DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT. CORPS OF ENGINEERS
P. O. BOX 4970
JACKSONVILLE. FLORIDA 32201

SAJBS August 1974

CENTRAL AND SOUTHERN FLORIDA PROJECT FOR FLOOD CONTROL AND OTHER PURPOSES

PART V

COASTAL AREAS SOUTH OF ST. LUCIE CANAL SUPPLEMENT 55--DETAIL DESIGN MEMORANDUM LEVEE 29, SECTION 3, BORROW CANAL ENLARGEMENT, PUMPING STATION 332, AND CONTROL STRUCTURES 194 (MOD), 333, 334, 335, 336, and 338

A. INTRODUCTION

1. Authorization. The project for Central and Southern Florida was originally authorized by the Flood Control Act of 30 June 1948 (Public Law 858, 80th Congress, 2nd Session). Specifically, the project features covered in this report were authorized by the Flood Control Act of 13 August 1968 (Public Law 90-483, 90th Congress, 2nd Session). The Monetary Authorization Act of 1970 (Public Law 91-282), Section 2, authorized funds for construction of specific improvements for the delivery of water from the Central and Southern Florida project to the Everglades National Park.

2. Scope and purpose. This report supplements Part V, Supplement 52, and presents detail designs and costs for a conveyance canal, pumping station, and six control structures that are part of a plan to increase flows to Everglades National Park and South Dade County.

3. References and prior reports. The basic references used in the preparation of this report are:

a. Part V, Supplement 52, General Design Memorandum, Conveyance Canals to Everglades National Park and South Dade County area;

b. The project document--Comprehensive Report on Central and Southern Florida for Flood Control and Other Purposes, dated 19 December 1947 (House Document 643, 80th Congress, 2nd Session);

c. Survey-Review Report--Water Resources for Central and Southern Florida, dated 15 February 1968 (House Document 369, 90th Congress, 2nd Session);

d. Survey-Review Report, South Dade County on Central and Southern Florida Project, dated 25 November 1959;

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e. Survey-Review Report, Southwest Dade County on Central and Southern Florida Project, dated 15 October 1963;

f. U. S. Department of the Interior, Geological Survey, Water Resources Division, Hydrologic Conditions during 1970 in Dade County, Florida, Tallahassee, Florida, 1972;

g. U. S. Department of the Interior, Geological Survey, Water Resources Division, Hydrologic Effects of Water Control and Management of Southeastern Florida, Tallahassee, Florida, 1971;

h. U. S. Department of the Interior, Geological Survey, Water Resources Division, Preliminary Evaluation of the Hydrologic Effects of Implementing Water and Sewerage Plans, Dade County, Florida, Tallahassee, Florida, 1971.

B. BASIC CONSIDERATIONS

4. Location. The features presented in this report would be located on the lower tip of Florida just north and east of the Everglades National Park. For location of the proposed work relative to other features of the Central and Southern Florida Flood Control Project see plate 2 and for the vicinity see plate 1.

5. Proposed plan. The plan would provide for the enlargement and extension of existing Levee 29 Borrow Canal, construction of Pumping Station 332, modifications of existing Control Structure 194, and construction of Control Structures 333, 334, 335, 336, and 338. The work would be part of the approved distribution plan to convey water from storage in Water Conservation Area No. 3A to Dade County and the Everglades National Park a total of 524 square miles of benefited area. The areas are described in detail in the general design memorandum, Part V, Supplement 52.

6. Local cooperation. a. General. The Central and Southern Florida Flood Control District is the body authorized to represent local interests. The required local cooperation was specified in the Report of the Board of Engineers for Rivers and Harbors dated 7 May 1968 and incorporated in the authorizing House Document No. 369, 90th Congress, 2nd Session.

b. Requirements. The work covered in this report would be constructed "provided that, prior to construction of the water management features of the project, local interests furnish assurances satisfactory to the Secretary of the Army that they will:

"(1) Make a cash contribution of 20 percent of the contract price plus supervision and administration for all items of work to be provided by the Corps of Engineers, an amount presently estimated at

$11,883,000 to be paid in a lump sum prior to start of construction or in installments prior to start of pertinent work items in accordance with construction schedules as required by the Chief of Engineers, the final apportionment of costs to be made after actual costs have been determined;

"(2) With appropriate jurisdiction, construct and thereafter maintain such canal facilities and other water control appurtenances as are necessary to realize the benefits from the improvements;

"(3) Provide without cost to the United States all lands, easements, and rights-of-way necessary for construction of the project, when and as required;

"(4) Assume the cost of construction of all new highway bridges, relocation of existing highway bridges, and alteration of utilities and other improvements except railroads, incident to the construction of the project;

"(5) Hold and save the United States free from damages due to the construction, operation, and maintenance of the project works;

"(6) Prohibit encroachment on the water-carrying capacity of the improved channels;

"(7) Operate and maintain the pumping stations, levees, canals, and other appurtenant works after completion of construction for flood control, navigation, and backpumping and delivery of water to Everglades National Park, the agricultural areas, and urban areas, in accordance with the regulations approved by the Secretary of the Army, except the levees, channels, locks, and control works of the St. Lucie Canal, Lake Okeechobee, Caloosahatchee River, and the main spillways of the water conservation areas."

7. Hydrology and hydraulic design. a. Hydrology. The hydrology is discussed fully in Section "E" of the General Design Memorandum (Part V, Supplement 52).

b. Hydraulic design of the canal and bridges. (1) Levee 29 Borrow Canal. The hydraulic design of Levee 29 Borrow Canal is in accordance with criteria and procedures presented in the General Design Memorandum (Part V, Supplement 52). Hydraulic design data for the canals are in table 1 and design water surface is shown in profile on plate 13. Backwater computations were performed and checked on the District Office computer using District Program WH03, Subcritical Flow Line in Trapezoidal Channels with Bridges. Hydraulic design computations are shown on table 1.

(2) Bridges. New project bridges would replace two plugs in Levee 29 Borrow Canal at Fish Management Areas 2 and 3. These new bridges are designed to pass the peak discharge without exceeding the maximum permissible velocity of 2.5 feet per second. Table 2 gives a summary of hydraulic design data for the bridges.

c. Structure hydraulic design. (1) Culvert Structures (S-194, S-336, and S-338). (a) Size. Structure 194 was sized based on using concrete pipe. Entrance losses were taken as 0.50 times the velocity head. The friction loss was based on Manning's formula with an "N" value of 0.012; and the exit loss was taken as a full velocity head. Structures 336 and 338 were sized based on using corrugated metal pipe. Entrance losses were taken as 0.50 times the velocity head. The friction loss was based on Manning's formula with an "N" value of 0.024; and the exit loss was taken as a full velocity head. Slide gates were provided on all culvert structures. Hydraulic-design data for Structures 194, 336, and 338 are given in table 6.

(b) Stone protection. Structures 194, 336, and 338 are located in rock; therefore, no stone protection is required in the channel bottom upstream and downstream of these structures. Protection would be provided on new embankments around pipe portals.

