	33
							21
-53.0	53.7					-53.0	10
			*Raised no head with pump operating at full capacity of 32 g.p.m.			300# Hammer w/18" Drop Used on 2" I.D. Spoon	

END FORM 1836 1 MAR 61 (EM 1110-1-1801) TRANSLUCENT PREVIOUS EDITION MAY BE USED UNTIL EXHAUSTED.

PROJECT C&SF Structure 18C HOLE NO. CB-S18C-2

HOLE NO. CB-S18-C-3

DEPARTMENT OF THE ARMY
DIVISION Corps of Engineers
INSTALLATION Jacksonville, Florida

DRILLING LOG

1. PROJECT: C&SF Structure 18C — SHEET 1 OF 1
2. LOCATION (Coordinates or Station): X = 656,810 Y: 362,509
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file no.): CB-S18-C-3
5. NAME OF DRILLER: G. M. Lineberger
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED; DEGREES WITH VERTICAL
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 40.6'
10. SIZE AND TYPE OF BIT: See remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Sprague & Henwood 40C
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED; UNDISTURBED
14. TOTAL NO. CORE BOXES: 2
15. ELEV. GROUND WATER: +2.0
16. DATE HOLE: STARTED 12/6/63; COMPLETED 12/9/63
17. ELEV. TOP OF HOLE: +1.6
18. TOTAL CORE RECOVERY FOR BORING (%): 74
19. Robert G. Kretchman, Geologist

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (drilling time, water loss, depth of weathering, etc., if significant)
+1.6	0.0					Bit & Barrel Bls/Ft +1.6
			PEAT, brown, very silty (PT)			2" I.D. Spoon Pushed
-0.4	2.0			100	1	-0.4
			LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes	75		" " 12 " " 17 -3.4 23
				82		" " 15 18 75 70 -8.4 74
-10.4	12.0		Layer of hard limestone from -10.4 to -13.4	60		" " 80 -10.4 81
				45		NX Diamond -13.4
				50		40 17 " " 41 2" I.D. Spoon 58 -18.4 90
-18.4	20.0		LIMESTONE, hard, light gray, sandy, fossiliferous, porous, friable, solution holes	88		NX Diamond -20.9
				96		" " -23.4
				72		" " -25.9
				100		" " -28.5
				65		" " -30.9
				50		" " -34.0
-34.0	35.6		LIMESTONE: medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes	90		25 54 2" I.D. Spoon 33 17 -39.0 7
-39.0	40.6					300# Hammer w/18" Drop Used on 2" I.D. Spoon

ENG FORM 1836 1 MAR 61 (EN 1110-1-1801) TRANSLUCENT — PREVIOUS EDITION MAY BE USED UNTIL EXHAUSTED.

PROJECT C&SF Structure 18C HOLE NO. CB-S18-C-3
C-3

HOLE NO. CB-S18C-4

DEPARTMENT OF THE ARMY
DIVISION Corps of Engineers
INSTALLATION Jacksonville, Florida

DRILLING LOG

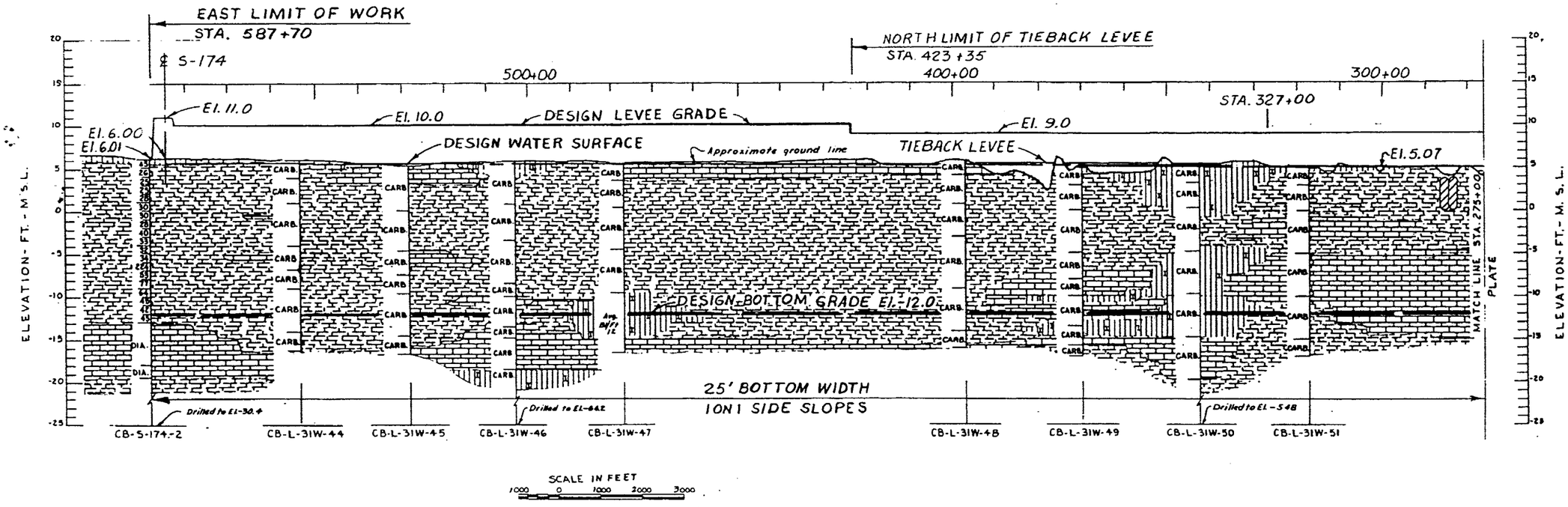
1. PROJECT C&SF Structure 18C — SHEET 1 OF 1
2. LOCATION (Coordinates or Station) X=656,850 Y=362,510
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file no.) CB-S18C-4
5. NAME OF DRILLER G. M. Lineberger
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED; DEGREES FROM VERTICAL
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE 42.5'
10. SIZE AND TYPE OF BIT See remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL Sprague & Henwood 40C
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED; UNDISTURBED
14. TOTAL NO. CORE BOXES 2
15. ELEV. GROUND WATER +2.0
16. DATE HOLE: STARTED 12/4/63; COMPLETED 12/5/63
17. ELEV. TOP OF HOLE +2.0
18. TOTAL CORE RECOVERY FOR BORING (%) 75
19. ~~SIGNATURE OF INSPECTOR~~ Robert G. Kretchman, Geologist

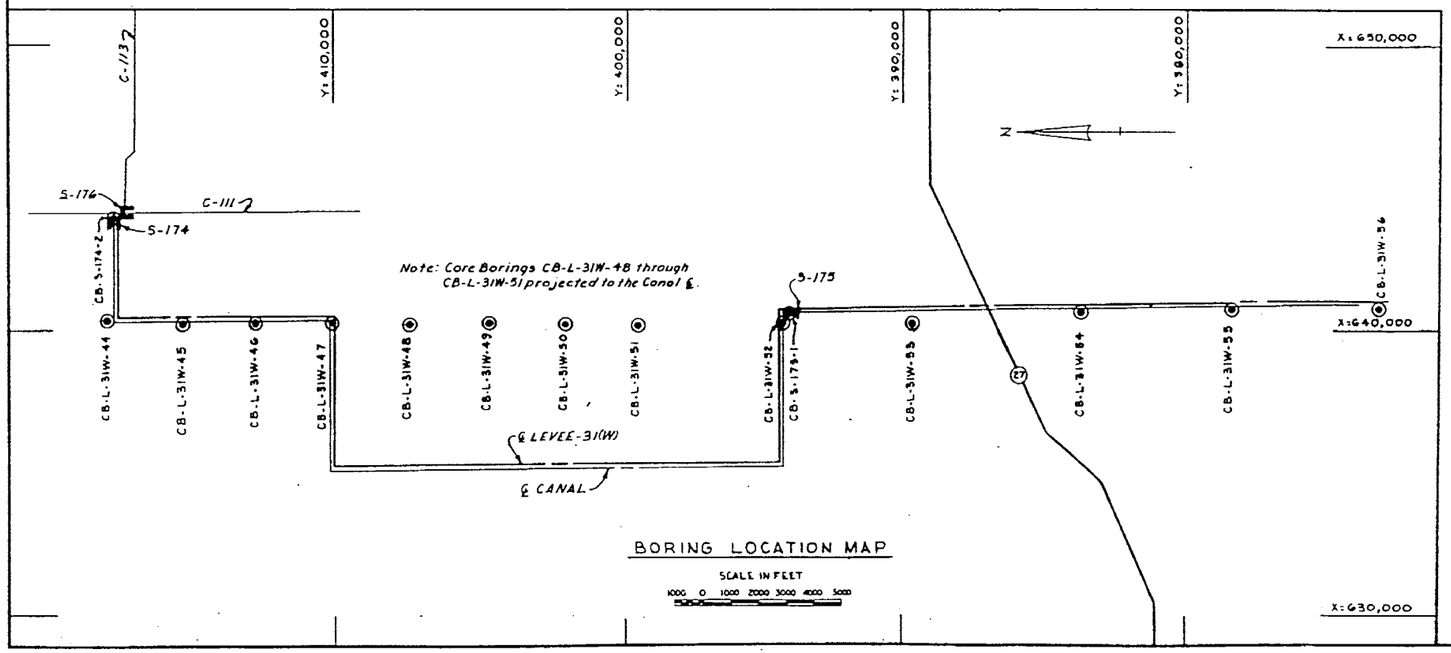
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	Blows/Ft
						Bit & Barrel	Blows/Ft
+2.0	0.0					+2.0	
+0.7	1.3		PEAT, dark brown, very silty (PT)		1	2" I.D. Spoon	Pushed
			LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable, solution holes	100			48
							80
						-3.0	15
							14
							10
							36
				75		" "	25
			Layer of hard limestone from -6.8 to -8.0			-6.8	45
				50		NX Diamond -8.0	
-9.8	11.8			45		2" I.D. Spoon -9.8	20 23
			LIMESTONE, hard, light gray, sandy, fossiliferous, porous, friable, solution holes, layer of medium hard limestone from -13.0 to -15.0	63		NX Diamond -13.0	
				50		2" I.D. Spoon -15.0	48 15
				60		NX Diamond -18.0	
				82		" " -21.0	
				85		" " -23.0	
				60		" " -25.5	
				100		" " -28.0	
				100		" " -30.5	
				100		" " -33.0	
				50		" " -35.5	
-35.5	37.5						
			LIMESTONE, medium hard, light gray, sandy, fossiliferous, porous, friable	80		2" I.D. Spoon -40.5	21 20 6 9 15
-40.5	42.5						
						300# Hammer w/18" Drop Used on 2" I.D. Spoon	

ENG FORM 1836 1 MAR 61 (EN 1110-1-1801) TRANSLUCENT — PREVIOUS EDITION MAY BE USED UNTIL EXHAUSTED.

C-111
GENERAL REEVALUATION REPORT
Appendix B
Geotechnical Investigations

PLATES





TIEBACK LEVEE DESIGN GRADE:
STA. 210+00 to 265+00 - EL. 5.5
STA. 265+00 to 327+00 - EL. 4.5
STA. 327+00 to 423+35 - EL. 5.5

SEE PLATE B-2 FOR LEGEND

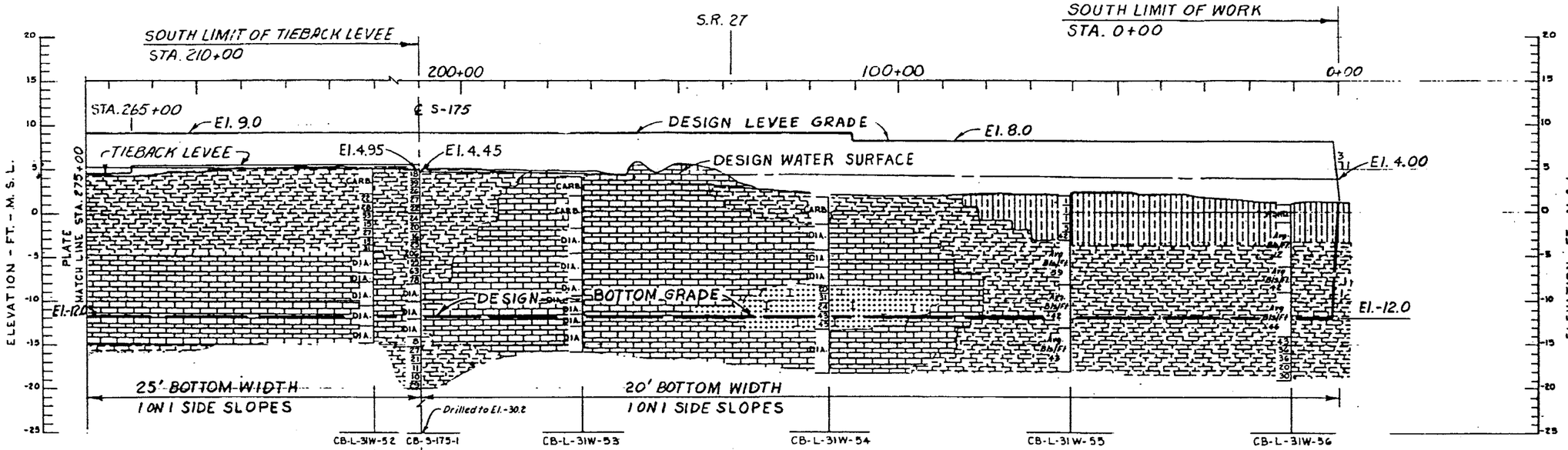
CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

LEVEE 31W
GEOLOGIC SECTION

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

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553

PLATE B-1



LEGEND.

- LIMESTONE FRAGMENTS, USED IN COMBINATION WITH OTHER SYMBOLS
- SAND, FINE TO COARSE, QUARTZ AND CALCITE, CONTAINS NUMEROUS LIMESTONE FRAGMENTS, COMPACT (SP)
- SILT, ORGANIC (OH)
- SILT, INORGANIC, GENERALLY SEMI INDURATED EXCEPT AT SURFACE, OCCASIONALLY CONTAINS LIMESTONE FRAGMENTS (ML)
- LIMESTONE, MEDIUM HARD, GENERALLY SILTY FROM CB-L31W-44 THROUGH CB-L31W-51, GENERALLY OOLITIC CB-L31-52 THROUGH CB-L31-56
- LIMESTONE, HARD, POROUS TO DENSE
- 72, 28, 53, 15, 27 — NUMBER OF HAMMER BLOWS REQUIRED TO ADVANCE A SOLID SPOON SAMPLER (2" I.D. x 2 1/2" O.D.) ONE FOOT USING A 300 POUND HAMMER FALLING 18 INCHES. THE SPOON IS 3 FT. LONG AND DRIVEN CONTINUOUSLY 5 FT., WHERE POSSIBLE.
- Ave 26/ft #3 — AVERAGE BLOWS PER FOOT FOR EACH FOOT OF ENTIRE RUN
- WSAD — WASHED AHEAD OF CASING
- CARB — DRILLED WITH CARBIDE TIPPED BIT
- DIA — DRILLED WITH DIAMOND BIT

PIPE DIA. CULVERT

CANAL SIDE INVERT

Note: See Plate 1 for Location map.