(c) Automatic gate controls will not be required on any of the structures.

(d) Instrumentation. Contract plans and specifications for the culvert structures would provide for the installation of upstream and downstream staff gages.

(2) Hydraulic design of Control Structures (S-333, S-334, and S-335). (a) General. Hydraulic design criteria for Control Structures 333, 334, and 335 are in accordance with criteria and procedures presented in the General Design Memorandum (Part V, Supplement 52). The following paragraph presents additional information on the hydraulic design and corrections or additions to the tables and plates presented in Part V, Supplement 52.

(b) Type of structures. Control Structures 333, 334, and 335 would be gated, trapezoidal, weir-type, spillways. Structure 333 would control the supply of water to Levee 29 Borrow Canal. Structures 334 and 335 would maintain water control in Levee 29 and Levee 30 Borrow Canals, respectively. Locations of the structures are shown on plate 1.

(c) Size. The spillway structures were sized to pass the design discharge with headwater and tailwater elevations determined from canal design water-surface profiles and flood routings. They would normally operate with a high degree of submergency. Therefore, the spillway openings were sized using D'Aubuisson's formula with a discharge coefficient of 0.80. A summary of hydraulic-design data is given in table 7. Discharge rating curves and applicable derivations, formulas, and coefficients for controlled and uncontrolled discharges are shown on plates 38, 46, and 51, respectively, for Structures 333, 334, and 335.

(d) Gates. Experience on similar projects has shown that rectangular vertical-lift gates are the most practicable and economical in this area. The bottom of the gates in the open position would be 1.0 foot above the design headwater elevation to provide clearance for passing vegetation and floating debris. The top of the gates in the closed position would be 1.0 foot above optimum headwater elevation. Overflow slots would be provided for passing small discharge and minimum flows without opening the main spillway gates. The slots would be equipped with slide gates opening from the top downward. The top of the slots would be 0.5 foot above high optimum headwater and would be 2.5 feet high for Control Structure 333, 2.0 feet high for Control Structure 334, and 1.5 feet high for Control Structure 335. The gates would be manually operated.

(e) Energy dissipation. The spillways are non-jump structures designed to pass the design discharges with small head differentials. Low velocities are expected in the vicinity of the structures over the full range of operating conditions. Energy dissipation would be by jet diffusion and turbulent mixing on a horizontal stilling basin with endsill.

(f) Stone protection. Spillway Structures 334 and 335 are located in rock. Therefore, no stone protection would be required in the channel bottom, but stone protection would be provided on new embankments around wingwalls for these two structures. Structure 333 is located in erodible material, and the lengths of stone protection upstream and downstream of the structure would be determined by computing mean velocities in the vicinity of the structure. Minimum stone protection length was terminated at approximately the point where the velocity was reduced to 2.5 feet per second under design discharge conditions or until the safety of the structures is assured.

(g) Automatic gate controls will not be required on any of the structures.

(h) Instrumentation. Contract plans and specifications for Spillway Structures 333, 334, and 335 would provide for the installation of upstream and downstream automatic water level recorders and staff gages.

C. GEOLOGY AND SOILS

8. Investigations performed. Core borings were drilled at about 2,000- to 3,000-foot intervals along L-29, Section 3, during 1950, 1951, and 1960, for construction of the original project. In 1973 a total of 10 additional core borings were drilled in the area to be excavated along the north berm of the existing borrow canal, and in the canal itself. Borings were drilled at the proposed structure sites as follows: Structure 332, 5 core borings and 91 wash borings; Structure 333, 4 core borings; Structure 334, 2 core borings and 8 wash probings; Structure 335, 2 core borings, and 8 wash probings; Structure 336, 2 core borings and 42 wash borings; Structure 338, 1 core boring, and Mod. to Structure 194, 2 core borings.

The purpose of the borings and wash probings was to determine the thickness and characteristics of the subsurface materials as they relate to excavation, foundation competence and dewatering methods. At the recently drilled borings, unconsolidated materials and softer portions of the rock were sampled using a standard split spoon (1-3/8" I.D. x 2" O.D.) driven with a 140-pound hammer falling freely 30 inches. At the older borings a solid sample spoon (2" I.D. x 2-1/2" O.D.) or hand auger was used. Hard rock was recovered by rotary drilling, using either 4" x 5-1/2" or "NX" size diamond bit and double tube core barrel, or an "NX" carboloy bit with either single or double tube core barrel. Generally, continuous samples of all materials encountered were collected. Unconsolidated materials were placed in wax-sealed jars. All sample materials from the recently drilled boring are stored in core boxes at the Corps of Engineers Dredge Depot in Jacksonville, Florida. Samples from the borings drilled in 1950, 1951, and 1960 were destroyed upon completion of the respective projects and after final payment was made to the contractor. Locations and designations of the core borings and locations of the wash probings are shown, in plan and/or profile, on plates as described in the following paragraphs.

9. Levee 29, Section 3. a. Materials encountered. Deposits of peat, muck, and calcareous silt are present at ground surface (about plus 6 m.s.l., elevation). The layer varies in thickness up to about 8 feet. Interbedded hard and medium hard limestone underlies the unconsolidated surface materials. The rock is porous, solution riddled, and generally permeable, although permeability decreases in a westward direction. The rock layer is also thinner along the western end of the alinement and is underlain by silty sand at about elevation minus 6. A geologic section along Levee 29, Section 3, based on the earlier borings, is shown on plate 13. The locations of the more recent borings are also shown on the section. Logs of all the core borings drilled along the alinement are shown in appendix A.

b. Excavation. Excavation would be in unconsolidated materials and in rock. Blasting may be necessary for economical excavation of the hard rock. Ripping may be necessary to excavate the medium hard rock economically.

c. Side slopes. Cut slopes would be 1 vertical on 2 horizontal; levee embankment slopes of 1 on 3 would be stable and could be maintained.

10. Structure 332. a. Materials encountered. A foot or two of soft calcareous silt is present at ground surface (elevation +4.0) at the proposed structure site. Beneath the silty surface mantle, limestone is present and extends to below elevation -32. The rock is hard with medium hard zones, and is porous, permeable and contains solution holes. A geologic section with boring location map for the site is shown on plate 19. The logs for the 5 borings are shown on plates 20 through 29.

b. Foundation conditions. The structure would be founded on hard and medium hard limestone at elevation -17. Any solution holes which may be encountered at foundation grade would be filled with tremie concrete.

c. Excavation. Excavation would be in limestone. Ripping may be necessary for economical excavation of the medium hard rock. Drilling and blasting of the hard rock may be necessary to excavate it economically.

d. Dewatering. Dewatering of the excavation would be by means of a steel sheet pile cofferdam and tremie seal. Dewatering information, obtained from recharge tests at the site, is shown on plate 28.