SCALE IN FEET
1000 0 1000 2000 3000

CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

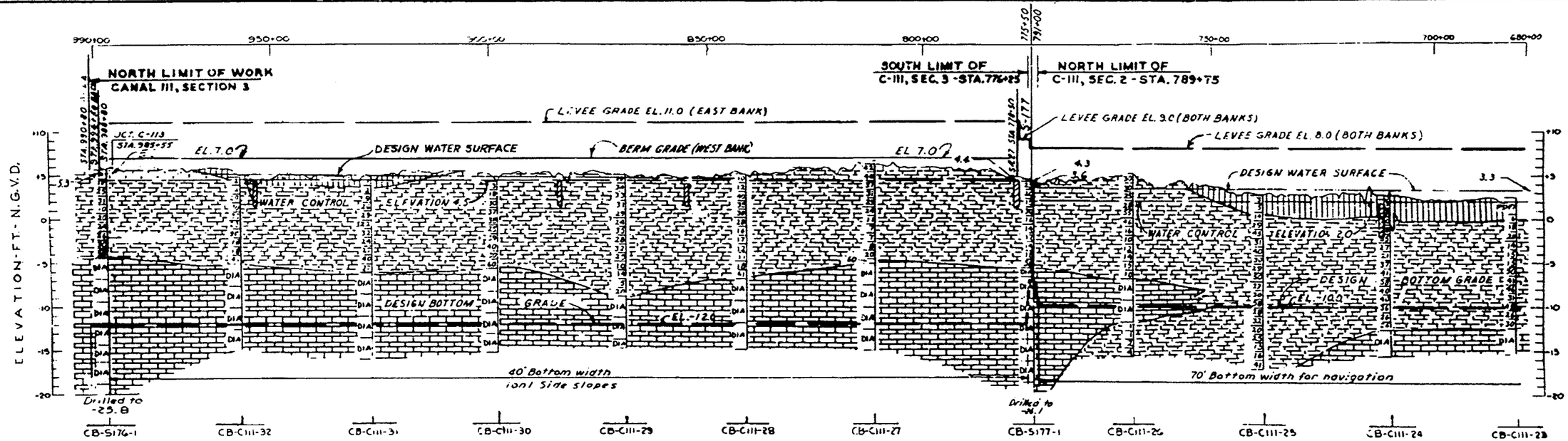
LEVEE 31W
GEOLOGIC SECTION

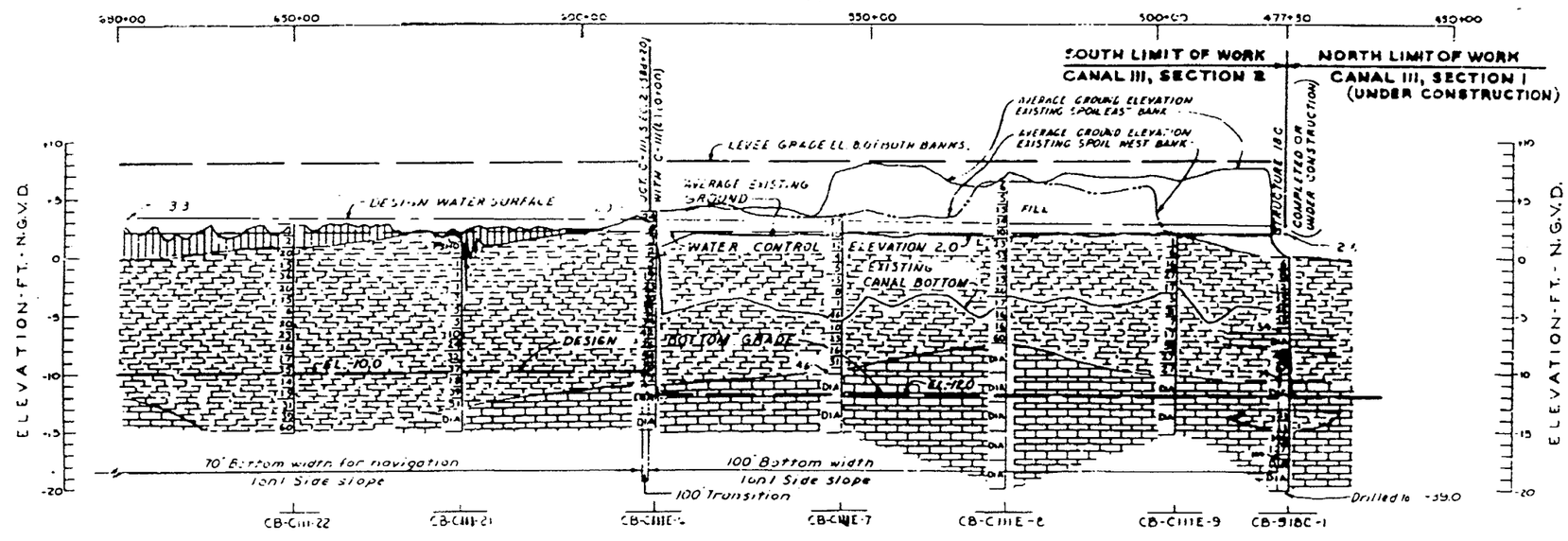
SCALES AS SHOWN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553

CORPS OF ENGINEERS

U S ARMY





CORE BORING SYMBOLS AND LEGEND

- SILT, CALCAREOUS (LOW PLASTICITY) (ML)
- LIMESTONE, HARD, SOLUTION RIDDLED, WITH THIN SOFT LAYERS, POROUS.
- LIMESTONE, MEDIUM HARD, OOLITIC, SOLUTION RIDDLED, SOLUTION HOLES PARTLY FILLED WITH SILT.
- 18 — NUMBER OF HAMMER BLOWS (350 FT. LBS. ENERGY) REQUIRED TO DRIVE A 2" INCH I.D. SOLID SAMPLE SPOON 1-FT. THE SPOON IS 5 FT. LONG AND DRIVEN CONTINUOUSLY 5 FT. WHERE POSSIBLE.
- FELL — SPOON SUDDENLY DROPPED AS ENTERING A CAVITY.
- PSHD — PUSHED SPOON DOWN WITHOUT AID OF HAMMER.
- DIA — DRILLED WITH "N" DIAMOND BIT.

NOTES:

1. MATERIAL CLASSIFIED IN ACCORDANCE WITH EM 1110-1-1806.
2. BORINGS TAKEN ALONG ℄ OF CANAL.

CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

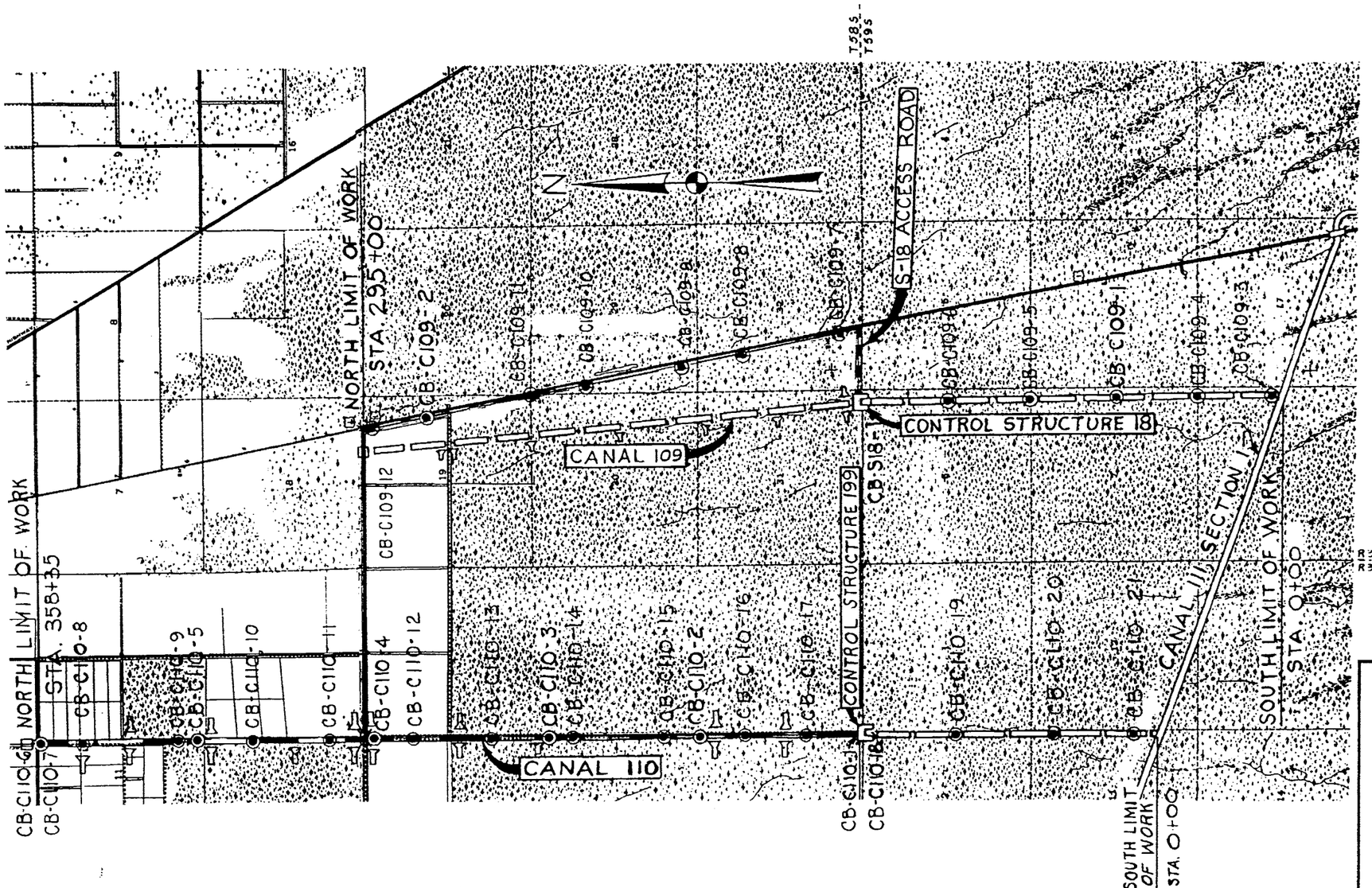
CANAL III AND CANAL IIIE GEOLOGIC SECTION

SCALES AS SHOWN

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

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553

PLATE B-3



LEGEND

- PROPOSED CONTROL STRUCTURE
- PROPOSED INLET STRUCTURE
- EXISTING INLET STRUCTURE
- PROPOSED CANAL
- IMPROVED CANAL
- EXISTING CANAL
- CORE BORING LOCATION AND DESIGNATION (CB-C110-1)
- SECTION CORNER (UNRECOVERED)
- ROAD CROSSING
- BRIDGE
- ACCESS ROAD

THIS PLATE REPRODUCED FROM U.S.C. & G.S. QUAD. SHEETS:
GLADES, 1956.
HOMESTEAD, 1956.

SCALE IN FEET
3000 0 3000 6000

CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

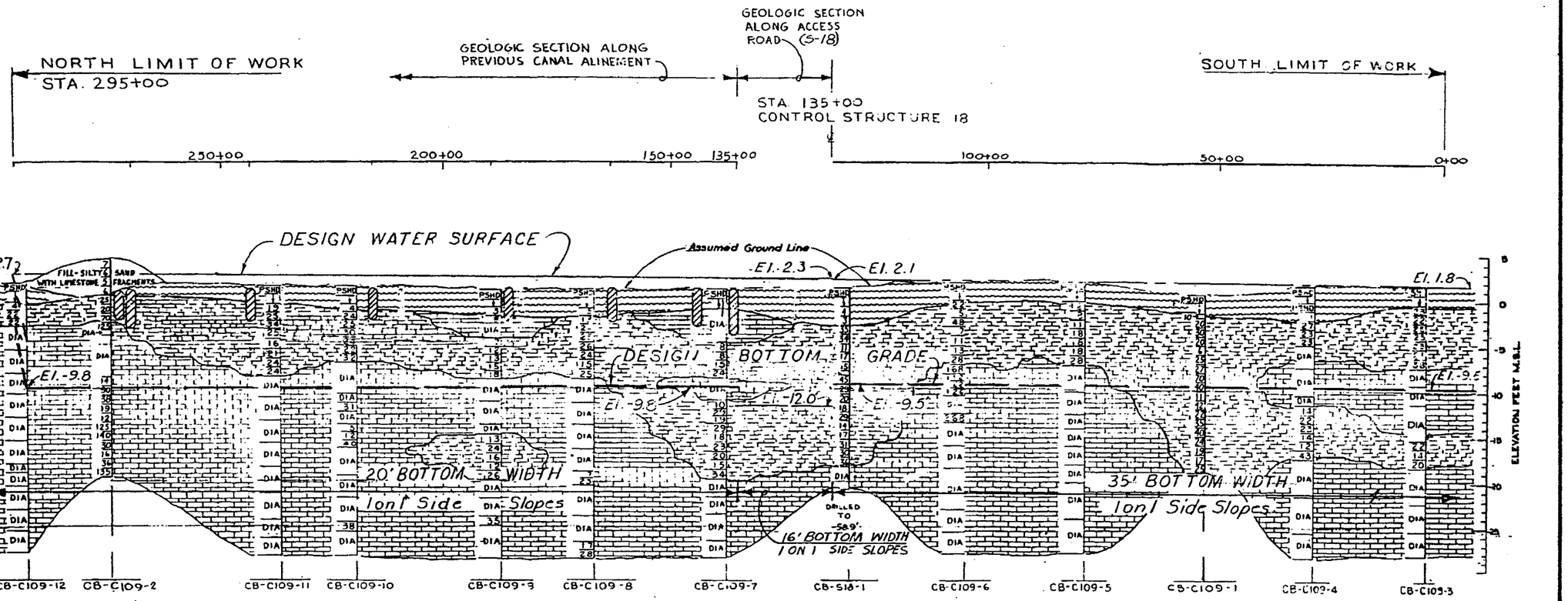
CANAL 109 AND CANAL 110 CORE BORING LOCATIONS

SCALES AS SHOWN

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

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553

PLATE B-4



LEGEND

- LIMESTONE - HARD, POROUS, FOSSILIFEROUS
- LIMESTONE - MEDIUM HARD, POROUS, FOSSILIFEROUS MANY THIN HARD LAYERS
- PEAT - DARK GRAY TO DARK BROWN LAYERS AND POCKETS OF VERY SOFT CALCAREOUS SILT (PT)
- 4, 8, 15, 10, 28, 16, 21, 24, 20, 10 — NUMBER OF HAMMER BLOWS REQUIRED TO ADVANCE A SOLID SAMPLE SPOON (2" I.D. x 2 1/2" O.D.) ONE FOOT, USING A 300 POUND HAMMER FALLING FREELY 18 INCHES. THE SPOON IS 5 FT. LONG AND IS DRIVEN CONTINUOUSLY 5 FT WHERE POSSIBLE.
- PSHD — PUSHED SPOON DOWN BY HAND
- DIA — DRILLED WITH "NX" DIAMOND BIT AND DOUBLE TUBED CORE BARREL
- PIPE DIA. CULVERT — CANAL SIDE INVERT

NOTE:
CORE BORING LOCATIONS SHOWN ON PLATE B-4.

CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

CANAL 109
GEOLOGIC SECTION

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

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553

NORTH LIMIT OF WORK
STA. 358+35

298+00 252+00 200+00

Approximate ground line along top of West spoil bank
Approximate natural ground line between borings
DESIGN WATER SURFACE
El. 3.5
El. 3.4
El. 3.3
SPOIL - CALCAREOUS SILT
EXISTING CANAL BOTTOM
SPOIL - LIMESTONE FRAGMENTS
EXISTING CANAL BOTTOM
DESIGN BOTTOM GRADE EL. -9.0
12' BOTTOM WIDTH 1 on 2 SIDE SLOPES
DESIGN BOTTOM GRADE EL. -10.5
25' BOTTOM WIDTH 1 on 1 SIDE SLOPES
MATCH LINE STA 86+50
ELEVATION - FEET, M.S.L.

CB-C110-7 CB-C110-8 CB-C110-9 CB-C110-5 CB-C110-10 CB-C110-11 CB-C110-4 CB-C110-12 CB-C110-13 CB-C110-3 CB-C110-14

150+00 100+00 93+35 50+00

SOUTH LIMIT OF WORK
STA. 0+00

CONTROL STRUCTURE 199

Approximate ground line along top of West spoil bank
DESIGN WATER SURFACE
Approximate natural ground line between borings
SPOIL LIMESTONE FRAGMENTS
El. 2.8
El. 2.6
EXISTING CANAL BOTTOM
DESIGN BOTTOM GRADE EL. -10.5
25' BOTTOM WIDTH 1 on 1 SIDE SLOPES
DESIGN BOTTOM GRADE EL. -12.0
40' BOTTOM WIDTH 1 on 1 SIDE SLOPES
MATCH LINE STA 86+50
ELEVATION - FEET, M.S.L.

CB-C110-15 CB-C110-2 CB-C110-16 CB-C110-17 CB-C110-18 CB-C110-19 CB-C110-20 CB-C110-21

LEGEND

- LIMESTONE, HARD, POROUS, FOSSILIFEROUS, SOLUTION HOLES, PERMEABLE
- LIMESTONE, MEDIUM HARD, POROUS PERMEABLE, MANY THIN HARD LAYERS
- SILT, CALCAREOUS, VERY SOFT (ML)
- PEAT, VERY SOFT SILT POCKETS (PT)
- 24 / 24 / 24 / 24 — NUMBER OF HAMMER BLOWS REQUIRED TO ADVANCE A SOLID SAMPLE SPOON (2" I. D. x 2 1/2" O. D.) ONE FOOT, USING A 300 POUND HAMMER FALLING FREELY 18 INCHES. THE SPOON IS 5 FT. LONG AND IS DRIVEN CONTINUOUSLY 5 FT. WHERE POSSIBLE.
- DIA — DRILLED WITH "NX" DIAMOND BIT AND DOUBLE TUBED CORE BARREL
- PSHD — PUSHED SPOON DOWN BY HAND
- FELL — SPOON FELL, AS THROUGH A CAVITY
- PIPE DIA. CULVERT — CANAL SIDE INVERT

SCALE IN FEET
-100' 0' 500' 1000'

NOTE:
CORE BORING LOCATIONS SHOWN ON PLATE B-4.

CENTRAL AND SOUTHERN FLORIDA PROJECT
CANAL III
GENERAL REEVALUATION REPORT

CANAL 110
GEOLOGIC SECTION

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

DATED: DECEMBER 1993 D.O. FILE NO. 498-36,553

PLATE B-6

C-111
GENERAL REEVALUATION REPORT
Appendix C
Real Estate Plan

Appendix C
Real Estate Plan

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Appendix C
Real Estate Plan

Table of Contents

Appendix C
Real Estate Plan

TABLES

PLATES

Appendix C
Real Estate Plan

1. Statement of Purpose.

This Real Estate Plan is tentative in nature for planning purposes only and both the final real property acquisition lines and the real estate cost estimates provided may change following approval of this General Reevaluation Report (GRR). The focus of this GRR is the restoration of the ecosystem that was affected by construction of the flood control project in the C-111 basin. The study focuses providing flood protection to the agricultural land in the C-111 basin, increased water supply to the Everglades National Park and environmental restoration to the Everglades.

2. Authorization.

The initial works of the Central and Southern Florida (C&SF) Project were authorized by the Flood Control Act of 30 June 1948 (Public Law 858, 80th Congress, 2d Session). C-111 is part of the South Dade County Area Plan of Improvement which was presented in Senate Document No. 138, 87th Congress, 2d Session and subsequently authorized as an addition to the C&SF Project by the Flood Control Act of 23 October 1962 (Public Law 87-874).

In 1968, the Everglades National Park (ENP) - South Dade Conveyance Canals were authorized by Public Law 90-483, Flood Control Act of 1968. The purpose of this system was for conservation and conveyance of water supplies to the eastern portion of the ENP and to the expanding agricultural and urban areas of south Dade County. Improvements to the L-31N borrow canal enabled delivery of water to Taylor Slough (via L-31W and S-332) and the Park's eastern panhandle (via C-111) to meet minimum water deliveries to ENP mandated by Public Law 91-282. No improvements were required in C-111 to handle the increased water supply.