11. Structure 333. a. Materials encountered. An embankment fill of sand and rock fragments, with a top elevation of about +19, is present at the structure site. Below the fill, at an elevation of about +5, a discontinuous layer of compacted peat is present in thickness to 2.5 feet. Below the peat interbedded hard and medium hard calcareous sandstone are present. The rock layer extends to about -10, is porous, permeable, and contains numerous solution holes. Below the rock, firm silty sand with limestone layers is present. A geologic section for the structure, and a core boring location map are shown on plate 37.

b. Foundation conditions. The structure would be founded on dense silty sand at elevation -8. Minor amounts of rock below that elevation would be removed and sandy material backfilled and compacted to restore the bottom of the excavation to -8.

c. Excavation. Except for the existing embankment fill, excavation would be almost entirely in rock. The hard rock may necessitate drilling and blasting to excavate economically. To excavate the medium hard rock economically, ripping may be necessary.

d. Dewatering. Dewatering would be by means of well points. Dewatering information obtained from recharge tests at the site is shown on plate 37.

e. Laboratory tests. Duplicate representative samples of unconsolidated materials were collected at the S-333 site. These samples were sent to the SAD Laboratory for grain size analysis. The results of the tests are shown by the grain size curves on plate 39.

f. Stone protection. Velocities at the ends of the structure would be low--less than 4 feet a second. However, near the structure, sand exposed in the channel bottom would require some protective cover. In the rocky areas of south Florida, it is our usual practice to place a layer of stone protection (material derived from required excavation) on backfilled slopes at hydraulic structures. An extension of that stone layer into the channel would provide ample protection against scouring. In the areas with exposed sand, filter cloth would be placed beneath the stone protection to preclude subsurface erosion. The stone protection would consist of a rock mixture obtained from structure excavation and reasonably graded from 18 inches down to fines. It would be placed in a layer two feet thick.

12. Structure 334. a. Materials encountered. At the surface, overlaying the bedrock, there is a layer of sandy, silty, organic muck which contains limestone fragments. This layer of soft overburden varies in thickness up to several feet thick. The bedrock underlaying the structure consists predominently of medium to hard limestone. A thin sand bed up to 2.8' thick occurs shallow in the section, above elevation -10 feet, and a thin clay lense 1' thick occurs at -17.5' in boring CB-S334-4. No soft beds occur at or below the foundation grade. A geologic section and core boring location map are shown on plate 45.

b. Foundation conditions. The structure would be founded on competent medium hard or hard limestone at elevation -23.0.

c. Excavation. Except for minor amounts of sand and muck, excavation would be in rock. Ripping may be necessary for economical excavation of the medium hard limestone. Drilling and blasting may be necessary to excavate the hard limestone economically.

c. Dewatering. A steel sheet pile cofferdam and tremie seal would be used for dewatering. Dewatering information, obtained from recharge tests at the site is shown on plate 45.

13. Structure 335. a. Materials encountered. Peat is present at ground elevation (+5) at the structure site. The peat layer averages about 5 feet in thickness and is underlain by limestone. The rock is alternately hard and medium hard and extends to depths below elevation -31. Geologic sections for the structure site, based on the wash probings as well as the core borings, are shown on plate 50. A location map of the borings and probings is also shown on that plate.

b. Foundation conditions. The surface peat layer will be removed along the access road and under the embankment landward of the wingwalls. The existing canal, in which the structure is to be located, has been excavated to below foundation grade. The bottom of the tremie concrete beneath the structure would be on competent limestone below the existing canal bottom at -17.

c. Excavation. Except for removal of peat, excavation would be chiefly in hard limestone. Blasting may be necessary for economical excavation of the rock.

d. Dewatering. Dewatering would be by means of a steel sheet pile cofferdam and tremie seal. Dewatering information, obtained from recharge tests at the site is shown on plate 50.

14. Structure 336. a. Materials encountered. The existing canal, in which the structure is to be located, has been excavated in limestone. The rock layer extends to well below the canal bottom. A few feet of unconsolidated sediments have accumulated on the canal bottom. A geologic section for the site, including a boring and probing location map is shown on plate 54.

b. Foundation conditions. The bottom of the existing canal is below the foundation grade (-1.8) of the culvert pipes. After removal of unsuitable material, sandy bedding material would be added to the overexcavation. The bedding material would be compacted and brought up to elevation -1.8. The bottom of the tremie concrete beneath the slide gates would be on competent limestone at -11.0.

c. Excavation. Except for unconsolidated materials lying at the bottom of the existing canal, excavation would be in limestone. The rock is medium hard and ripping may be necessary for economical excavation.

d. Dewatering. Dewatering of that portion of the excavation beneath the headwalls would be by means of a steel sheet pile cofferdam and tremie seal. The culvert pipes would be placed in the wet. Dewatering information, obtained from recharge tests at the site is shown on plate 54.

15. Structure 338. a. Materials encountered. One core boring was drilled at the structure site which is underlain by limestone. The rock is hard with medium hard zones, porous, permeable, and contains numerous solution holes. The log for the core boring (CB-S338-1) is shown on plate 57 and the boring location, is indicated on plate 55.

b. Foundation conditions. The structure would be founded on limestone at about -7.

c. Excavation. Excavation would be virtually all in rock. Ripping may be necessary for economical excavation of the medium hard portions of the rock, while blasting may be necessary to excavate the hard portions economically.

d. Dewatering. Dewatering of that portion of the excavation beneath the headwalls would be by means of a steel sheet pile cofferdam and tremie seal. The culvert pipes would be placed in the wet. Dewatering information obtained from recharge tests at the site is shown on plate 57.

16. Mod. to Structure 194. a. Materials encountered. At ground elevation (+8.5) limestone is present. The rock extends to depths in excess of 33 feet. It is soft or medium hard above about -10, and hard below that elevation. The rock is porous, permeable, and contains numerous solution holes. At the first of 2 core borings at the site, a cavity was encountered between -21.7 and -22.5. At the second hole a cavity was encountered from -7.1 to -10.7. A geologic section for the structure, with boring location map, is shown on plate 32.

b. Foundation conditions. The culvert pipe would be founded on competent limestone at an average elevation of -3.5. The bottom of the tremie concrete beneath the slide gates would be on competent limestone at -12.0. The cavity between -21.7 and -22.5, below the west end of the culvert pipe, would not affect the competence of the rock foundation. The cavity between -7.1 and -10.7, below the east end of the pipe, would not pose a problem as the weight exerted by that end of the pipe would not be excessive.

c. Excavation. Excavation would be in medium hard and soft limestone. Ripping may be necessary for economical excavation.

d. Dewatering. Dewatering of that portion of the excavation beneath the headwalls would be by means of a steel sheet pile cofferdam and tremie seal. The culvert pipes would be placed in the wet. The known permeability of the rock in the area is reconfirmed at the structure site by 100 percent drill water loss during drilling operations.

17. Contract Plans. Prior to the preparation of contract plans one additional boring on the east abutment of Structure 334 and two borings, one on each abutment of Structure 336, are needed to better determine the material to be excavated. Typical contract core boring logs for a structure are shown on plates 20 and 21. Typical contract core boring logs for Levee 29, Section 3, are shown in appendix A. Core boring notes with information applicable to Levee 29, Section 3, and/or the structures are shown on plate 59. Grain size curves to be shown in contract plans are shown on plate 39.

D. STRUCTURAL DESIGN

18. General. The plan on plate 1 shows an overall view of the proposed plan of improvement. For the proposed site plans and other structural details, see plates 3 through 58.

19. Levee 29, Section 3, borrow canal enlargement. a. General. Approximately 10.7 miles of existing Levee 29, Section 3, borrow canal would be enlarged and the canal would be extended 0.2 mile westward. The completed canal would extend from Structure 333 at the edge of Water Conservation Area No. 3A eastward approximately 10.9 miles to Levee 30 borrow canal. The hydraulic design data is shown in table 1 and on plate 13 which also shows the geologic section. Plates 3 through 9 are aerial mosaics showing the proposed work, and typical sections are shown on plates 11 and 12.

b. Alinement. The alinement follows existing Levee 29, Section 3, borrow canal and the enlargement would shift the canal centerline to the north. The excavation of the 0.2 mile reach of new canal would require a northward shift of Levee 29 in that reach. The levee relocation is shown on plates 4 through 9.

c. Construction method. Levee 29, Section 3, borrow canal would be enlarged by dragline. The canal would be excavated by a dragline working from the north bank and the excess material would be placed on the crown in a manner that would enlarge the levee embankment northward. Levee 29 would be relocated at the west end as described in the paragraph above and the excess material placed in the specific disposal area as shown on plate 9.

d. Embankment. The borrow canal would be enlarged by tracking on the existing berm. In the area where the levee is to be relocated a 40-foot berm would be constructed.

e. Embankment material. Peat, silt, silty sand, and limestone would be placed in the required berm and levee. No special treatment would be required for the materials due to balance of quantities.

f. Excess material would be placed as discussed in paragraph c above.

g. Clearing would consist of heavy grass, shrubs, and light trees and would be disposed of by burning. Burning would be coordinated with the Dade County Department of Pollution Control.

20. Pumping Station 332. a. Location and access. Structure 332 would be located on the west side of the existing Levee 31(W) borrow canal, and will supply water to the Taylor Slough area of Everglades National Park. Access during construction and for operation and maintenance would be from State Highway 27 along the existing Levee 31(W), across Structure 175, thence along the south and western side of L-31(W) borrow canal to the proposed structure site, a distance of about 2.3 miles (see plate 10).

b. Description of structure. Structure 332 would be an electric motor-driven pumping station with a variable pump arrangement. At the structure site, parking and turn-around areas would be provided on the north and south sides of the structure with a reinforced concrete service bridge spanning the structure. The service bridge over the pumping station structure would provide access for service vehicles. A service door at the north end of the superstructure would provide access for permitting installation and maintenance removal of the machinery and equipment. Office and toilet facilities for operating personnel would be provided. The upstream wingwalls would be steel sheet pile walls capped with steel channels. Inareas where the sheet piling cannot be driven due to hard rock, the bottom of the walls would be supported by tremie concrete placed in a trench blasted in the rock. Anchor walls connected to steel tie rods would provide the top support for the walls. The downstream wingwalls would be reinforced concrete inverted "T" walls. A concrete apron and end sill would be provided on the downstream side of the structure. The superstructure would consist of concrete columns and concrete block curtain walls. Windows, doors, and forced-air fans would be installed to provide adequate lighting and ventilation. The roof would slope to insure positive drainage. The superstructure would house the pumps, pump drive, motors, motor control center, station crane, office and toilet.

c. Dewatering. (1) During construction a steel sheet pile cofferdam and a tremie seal would be used for dewatering. The tremie seal would be approximately nine feet thick and would form a foundation for the structure and would seal the porous rock.

(2) Pump bays could be independently dewatered, as required for inspection or removal of equipment by placing timber needles across the intake trash racks and dewatering by means of a portable pump.

d. Flapgates. The flapgates installed at the end of each pump tube would serve to prevent backflow through the tubes.

e. Bypass requirements. No bypass would be needed since the structure would be located in a new cut on the west bank of Levee 31(W) borrow canal.

21. Spillway Structure 333. a. Location and access. Structure 333 would be located in L-29 borrow canal just north of U. S. Highway 41 connecting L-29, Section 2 borrow canal with L-29, Section 3 borrow canal. Access during construction and for operation and maintenance would be from U. S. Highway 41 via the proposed access road to the structure site, a distance of about 200 feet as shown on plate 34.

b. Description of structure. Structure 333 would be a one bay (29-foot bay width) reinforced concrete U-shaped, trapezoidal weir-type, gated spillway. The vertical-lift gates would be manually controlled. The structure would include a 23' 8" wide reinforced-concrete service bridge, a reinforced-concrete operating platform, steel sheet pile wingwalls, and a control house. A steel sheet pile cutoff would be provided under the upstream and downstream edge of the structure. Wellpoints would be used for dewatering during construction. Provisions would be made for dewatering the structure by use of needles and needle beams upstream and downstream of the vertical-lift gates. Such a closure would serve not only for maintenance, but also as an emergency temporary closure if a gate needed to be removed. Needles and needle beams furnished for other project structures already constructed would also be used at this structure. Stone protection would be provided upstream and downstream of the structure to protect against erosion. Safety barriers would be provided upstream and downstream of the structure. Structural details of the structure are shown on plates 34 and 35.

c. Gates. The spillway gate for Structure 333 would be wheeled vertical lift gate of welded construction consisting of structural carbon-steel members and skinplates and would be designed for maximum head differentials. Skinplates would be located on the upstream side of the gate. Rubber seals that would seat against corrosion-resisting steel side angles and bottom plates would be provided. The gates would be manually controlled. Hoisting equipment for the hydraulically powered gate hoist (cable lifts) would be mounted on the operating platform. The gate would be provided with hand-operated slide gates which would minimize operation of the vertical-lift gates.

d. Bypass requirements. No bypass will be needed since construction would be in a new canal area in which there is no flow at this time.

22. Spillway Structure 334. a. Location and access. Access during construction would be from U. S. Highway 41 across the L-30 plug to the existing L-29, thence along L-29 to the structure site a distance of approximately 1,500 feet. Access for operation and maintenance would be from U. S. Highway 41 a distance of approximately 100 feet as shown on plate 42.

b. Description of structure. Structure 334 would be a one-bay (29-foot bay width) reinforced concrete U-shaped, trapezoidal weir-type, gated spillway. The vertical-lift gates would be manually controlled. The structure would include a 23' 8" wide reinforced-concrete service bridge, a reinforced-concrete operating platform, steel sheet-pile wingwalls, and a control house. The structure would be on tremie and a steel sheet pile cofferdam would be used for dewatering during construction. Provisions would be made for dewatering the structure by use of needles and needle beams upstream and downstream of the vertical lift gates. Such a closure would serve not only for maintenance, but also as an emergency temporary closure if a gate needed to be removed. Needles and needle berms furnished for other project structures already constructed would also be used at this structure. Stone protection would be provided upstream and downstream around the embankment of the structure to protect against erosion. Safety barriers would be provided upstream and downstream of the structure. Structural details of the structure are shown on plate 42 and 43.

c. Gates. The spillway gate for Structure 334 would be wheeled vertical lift gate of welded construction consisting of structural carbon-steel members and skinplates and would be designed for maximum head differentials. Skinplates would be located on the upstream side of the gates. Rubber seals that would seat against corrosion-resisting steel side angles and bottom plates would be provided. The gates would be manually controlled. Hoisting equipment for the hydraulically powered gate hoist (cable lifts) would be mounted on the operating platform. The gate would be provided with hand-operated slide gates which would minimize operation of the vertical-lift gates.

d. Bypass requirements. No bypass would be needed during construction of Structure 334.