3. Project Location.

The Canal 111 (C-111) Basin is part of the comprehensive Central and Southern Florida (C&SF) Flood Control Project. The study area is located in the extreme southeast of Dade County, Florida, approximately 40 miles southwest of downtown Miami, and four miles west of Homestead. Dade County is Florida's most populous county and the state's third largest in land area. Dade County is bordered on the north by Broward County, to the west by Collier County and to the south by Monroe County, which contains the Florida Keys. Eastern Dade County is bordered by the Atlantic Ocean. Along the western border of Dade County is the Florida Everglades and the Everglades National Park.

The project area is generally known as the East Everglades and is a large expanse of land in extreme southeast Dade County that is approximately 32 miles long, located east of Everglades National Park and west of Homestead. The boundaries of the area form an irregular shape, but are generally C-111 and L-31N to the east, the Everglades National Park to the west, Tamiami Trail to the north and C-111 to the south extending to U.S. 1. Primary arteries providing access to the area are Krome Avenue (U.S. 27) to the east, U.S. 1 to the south and east and S.R. 9336 leading from Homestead and Florida City into the Everglades National Park. Land elevations in the East Everglades vary from 8.5 feet above mean sea level east of C-111 to one foot in the area's southwest corner adjacent to the Park boundary.

4. Project Description.

There are several alternative project plans; however, Plan 6A is the recommended plan. The objective of Plan 6A is to deliver more water to the area north of Taylor Slough and the adjacent Rocky Glades area west of L-31N. To provide for higher stages and longer hydroperiods in the marshes, a "buffer zone" would be created to protect the developed areas east of L-31N. The zone would extend from the 8.5 square mile residential area north of SW 168th Street, south to include the entire Frog Pond ownership. To create the buffer zone, two new levees (L-31W Tieback and S-332D Tieback) and borrow canal system with four pump stations (S-332A, S-332B, S-332C, and S-332D) would be constructed roughly parallel and to the west of L-31N and C-111. At the south end of the buffer zone the L-31W Tieback levee would turn eastward and tie to the C-111 levee. The cut off portion of L-31W to the west of the L31W Tieback, and the portion of L-31W south of the new borrow canal would be filled to ground level. The north end of the L-31W Tieback would tie to the south end of the seepage levee near S-357 (proposed structures just south of the 8.5 square mile area included as part of the Modified Water Deliveries to Everglades National Park Project design). S-332D Tieback will tie into high ground in the Rocky Glades area somewhat north and one-half mile west of the junction of C-102 and L-31N borrow canal. A southern segment of the levee would turn eastward and run parallel to L-31W about one-half mile west of L-31N and tie into a new pump station that would be located immediately west of S-174 (S-332D). Four pump stations and four borrow canals would draw water from Canal L-31N and the buffer area into the new canal and ultimately into Taylor Slough.

A new canal known as the Spreader Canal (C-111 North) would be constructed in the lower C-111 area to maintain flood protection capability and to supply water for environmental restoration of the area served by C-109 and C-110. The Spreader Canal would receive water from C-111E and provide conveyance east across Canals 109 and 110. Canals 109 and 110 would be plugged in several places to allow overland flow.

A large mound of material excavated in the construction of C-111 remains on the canal's south bank. Its partial gaps would be leveled to natural ground level to allow sheet flow southward. Major flood waters could be passed through the C-111 and S-197 system to Barnes Sound.

The mounds of material along C-111 and the material to be excavated from the gaps will be used to construct the new levees. If additional material is needed, the proposal is to excavate the material from the Everglades National Park adjacent to S-332B, S-332C and S-332D.

All construction work areas, access roads and disposal areas are located within the proposed right-of-way limits.

For the purpose of this planning document, all non-Federal lands identified for project purposes have been valued in fee to reflect the worst case scenario. There are approximately 11,866 acres of land required to support this project, 1,078 acres located within the Everglades National Park. Prior to acquiring any lands, a Real Estate Design Memorandum (REDM) will be prepared to determine if lesser estates can be acquired. Operational Studies will be conducted for the recommended plan during the design and construction phase to identify the optimum operating strategy for C-111 Project and the Modified Water Deliveries to ENP Project.

Because operational studies have not been completed, no determination can positively be made at the present time as to the exact number of acres required for the proposed plan nor can the estates be determined. For the lands underlying the proposed new structures (four new pump stations, the four new getaway canals, the new levees, [S-332D Tieback levee and L-31W Tieback levee], and the connector canal from C-111 to S-332) would probably have to be acquired in fee because there would be "no functional use of the land after imposition of the easement" or more than likely any easement acquired would be valued "in excess of 75 percent of fee value". (ER 405-1-2, Draft Chapter 12, paragraph 12-18b.) As to the lands within the retention/detention area in the Rocky Glades between the proposed L-31W Tieback levee and the proposed S-332D Tieback levee, the estate which would be acquired would depend on the finalization of the operating studies. It may be possible that only a permanent flowage easement would be required. The impact of the proposed plan on the remaining lands also can not as yet be determined. Upon completion of operational studies and the Feature Design Memorandum, a final determination will be made as to the exact acreage to be acquired and the estates required.

5. Government Owned Lands.

Approximately 1,078 acres of the Everglades National Park is proposed for the project. The Park boundary meanders through the western portion of the buffer zone throughout the Rocky Glades area. Everglades National Park land is included in total project acreage but has not been valued.

6. Sponsor Owned Lands.

Approximately 300 acres of the proposed project area are owned in fee by South Florida Water Management District (SFWMD). The majority of this land is in the southern portion of the proposed project.

The Department of Interior (DOI) legislation to amend the Everglades National Park Protection and Expansion Act of 1989 (P.L. 101-299), authorized the funding to acquire and cost share the lands in the Rocky Glades and Frog Pond through a 25 percent Federal (DOI) contribution. There is a strong possibility that the lands needed to support the C-111 Project will be sponsor owned prior to lands being requested for the project.

7. Appraisal Information.

The following information is extracted from the gross appraisal and the revised gross appraisal prepared for this project.

a. General. The project real estate requirements include two land classifications. From the 8.5 square mile area on the projects extreme north end, south to the southern limits of the Frog Pond, land use is agricultural. Features in this northern portion of the project include the New Canal, three cross canals for conveyance between the New Canal and L-31N, and several flood control structures. The area between the New Canal and L-31N is known as the "buffer zone". It extends from the 8.5 square mile area south to include the Frog Pond. The project's southernmost features include construction of the Spreader Canal, the plugging of C-109 and C-110 to improve overland conveyance, and the creation of gaps along the south bank of lower C-111. The land classification throughout this area is designated wetlands.

Affected agricultural land extends from SW 168th Street (the southern limit of the 8.5 Square Mile Area) to the southern portion of the Frog Pond. The area north of the Frog Pond to SW 168th Street is known as the Rocky Glades. It lies contiguous to the west of C-111/L-31N with Everglades National Park bordering the area to the west. The affected area contains approximately 290 ownerships ranging in size from 5 acres to $\pm$ 300 acres. A portion of the New Canal and buffer zone is within the Everglades National Park. The Park boundary meanders through the western portion of the buffer zone throughout the Rocky Glades area. Everglades National Park land is not included in project acreage.

Project lands in the Rocky Glades and the Frog Pond are west of C-111/L-31N. They do not receive the level of flood protection offered by the canal and are considered a riskier farming venture.

b. Rocky Glades. Project features in the Rocky Glades area north of the Frog Pond are contiguous to the buffer zone. The buffer zone in the Rocky Glades totals 5,322 acres all of which are valued in fee simple. The fee value for this area is $25,335,000. This

represents the maximum interest potentially required. Exact acreage and estate will be determined in the Real Estate Design Memorandum.

c. Frog Pond. The Frog Pond ownership is ± 5,215 acres in size of which approximately 389 acres are protected tree islands and sloughs. The remainder of the Frog Pond is productive rock plowed land. The fee value for this area is $11,994,500. This represents the maximum interest potentially required. Exact acreage and estate will be determined in the Real Estate Design Memorandum.

d. Project's Southern Portion - Wetland. The project land requirements for the Spreader Canal, C-109, C-110 and the gaps along lower C-111 require a total of 251 acres of designated wetlands. The features lie predominately within one large wetland tract owned by South Florida Water Management District. Land requirements are valued in fee simple. The real estate value for this area is $251,000. This represents the maximum interest potentially required. Exact acreage and estate will be determined in the Real Estate Design Memorandum.

e. Improvements. There are four residential improvements with outbuildings and/or pole sheds located in the Rocky Glades area. Their total value is estimated by the Cost Approach to be $149,300.

f. Benefits. Benefits associated with the project are the general benefits to the farmers east of the existing L-31N, thus having no effect on this valuation. There are no special benefits associated with the project. Wetland tracts to the south are not enhanced or diminished in value by any increase in stages.