23. Spillway Structure 335. a. Location and access. Structure 335 would be located in the existing L-30 borrow canal upstream of U. S. Highway 41 and west of State Highway 27. Access during construction and for operation and maintenance would be from State Highway 27 (Krome Avenue) via the proposed access road to the structure site, a distance of about 200 feet as shown on plate 47.

b. Description of structure. Structure 335 would be a one-bay (20-foot bay width) reinforced concrete U-shaped, trapezoidal weir-type, gated spillway. The vertical-lift gate would be manually controlled. The structure would include a reinforced-concrete service bridge, a reinforced-concrete operating platform, steel sheet-pile wingwalls, and a control house. The structure would be on tremie and a steel-sheet-pile cofferdam would be used for dewatering during construction. Provisions would be made for dewatering the structure by use of needles and needle beams upstream and downstream of the vertical lift gates. Such a closure would serve not only for maintenance, but also as an emergency temporary closure if a gate needed to be removed. Needles and needle beams furnished for other project structures already constructed would also be used at this structure. Stone protection would be provided upstream and downstream around the embankment of the structure to protect against erosion. Safety barriers would be provided upstream and downstream of the structure. Structural details of the structure are shown on plates 47 and 48.

c. Gates. The spillway gate for Structure 335 would be wheeled vertical lift gate of welded construction consisting of structural carbon-steel members and skinplates and would be designed for maximum head differentials. Skinplates would be located on the upstream side of the gates. Rubber seals that would seat against corrosion-resisting steel side angles and bottom plates would be provided. The gates would be manually controlled. Hoisting equipment for the hydraulically powered gate hoist (cable lifts) would be mounted on the operating platform. The gate would be provided with hand-operated slide gates which would minimize operation of the vertical lift gates.

d. Bypass requirements. In order to allow continuous flow of L-30 borrow canal during construction, the proposed construction would be performed in two stages. The first stages would consist of the spillway and its east wingwalls. During this construction, bypass flow would be between the cofferdam for the spillway and the existing south bank of the canal. The minimum bypass requirement is 80 square feet below elevation 5.5. The second stage would consist of the west wingwalls. During this construction, bypass flow would be through the completed spillway.

e. Existing structure. Existing Structure 24B would remain in place and operational during the construction of Structure 335. When Structure 335 is complete and operational, Structure 24B would be removed and the canal section restored in the vicinity of the removed structure.

24. Culvert Structure 336. a. Location and access. Structure 336 would be located in existing Tamiami Canal (C-4) adjacent to U. S. Highway 41. Access during construction and for operation and maintenance would be from U. S. Highway 41 via the proposed access road to the structure site, a distance of about 70 feet as shown on plate 52.

b. Description of structure. Structure 336 would be a three-barrel, 54-inch corrugated metal pipe culvert with reinforced-concrete intake headwall and operating platform on the upstream side. The structure would be provided with a manually operated, standard slide gate that would withstand the maximum water pressure. Canal flow would be diverted through the adjacent borrow area north of Canal 4 during construction. Stone protection would be provided on the culvert embankment side slopes to protect against erosion. Details of the proposed work are shown on plate 53.

25. Culvert Structure 338. a. Location and access. Structure 338 would be located in existing canal (C-1) just west of State Highway 27 (Krome Avenue). Access during construction and for operation and maintenance would be from State Highway 27 via the proposed access road to the structure site, a distance of about 175 feet as shown on plate 55.

b. Description of structure. Structure 338 would be a two-barrel, 84-inch corrugated metal pipe culvert with reinforced concrete intake headwall and operating platform on the upstream side. The structure would be provided with a manually operated, standard slide gate that would withstand the maximum water pressure. Stone protection would be provided on the culvert embankment side slopes to protect against erosion. Details of the proposed work are shown on plate 56.

c. Bypass requirements. In order to allow continuous flow in canal (C-1) a bypass canal would be required. The minimum bypass requirement is 100 square feet below elevation 5.0.

26. Culvert Structure 194 (Mod). a. Location and access. Structure 194 is located in existing canal (C-102) at the intersection of State Highway 27 and Canal 102. Access during construction and for operation and maintenance would be from State Highway 27 during construction. A temporary detour road will be built just east of the proposed construction area.

b. Description of structure. Structure 194 is an existing 84-inch gated culvert which will be modified by adding of an additional 84-inch gated culvert. New construction would consist of a one-barrel, 84-inch concrete pipe culvert with reinforced-concrete intake headwall and operating platform on the upstream side. The structure would be provided with a manually operated, standard slide gate that would withstand the maximum water pressure. Canal flow would be maintained through the existing Structure 194 during construction. Stone protection would be provided on the culvert embankment side slopes to protect against erosion. Details of the proposed work are shown on plate 31.

27. Control house. Concrete block control houses would be provided at Structures 333, 334, and 335 to house the manual controls, electrical works, stilling wells, hydraulic power unit, and generator unit.

28. Stability and design analysis of structures. a. Scope. This section covers the design criteria and stability analysis of the concrete features of the structures. In general, the design of each important feature is described in the following text or on the plates.

b. General. The structural design is based on standard practice as set forth by the engineering and design manuals (EM 1110 series), Corps of Engineers, U. S. Army, and Building Code requirements for Reinforced Concrete (A.C.I. Code), subject to modifications indicated by engineering judgment and experience.

c. Working stresses. (1) General. The allowable working stresses are in accordance with EM 1110-1-2101, "Working Stresses for Structural Design," and applicable codes and standards of other agencies.

(2) Concrete. Working stresses for concrete are in accordance with above references using a minimum specified compressive strength (f'c) of 3,000 p.s.i. and a modular ratio (n) of 9.

(3) Reinforcing steel. Working stresses for reinforcing steel are in accordance with above references for billet-steel of intermediate grade.

(4) Structural steel. Working stresses are in accordance with above references based on appropriate basic stresses.

d. Unit weights and soil properties. Unless shown otherwise on the stability plates, the unit values of the soil to be used in the design of the structures are listed below. Active lateral pressures are used in the stability analysis and At-Rest pressures used in the reinforced concrete design.

Wt. of moist earth = 110 #C.F.
Wt. of submerged earth = 62.5 #C.F.
Active lateral pressure (moist earth = 37 #/SF/F
Active lateral pressure (submerged earth) = 21 #/SF/F
At-rest lateral pressure (moist earth) = 53 #/SF/F
At-rest lateral pressure (submerged earth) = 30 #/SF/F
Passive lateral pressure (moist earth) = 330 #/SF/F
Passive lateral pressure (submerged earth) = 188 #/SF/F
Wt. of concrete = 140 #/SF/F

e. Stability analysis. (1) General. Each structure is designed to be stable under the most severe combinations of loads expected. The resultant of loads is within the kern for all conditions. Uplift is assumed to act over 100 percent of the base area. Uplift is assumed to vary from 100 percent of headwater to 100 percent of tailwater varying uniformly for the length of the structure.

(2) S-332. The stability analysis results of this pumping station are shown on plate 17. To obtain stability for this structure during the condition when the bay opposite the office overhang is dewatered, the base slab was extended under the backfill for five feet by the width of the structure. The structure would be founded on tremie concrete which is on rock; therefore there will be no settlement problems. The lateral pressures are relatively low compared to the weight of the structure; therefore there are no sliding problems.

(3) S-333, S-334, and S-335. These one-bay spillways would be similar. The stability analysis results are shown on plates 36, 44, and 49. These structures would be all very stable, the base pressures are low for the foundation materials, the water level differentials would be small; therefore sliding safety factors are high. The base slab of S-333 was extended two feet outside of the abutment walls by the length of structure to obtain weight. Without the weight of this base slab extension and the soil above it, the resultant vertical load during the maintenance dewatered condition was very small, creating possible tension under a portion of the structure.

f. Structural analysis. (1) Substructure. The structures would be designed using conditions that produce the critical design for each portion of the structure. The relatively thin slabs and walls would require substantial reinforcement at the points of maximum moment. All monoliths are rigid frames and the slabs and walls will be designed for the distributed stresses.

(2) S-332 Superstructure. The columns, beams, and roof would be designed for the following loads. Wind - 35#/S.F., roof live load - 20 #/S.F.

(3) Service bridges. The service bridges of the spillways would be simple span concrete slabs. The service bridge of the pumping station would be a portion of the rigid frame of the structure. The slabs would be designed for dead load plus an H20-44 truck loading as presented in the AASHO specifications.

(4) Gate hoist platforms. The gate hoist platforms would be two L-beams each bay spanning the gate bay. The platforms would be designed for two conditions, one using the normal gate hoist load plus 50 #/S.F. live load, and the other using 200 percent overload capacity of the hoisting machinery.

29. Mechanical and electrical design of Pumping Station 332.

a. Basic design criteria and considerations. The basic hydraulic design criteria for Pumping Station 332, as shown in table 3, indicates average flow rates varying from a maximum of approximately 160 c.f.s. for the month of October to a minimum of 4 c.f.s. for the months of April and May. The proposed pumping equipment would operate against all heads resulting from intake and discharge pool water levels shown in Table 4.

During preliminary studies, consideration was given to an arrangement whereby a total of two identical pumps would be provided, each capable of providing 50 percent of the required maximum 160 c.f.s. This would have permitted the use of two units having a nominal discharge diameter of approximately 42 inches, thus making possible the application of units carried as standard design by some manufacturers. The total of two units at the proposed facility, in lieu of the minimum of three established by Corps policy for primary flood control facilities, was considered allowable inasmuch as the proposed facility is not for flood control but is for supplying water to ENP. Such original units would have been driven through right angle gear reduction units by diesel engines. This arrangement would have afforded good operational flexibility, variable speed control, and a self-reliant station totally independent of commercial power outages. Required variations in average monthly flow rate would have been achieved by means of intermittent or time-cycling operation of the two units as required to total out the average c.f.s. for a given month.

Subsequent to the above-referenced preliminary studies, local interests indicated that they preferred (1) an electric motor-driven installation rather than diesel-powered; (2) continuous uniform and surge-free flow rates as shown in table 5 for the respective months; and (3) an installation automatically controlled to the extent that, once started, it could be left in operation without constant attendace.

Additional studies culminated in the plan presented and recommended herein. This plan would consist of a total of six (6) pumping units, all of identical type pumps but of various nominal discharge diameters. Each pump is to be driven by a direct-connected electric motor. Each pump-motor assembly will operate at one constant r.p.m. The six pumps will be arranged as shown on plate 15. By selective operation, the pumps will provide constant flow rates approximating, within practicable limits, the average flow rates for the respective months as required by table 3.

The pumps contemplated in the preceding paragraph would be of such nominal sizes as will insure not only fully competitive equipment, but also items which can be furnished either as stock items or at least standard designs of the various manufacturers.

29. Mechanical and electrical design of Pumping Station 332.

a. Basic design criteria and considerations. The basic hydraulic design criteria for Pumping Station 332, as shown in table 3, indicates average flow rates varying from a maximum of approximately 160 c.f.s. for the month of October to a minimum of 4 c.f.s. for the months of April and May. The proposed pumping equipment would operate against all heads resulting from intake and discharge pool water levels shown in Table 4.

During preliminary studies, consideration was given to an arrangement whereby a total of two identical pumps would be provided, each capable of providing 50 percent of the required maximum 160 c.f.s. This would have permitted the use of two units having a nominal discharge diameter of approximately 42 inches, thus making possible the application of units carried as standard design by some manufacturers. The total of two units at the proposed facility, in lieu of the minimum of three established by Corps policy for primary flood control facilities, was considered allowable inasmuch as the proposed facility is not for flood control but is for supplying water to ENP. Such original units would have been driven through right angle gear reduction units by diesel engines. This arrangement would have afforded good operational flexibility, variable speed control, and a self-reliant station totally independent of commercial power outages. Required variations in average monthly flow rate would have been achieved by means of intermittent or time-cycling operation of the two units as required to total out the average c.f.s. for a given month.

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The pumps contemplated in the preceding paragraph would be of such nominal sizes as will insure not only fully competitive equipment, but also items which can be furnished either as stock items or at least standard designs of the various manufacturers.

In the final analysis, consideration was also given to substitution of a more non-clog type pump for the smallest of the six units. This would have allowed wider spacing of the intake trash rack bars, thus lowering net approach velocities through the rack. It was determined, however, that the more non-clog type required the same motor horsepower, and that the net approach velocity through the rack as required for the original propeller-type pump was safely conservative. The use of the non-clog unit was therefore abandoned in favor of providing an installation wherein all of the main pumps, although varying in nominal size, would be of identical type and configuration.