8. Severable Use Rights (SUR).

a. Background. The Metropolitan Dade County Government, as part of its zoning regulations, enacted Code Section 33B in October 1981 to protect, enhance and preserve the public and private resources of the East Everglades. These land management and development regulations are designed to provide a development alternative to on-site development of owners of land located in the East Everglades. The Code section (33B-43) creates Severable Use Rights (SURs) for these owners in statutory designated amounts. These SURs are transferrable and can be used to secure a development bonus for the development of other lands located in unincorporated Dade County.

b. Valuation of SUR. Appraisers can value SURs using the sales comparison approach if there are sufficient transactions to constitute a market. When the market is inadequate, appraisers may use the income capitalization approach. In such cases, property through the acquisition of a SUR is adjusted for administrative, legal and other costs incurred.

c. Real Property or Personal Property. For acquisition of lands by the United States Park Service within the expanded Everglades National Park and for the acquisition of the land within the eight and one half square mile area required for the Modified Water Deliveries to the ENP being acquired by the U.S. Army Corps of Engineers, the United States Department of Justice is presently in the process of determining whether SURs are real or personal property and whether the Federal government will be required to purchase the SURs. The REDM will fully address the acquisition of the SURs. For the purpose of C-111 project, any value placed on SUR if acquired would be covered in contingencies. The fee estates contained in Paragraph 23 of this report provides for acquisition of the SURs (alternative one) and for fee acquisitions which excluded the SURs (alternative two).

9. Relocation Assistance (Public Law 91-646).

There are four (4) residential improvements within the project area that may be affected by this project. If affected, the local sponsor will be required to pay relocation payments as specified under the provisions of Title II of Public Law 91-646. At this time, the estate needed in this area can not be identified. For the purpose of this planning report, estimated relocation costs are being included in total project costs.

Estimates of costs to comply with Public Law 91-646 total $90,000. This figure represents a payment of $22,500 for each of the 4 owner-occupied residential relocations which includes expenses incurred for recording fees, transfer taxes and costs of prepayment for pre-existing mortgages incident to conveying real property to the local sponsor and the estimated costs with providing displaced persons with comparable decent, safe and sanitary replacement housing.

A preliminary survey of the area indicates that there appears to be sufficient decent, safe and sanitary replacement housing available for persons affected under the project.

10. Acquisition/Administrative Costs.

Data included in calculating the project acquisition/administrative costs include an estimate of 290 ownership tracts as determined by tax maps and 4 residences requiring PL 91-646 relocations assistance.

Federal Acquisition/Administrative Cost Estimate:

Project Planning	$ 40,000
Review of Acquisitions (290 @ $500 ea)	$ 145,000
Review of Appraisals (290 @ $400 ea)	$ 116,000
Review of Condemnations (estimate of 50 @ $2,000)	$ 100,000
Review of PL 91-646 (4 @ $300)	$ 1,200
Review of Temporary Permits	$ 500
Draft PCA Review by Real Estate	$ 2,000
Total Federal Acquisition/Administrative Cost (Rounded)	$ 404,700

Non-Federal Acquisition/Administrative Cost Estimate:

Acquisitions (290 @ $3,000 ea)	$ 870,000
Appraisals (290 @ $1,500 ea)	$ 435,000
Condemnations (Estimate of 50 @ $20,000 ea)	$1,000,000
PL 91-646 Assistance (4 @ $3,000 ea)	$ 12,000
Temporary Permits	$ 5,000
Damage Claims	$ 5,000
Total Non-Federal Acquisition/Administrative Cost (Rounded)	$2,327,000

11. Relocations.

a. Public Highways and Bridges. One bridge crosses the floodplain of Taylor Slough, south of S-332 and physically located within Everglades National Park along State Road 9336. Increased water from the alternative requires the bridge over Taylor Slough to be expanded. State Road 9336 will be temporarily relocated to maintain traffic flow during construction of bridge openings. A temporary bypass extending 50 feet south of the existing road will be constructed adjacent to the existing road. The land needed for the bypass road is Federally owned and is not valued but has been included in the total project acreage.

b. Utilities Relocations. There are no known utilities affected by the project.

c. Relocations of Towns and Cemeteries. There are no known towns or cemeteries located within the project area.

12. Non-Federal Operation/Maintenance Responsibilities.

The operation and maintenance cost of the project are a local responsibility. However, the Flood Control Act of 1968 specified the annual pumping costs, including fuel, lubricants, proportional depreciation and repairs, and operating labor for the pump stations are cost shared 60 percent Federal and 40 percent non-Federal.

13. Local Sponsor's Authority to Participate in the Project.

The South Florida Water Management District was created by virtue of Florida Statutes, Chapter 373, Section .069. The South Florida Water Management District was created to further the State policy of flood damage prevention, preserve natural resources of the State including fish and wildlife and to assist in maintaining the navigability of rivers and harbors. (There are other enumerated purposes but they are not directly applicable to this project.) The South Florida Water Management District is specifically empowered to

> "Cooperate with the United States in the manner provided by Congress for flood control, reclamation, conservation, and allied purposes in protecting the inhabitants, the land, and other property within the district from the effects of a surplus or a deficiency of water when the same may be beneficial to the public health, welfare, safety, and utility". (Section 373.103)

To carry out the above purposes, the South Florida Water Management District is empowered to

> "...hold, control, and acquire by donation, lease, or purchase, or to condemn any land, public or private, needed for rights-of-way or other purposes, and may remove any building or other obstruction necessary for the construction, maintenance, and operation of the works; and to hold and have full control over the works and rights-of-way of the district".

The term "works of the district" is defined by Section 373.019 to be

> "those projects and works, including, but not limited to, structures, impoundments, wells, and other water courses, together with the appurtenant facilities and accompanying lands, which have been officially adopted by the governing board of the district as works of the district".

Section 373.139 specifically empowers the South Florida Water Management District

> "...to acquire fee title to real property and easements therein by purchase, gift, devise, lease, eminent domain, or otherwise for flood control, water storage, water management, and preservation of wetlands, streams and lakes, except that eminent domain powers which may be used only for acquiring real

property for flood control and water storage".

The eminent domain power is potentially limited to the above cited purposes and a resort to Federal acquisition might be required if it is construed that South Florida Water Management District's power is limited to the above cited purposes (flood control, water storage or district works). The question essentially becomes whether the governing board's adoption of the project as a district works allows use of its eminent domain powers under Section 373.086 or whether the project is for flood control and/or water storage purposes.

14. Hazardous and Toxic Wastes (HTW).

In accordance with ER 1165-2-132, an initial HTRW assessment appropriate for this study has been completed. No HTRW sites were identified on project lands.

15. Attitude of Owners.

Based on information from Jacksonville District Planning Division, the majority of the landowners do not support the project and are not willing sellers.

16. Recreation Resources.

There are no known separable recreation lands included within project lands.

17. Outstanding Rights.

Known outstanding rights include easements for roads, power lines and communication cables.

18. Minerals.

Based on South Florida Water Management District's experience to date, there is a minimal amount of outstanding mineral rights in the project area.

19. Standing Timber and Vegetative Cover.

Proposed acquisition of lands for project implementation will not consist of any area which will include standing timber or other vegetative cover that has significant recreation or scenic value, therefore, there will be no reservation of standing timber for the proposed acquisition. Standing timber has been determined to have no merchantable value.

20. Mitigation.

There are no mitigation requirements for this project.

21. Summary of Project Real Estate Costs.

The following is a summary of real estate costs for subject project.

Lands and Damages

Lands (11,866 acres total) Fee Simple: 10,788 acres $37,580,000 ENP lands: 1,078 acres	
Subtotal	$37,580,000
Improvements:	$ 149,300
Severance Damages	$ 0
Minerals	$ 0
Total Lands and Damages (Rounded)	$37,730,000
Acquisition/Administrative Costs (Rounded)	
Federal:	$ 405,000
Non-Federal:	$ 2,327,000
Public Law 91-646 Payments (Rounded)	$ 90,000
Contingencies (25%)*(Rounded)	$10,138,000
Total Estimated Project Real Estate Costs	**$50,690,000**

*A contingency of 25% is estimated to cover uncertainties associated with such elements as valuation variance, negotiation latitude, condemnation awards and interest, and refinement of boundary lines during ownership verification.

22. Real Estate Acquisition Schedule.

The following information was taken from the proposed Project Management Plan. Based on past experience with South Florida Water Management District, Real Estate Division estimates that acquisition of approximately 290 parcels will require no less than 36 months.

Project PCA execution	Mar 96
Initiate Acquisition	Mar 96
Contracts 1 and 2 (Public lands):	
Complete Acquisition/Certify Lands	Apr 96
Construction Contract Advertised	Jun 96
Contract 3:	
Complete Acquisition/Certify Lands	Oct 98
Construction Contract Advertised	Dec 98
Contract 4:	
Complete Acquisition/Certify Lands	Aug 99
Construction Contract Advertised	Oct 99

23. Estates to be Acquired.

Fee (Alternative One)

The fee simple title to (Tracts __ & __) subject, however, to existing easements for public roads and highways, public utilities, railroads, pipelines.