The recommended arrangement is illustrated on plates 15 and 16. Equipment cost estimates are presented in table 10.

b. Pump rating criteria. In order to simplify both the procurement specification and the operational criteria, and to be able to pump against any differential head possible from the intake and discharge pool water levels shown in Table 4, each pump would have a basic rating of its respective design capacity at a corresponding total head of 8 feet as shown in Table 5. With the setting shown on plate 16, all discharge inverts would be at elevation 5.75; i.e., slightly above the maximum discharge pool anticipated. This arrangement and selection of nominal sizes also results in generally acceptable discharge terminal velocities (approximately 9 to 10 feet per second) and velocity heads through the systems, including losses through the flap gates. Standard catalog curves published by the pump manufacturers show such pumps, as listed in table 5, would have typical total head efficiencies ranging from 65 to 75 percent while operating at rated condition. These are considered as reasonable acceptable values; lower values would increase operating costs to be borne by the Using Agency; higher efficiencies would generally require larger, slower equipment and therefore result in higher first cost in both pump and motor assemblies. All pumps will be completely self-priming, using only the power derived from the respective drive motors.

c. Pump setting, suction bay and discharge tube requirements. The pumps would be set with the bell mouth located at approximately elevation -4.0 feet. This provides a minimum of 7 feet submergence below the presently contemplated minimum drawdown elevation 3.0, and 6 feet below future anticipated drawdown elevation, the latter elevation being 1-foot below the present normal drawdown in order to allow for eventual subsidence of the tributary area and as a margin of safety against possible cavitation in the design of the pump. Intake sump floor would be set at elevation -6.5. Suction bay widths would vary from 9 feet clear for each of the two largest units to 18 feet for the bay containing the four smaller units. These widths, plus the loss of area through the trash racks and splitter baffle in the 18-foot bay, provide proper flow distribution and moderate approach velocities to the bells. This would also give a submerged propeller under all conditions to insure effective self-priming. The invert lip (crest) of each pump discharge elbow would be set at elevation 5.75, thus providing a free discharge into the discharge pool at all operating pool levels shown in table 4. Provision of vacuum breakers or air release valves for shut-down and starting procedures is not considered necessary for the arrangement shown. Setting of the discharge invert at elevation 5.75 also provides automatic protection against backflow for all discharge pool stages anticipated; however, an automatic flapgate will also be provided at the discharge terminus of each individual pumping system as a means of insuring absolute protection against any possible backflow through the pumps regardless of discharge pool stages. The flap further provides dual protection against backflow, consistent with Corps policy, for all discharge pool stages.

d. Power required for pumps. Using constant speed, direct connected electric motors, the motor horsepower and r.p.m. values shown in table 5 will provide sufficient capability for making the pumps completely self-priming during starting, and also provide approximately 10 percent reserve above the power required for continuous operation at the rated pump condition shown in table 5.

e. Station equipment. (1) Main pumps. The pumps would be of the vertical axial-flow type having a rated (design) head-capacity as shown in table 5. They would be required to be completely self-priming and to operate satisfactorily and continuously at the design head-capacity condition. Nominal discharge diameters would be stipulated for the pumps as shown on plate 15, and they would be required to be of such proportions as to permit their proper installation and operation within the confines of definite structural limitations as indicated on plates 15 and 16. The arrangement shown also incorporates a pump setting which will provide a free discharge terminus with any discharge pool surface elevation presently contemplated for operation. Each pump will be supported by a structural beam grillage carried by the sidewalls of the pump bay. A Dresser-type coupling will be provided where the pump discharge elbow connects to the wall-imbedded discharge tube in order to facilitate pump installation or removal; and to isolate the structure from vibration originating within the pump. The pumps would be sectioned as necessary so that, following removal of the beam support grillage, the pump sections could be dismantled as require to permit their removal to the operating floor by means of the station crane. Each pump discharge tube would extend as shown from the pump discharge elbow, through a Dresser-type coupling, through the station discharge wall, and to the respective flap gate. The pumps will be oil lubricated, with solenoid-actuated drip-feed oilers. Propellers will be of cast bronze, cast steel or ductile iron, as standard with the manufacturer. Pump casing and support column will be either cast or weldment. Pump discharge elbow will be of the inclosed type for below ground discharge as indicated on plate 16. Located at the final discharge opening of each discharge tube will be a standard-type automatic flap gate, the design of which incorporates an anti-slamming feature, e.g., Armco model 50-C hydraulic cushion type. This type of gate, in conjunction with the setting of the discharge elbow at elevation 5.75, should insure absolute protection against reverse flow through the pump regardless of discharge pool stages.

(2) Motors. Each main pump shall be direct connected to a vertical hollow-shaft type motor. The motor shall have a continuous-duty rating for the horsepower and r.p.m. listed in table 5. Each motor shall be designed for operation on 460-volt, 3-phase, 60-hertz electrical service.

(3) Dewatering. Dewatering of the main pump sumps, as required for inspection or removal of the main pumps, would be achieved by placing timber needles across the intake trash racks and dewatering by means of a portable pump.

(4) Station service system. A vertical turbine-type pump will be located as shown on plate 16. The pump will draw water from one of the main pump intake sumps. Lines will extend to strategic points both inside and outside the station to provide for washdown and secondary fire protection. A branch of this system will connect in turn to a filter and pressure storage tank in order to provide a suitable supply for toilet facilities. Such arrangement would automatically provide a limited amount of water from the pressure storage tank for periodic back-flushing of the station service pump, as required for clearing the intake strainer.

(5) Ventilating system. Adequate ventilation of the operating floor will be assured by means of wall-mounted exhaust fans strategically located within the building. Fans will be provided with manually operated louvers.

(6) Station crane. A manually operated 5-ton capacity overhead bridge-type crane will be located in the station for general service and maintenance. The crane will be adequate for handling major items of equipment, including pump motors, pump sections, or a complete pump assembly after removal of the motor.

(7) Trash removal equipment. Experience at existing installations containing pumping equipment of similar or slightly greater capacity indicates that, except possibly during extended periods of continuous operation, only occasional removal of trash and debris from the intake racks is necessary. Due to the relatively small size of these racks, it is expected that any necessary servicing can generally be accomplished by hand-raking. It is anticipated, therefore, that no trash

raking or rack cleaning equipment will be provided at the proposed station. The proposed station will be provided only with stationary bar-screen type trash racks extending laterally across each pump intake sump and vertically from the intake service bridge to the sump floor at elevation -6.5. Provision of the stationary racks is considered mandatory from the standpoint of safety in addition to prevention of pump fouling. Not only would such racks protect the pumps from damage in the event a chunk of timber, such as a fence post, were to enter the intake channel, but the racks also preclude any possibility of an animal or person deliberately or otherwise swimming, falling into, or by any means entering the pump intake sump and thereupon being drawn into the pump suction bell and drowned.

(8) Standby station operating power. In addition to an expressed preference for the main pumps to be operated by electric motors rather than by diesel engines, local interests have also indicated that unscheduled shutdown of the station operating capability, such as could result from commercial power outages, would pose no critical problem. Consistent with these considerations, no standby or emergency engine-generating capability will be provided at the proposed station. Battery operated emergency lighting will be provided.