Language to follow description: TOGETHER WITH the Severable Use Rights (SURs) associated with the described land, which rights exist pursuant to Metropolitan Dade County Code Section 33B.

Fee (Alternative Two)

The fee simple title to (Tracts __ & __) subject, however, to existing easements for public roads and highways, public utilities, railroads, pipelines.

Language to follow description: LESS AND EXCEPT the Severable Use Rights (SURs) associated with the described land, which rights exist pursuant to Metropolitan Dade County Code Section 33B, and which rights are expressly severed from the described land and retained by the Grantor.

In accordance with the requirements of Metropolitan Dade County Code Section 33B-45(f), the following provision is included in this deed:

This instrument restricts the use of the above described land to nonresidential uses.

Temporary Borrow Area Easement

A temporary and assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. ___ & ___), for a period not to exceed 3 years, beginning with date possession of the land is granted to the United States, for use by South Florida Water Management District, its representatives, agents, and contractors as a borrow area, including the right to borrow excavate and remove material, move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the C-111 Flood Control Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

24. Map. Real Estate Project Planning Maps are included in this appendix as plates C-1 through C-4.

C-111
GENERAL REEVALUATION REPORT
Appendix C
Real Estate Plan

TABLES

Table C-1
CHART OF ACCOUNTS

01	LANDS AND DAMAGES		
01A00	PROJECT PLANNING		40,000
01B--	ACQUISITIONS		
01B20	BY LOCAL SPONSOR (LS)		870,000
01B40	REVIEW OF LS		145,000
01C--	CONDEMNATIONS		
01C20	BY LS		1,000,000
01C40	REVIEW OF LS		100,000
01E--	APPRAISALS		
01E30	BY LS		435,000
01E50	REVIEW OF LS		116,000
01F--	PL 91-646 ASSISTANCE		
01F10	BY LS		12,000
01F40	REVIEW OF LS		1,200
01G--	TEMPORARY PERMITS/LICENSES/RIGHTS-OF-ENTRY		
01G20	BY LS		5,000
01G40	REVIEW OF LS		500
01G60	DAMAGE CLAIMS		5,000
01M00	PROJECT RELATED ADMINISTRATION (PCA REVIEW)		2,000
01R--	REAL ESTATE PAYMENTS		
01R10	LAND PAYMENTS		
01R1B	BY LS		37,730,000
01R2-	PL 91-646 ASSISTANCE PAYMENTS		
01R2B	BY LS		90,000
01RX	CONTINGENCIES	10,138,000	
TOTAL REAL ESTATE COSTS EXCLUDING CONTINGENCIES (RD)			$40,552,000
TOTAL REAL ESTATE CONTINGENCIES COST (RD)		$10,138,000	
TOTAL PROJECT REAL ESTATE COST (RD)			$50,690,000

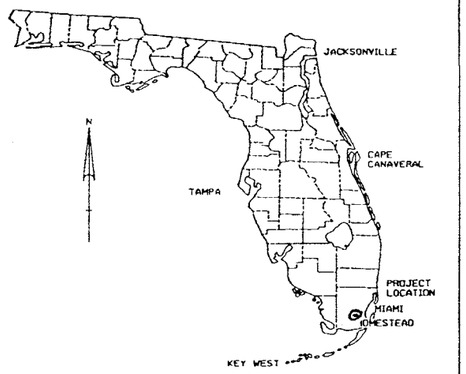
C-111
GENERAL REEVALUATION REPORT
Appendix C
Real Estate Plan

PLATES

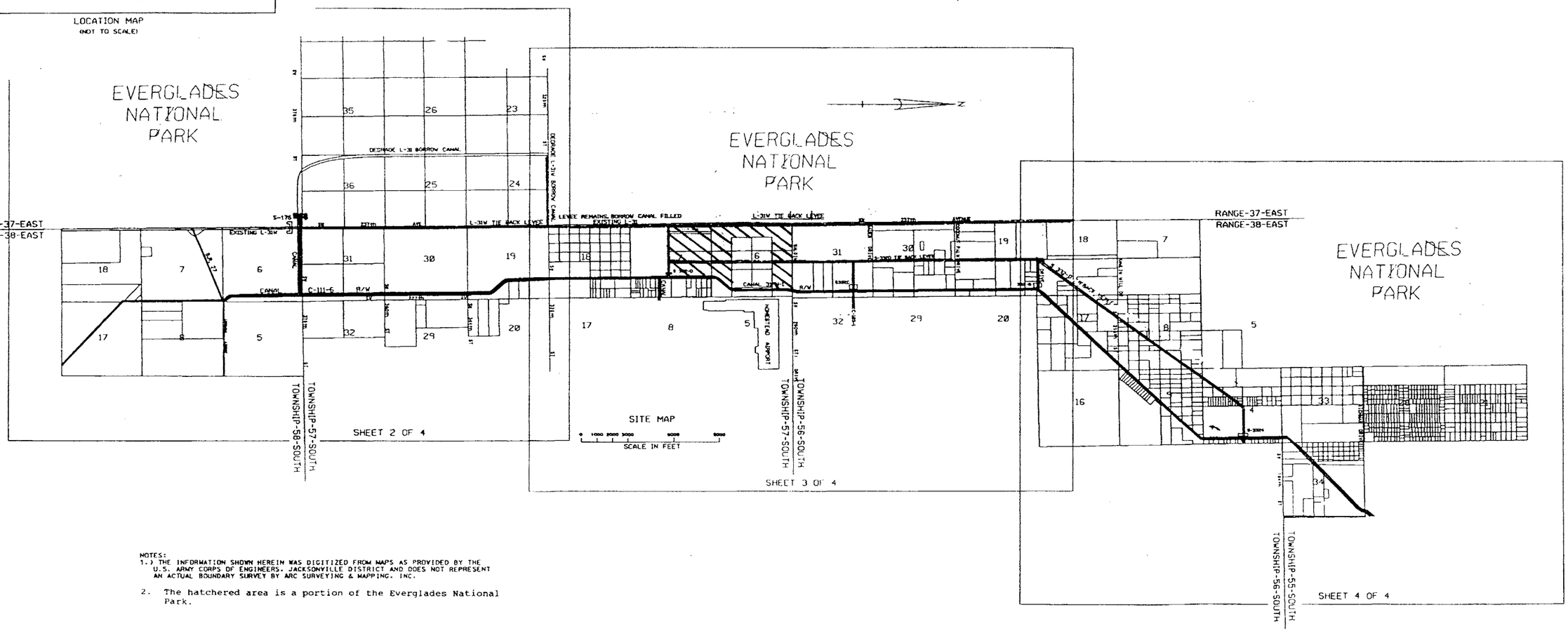
SAFTEY ON THIS JOB DEPENDS ON YOU

US Army Corps of Engineers

REVISIONS					
NO.	SYM	ZONE	DESCRIPTION	DATE	APPROVED



LOCATION MAP
(NOT TO SCALE)



NOTES:
1.) THE INFORMATION SHOWN HEREIN WAS DIGITIZED FROM MAPS AS PROVIDED BY THE U.S. ARMY CORPS OF ENGINEERS, JACKSONVILLE DISTRICT AND DOES NOT REPRESENT AN ACTUAL BOUNDARY SURVEY BY ARC SURVEYING & MAPPING, INC.

2. The hatchered area is a portion of the Everglades National Park.

PLATE C-1

ARC SURVEYING AND MAPPING, INC.
5202 SAN JUAN AVENUE, JAVKSONVILLE, FLORIDA

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

A SKETCH SHOWING PROPERTY ALONG
CANAL C-111
DADE COUNTY, FLORIDA

COVER

SIZE F

DRAWN BY: WALLEN
DATED: 3/22/1994
SCALE: AS SHOWN
SHEET 1 OF 4

SAFETY ON THIS JOB
DEPENDS ON YOU

REVISIONS					
NO.	SYM	ZONE	DESCRIPTION	DATE	APPROVED

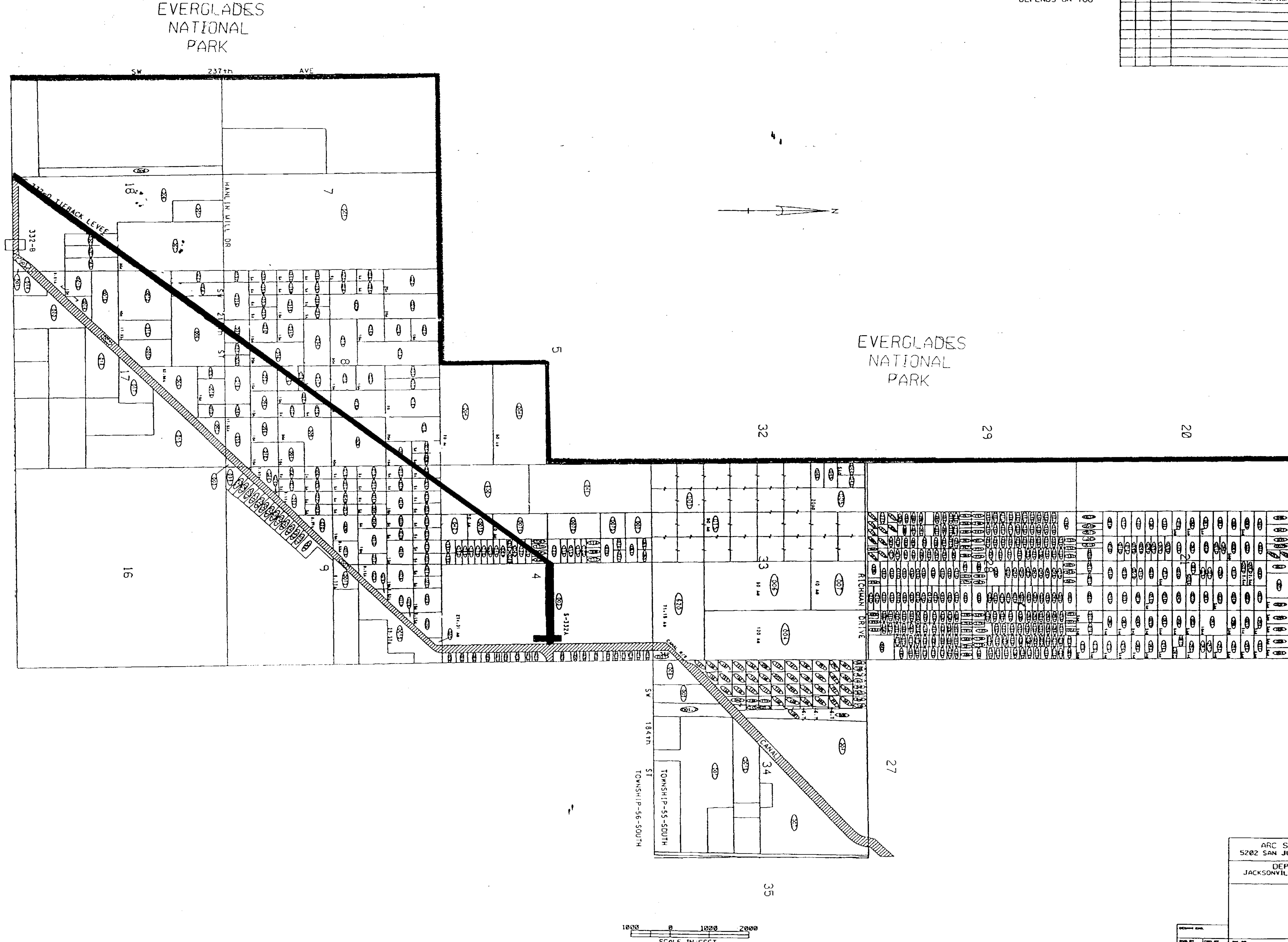


PLATE C-2

ARC SURVEYING & MAPPING, INC.
5202 SAN JUAN AVENUE, JACKSONVILLE, FLORIDA

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

CANAL C-111

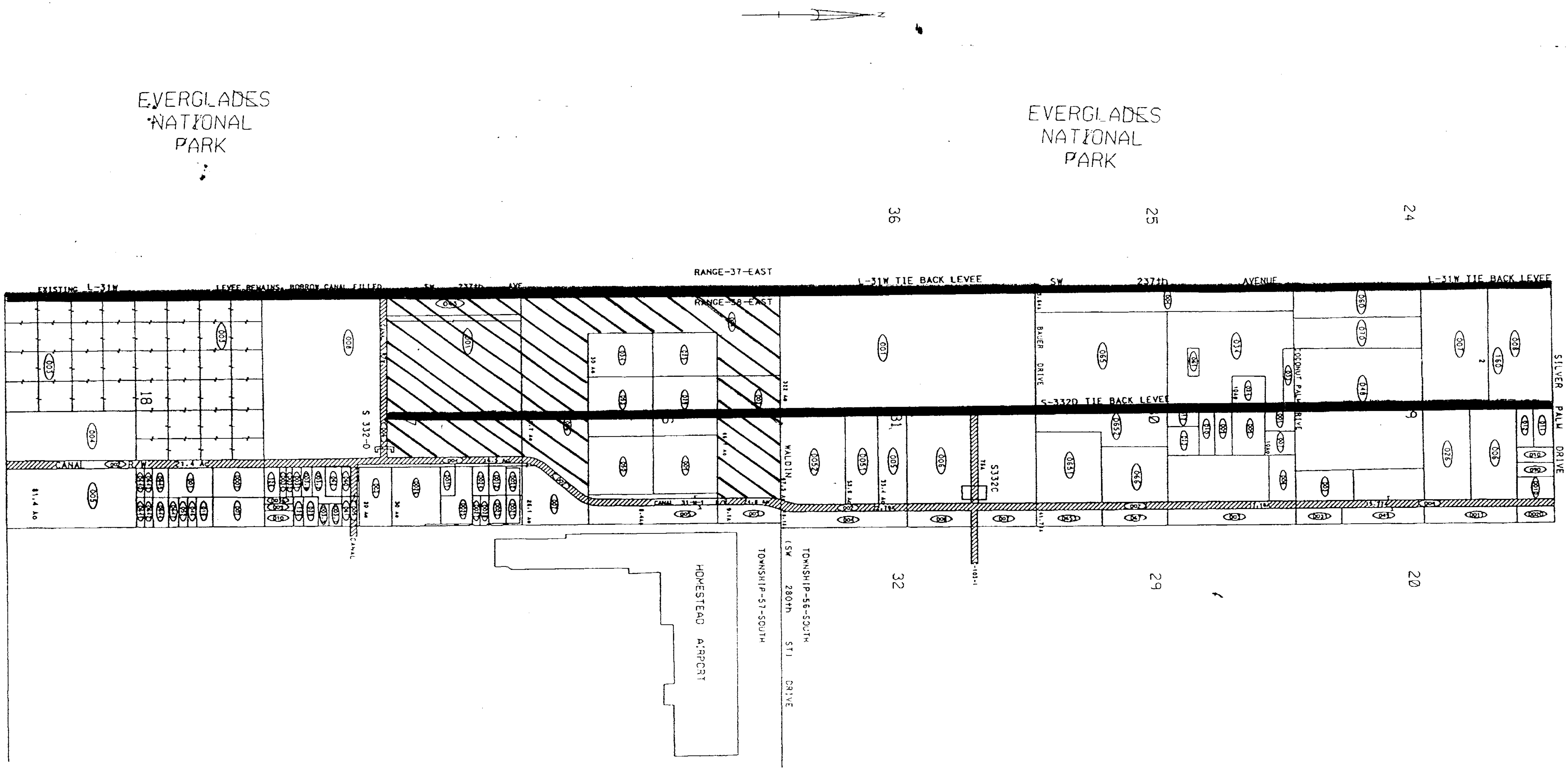
PLANNING MAP

SIZE F

SCALE: AS SHOWN | DATED: MARCH 1994 | SHEET 2 OF 4

SAFETY ON THIS JOB DEPENDS ON YOU

NO.	SYM	ZONE	REVISIONS DESCRIPTION	DATE	APPROVED



NOTE:
1. The hatchered area is a portion of the Everglades National Park.

1000 0 1000 2000
SCALE IN FEET

PLATE C-3

ARC SURVEYING & MAPPING, INC.
5202 SAN JUAN AVENUE, JACKSONVILLE, FLORIDA

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

CANAL C-111

PLANNING MAP

DATED: MARCH 1994 SHEET 3 OF 4

SAFETY ON THIS JOB DEPENDS ON YOU

REVISIONS					
NO.	SYM.	ZONE	DESCRIPTION	DATE	APPROVED

N

EVERGLADES NATIONAL PARK

EVERGLADES NATIONAL PARK (U.S. GOVT)

RANGE-37-EAST

RANGE-38-EAST

SW 237th AVE

SW 376th ST

SW 328th ST

SW 227th AVE

SW 360th ST

SW 344th ST

EXISTING L-31W

DEGRADE L-31W BORROW CANAL

L-31W TIE BACK LEVEE

S-175

S.R. 27

CANAL C-111-6 R/W

CANAL C-111

INGRAHAM HIGHWAY

ALL OF SECTION LESS OIL, GAS & MINERAL INTERESTS OF SE¼

TOWNSHIP-57-SOUTH

TOWNSHIP-58-SOUTH

1000 0 1000 2000
SCALE IN FEET

PLATE C-4

ARC SURVEYING & MAPPING, INC.
5202 SAN JUAN AVENUE, JACKSONVILLE, FLORIDA

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

CANAL C-111

PLANNING MAP

DESIGN DWG.
DWG. BY WILLIS | CHKD. BY
DWG. NO. | SIZE F | CAD. NO.
DATED:
SCALE: AS SHOWN | DATED: MARCH, 1994 | SHEET 4 OF 4