(9) Automatic shutdown control. By means of a stilling well and float-actuated control at each pump sump, all pumps in a respective sump area will be subject to automatic shutdown in the event of low water level. This provides pump protection, independent of personnel action, should the intake rack become clogged or the sump water level drop below a pre-set level for any reason. The cutoff setting would be field adjustable.

f. Recommendations. (1) All pumping units to be of identical type. It is intended that the six (6) pumping units at the proposed Pumping Station 332 shall be of the type, size, rating, and configuration shown in table 5 and plate 15. Pumps as shown would be obtainable either from stock, or at least from basically standard design, from several manufacturers, thus eliminating special development costs. It is therefore proposed that main pumps, motors, and all other operating equipment not be obtained by separate supply procurement but be included, plus their installation, in the general construction contract for the proposed station. It is also proposed to require that all 6 main pumping units be furnished by the same manufacturer. Responsibility for the furnishing and installation of all operating equipment would therefore be borne by the construction contractor, with installation of the primary pumping equipment under direction of an erecting engineer provided by the equipment manufacturer. This procedure would centralize the responsibility for the final as-installed performance of the completed station, including that of the primary pumping equipment, with the one primary construction contractor. Invitation drawings would apprise the bidder of the limiting structural dimensions and water control elevations in order that he might take such factors into account in arriving at the expected performance to be guaranteed in his bid. It is also considered that the proposed arrangement requiring all 6 main pumping units to be of identical type could result not only in possible price advantage on first cost, but the multiplicity of identical-type units throughout the station should simplify maintenance and operational considerations for the using agency.

(2) Bid guarantees. Each bidder would be required to state in his bid that each pump he furnishes (a) will be of the nominal discharge diameter as shown on plate 15; (b) will operate satisfactorily and continuously without evidence of cavitation, undue vibration, or other evidence of hydraulic instability in the setting, structural and hydraulic limitations imposed by the specification; (c) will deliver the required head-capacity and r.p.m. condition stated in the invitation; and (d) will perform at the rated head-capacity in such manner as to provide not less than 10 percent reserve power when direct-connected to a motor of the HP and r.p.m. also listed for the respective pump. Failure to include such information with the bid would cause rejection of the bid.

(3) Certified tests. In view of the expectation that the pumps proper would be standard, perhaps even stock items, and inasmuch as guarantees of certain performance factors as stated in the preceding paragraphs, are to be included in the bid, it is considered that the cost of requiring a witnessed model or factory test of the proposed equipment would not be justified. In addition, the precise results of a model or factory prototype test would be of diminished value when applied to the installed prototypes, considering effects of individual prototype discharge tubes and flap gates. For the above reasons, and in lieu of a witnessed model or factory prototype test, it is intended to require that the contractor furnish certified test results either on each of the prototype pumps, or on an identical pump, with information sufficient to demonstrate full compliance with pump performance guaranteed by the bid. If deemed necessary upon completion of installation, a field acceptance verification test could be conducted by the Government on one or more pumping systems to determine generally satisfactory performance and compatibility. Field measurement of capacity would not be practicable. Direct comparison between field performance or measurements, and guaranteed bid characteristics would provide the basis for final acceptance or rejection with respect to performance guarantees. In effect, acceptance of the pumping assemblies would be based on certified data furnished by the contractor, but subject to such verification, adjustment, or general observation as is practicable to conduct in the field on the completed installation.

(4) Recommendations. It is recommended, on the basis of the engineering investigations and cost estimates presented herein, that the proposed plan for installation of six axial-flow type vertical-shaft propeller pumps, complete with discharge tubes and flap gates, be adopted for Station 332. It is further recommended that all machinery and equipment listed on table 10, including the installation of such equipment, be included as a part of the general contract for construction of the station. This would centralize responsibility for all aspects of the purchasing, installation, construction,and performance of the entire facility with one prime contractor. It is further recommended that the plan proposed in this report be approved.

g. Electrical design. (1) Electrical service. A transmission line of approximately three miles in length would be provided by the local power company at project cost as required to provide a 400 ampere, 480 volt, three phase, 60 hertz, commercial electrical service.

(2) Electrical distribution. A motor control center would be provided with combination reduced-voltage starters for 100 horsepower motors, and with combination across-the-line starters for smaller sized motors. Float switches would be provided to automatically stop pumps should the water level drop below a safe pumping level. Distribution would be essentially as shown on the One Line Diagram, plate number 18.

(3) Lighting. Fixtures would be installed as required to provide 30-foot candles of illumination. Exterior lighting controlled by a photo-electric switch would be provided for security purposes.

(4) Wiring. Conforming to CE 1404.04 guide specifications would be installed in conduit.

30. Mechanical and electrical designs of Control Structures 333, 334, and 335. a. Mechanical designs of control structures. The gate operating machinery and related equipment for Structures 333, 334, and 335 would be essentially as shown on plate 41. The gate would be raised and lowered by means of a horizontal hydraulic cylinder connected to a 2-part sheave block assembly over which the cables run, one end of each cable being fastened to the gate and the other dead-ending to the base of the hoist unit. A motor-driven, hydraulic-power unit with all control valves mounted thereon would be located in the control house.

Gate hoist capacity, operating load and hydraulic pressure, for the structures is shown on plate 41. The hydraulic cylinder bore and rod size are shown on plate 41 with a stroke of one-half the gate travel would be used. The gate operation would be manufally controlled from the service bridge. Upstream, downstream, and gate position recorders would be provided for proper gaging of the discharge. Two

18-inch and one 10-inch stilling well for headwater and tailwater recording would be located in the control house as shown on plate 41. Gate opening position would be transmitted by a selsyn device located on the hoist unit to a recording unit located in the control house. A standby 10 kilowatt engine generator set for use during commercial power failure would be provided as shown. The elevation of the service bridge relative to the respective gate elevation when in the normal full open position necessitates providing a structural pit for gate servicing, as shown on plates 35, 43, and 48.

b. Electrical design of control structure. Electrical installations would be provided as shown on plate 40.

(1) Power supplies. The local power company would provide a 120/240 volt, single phase, 60 hertz, three wire electrical service. A small engine-generator set would provide emergency power in cases of failure of the commercial service.

(2) Manual gate control. Open-close-stop push button stations at the spillway structure would be provided for manual gate control.

(3) Relay cabinet. A wall-mounted cabinet would be provided for necessary open-close control relays. A time-delay relay would provide a 5-second energization delay to a dumping solenoid valve to permit unloaded start of the hydraulic power unit motor.

(4) Lighting. An industrial fluorescent fixture would be provided for control house lighting. Exterior lighting for security purposes would be automatically controlled by a photo-electric relay.

(5) Convenience outlets. Ground fault interruption protection would be provided for convenience outlet circuits.

(6) Wiring. Insulated copper conductors conforming to CE 1404.04 would generally be installed in either rigid galvanized steel conduit or schedule 40 rigid plastic conduit.

(7) Grounding. Ground rods and large embedded metallic masses would be utilized for a project main ground installation, and would be tied together with AWG No. 1 ground wire. Frames or inclosures of electrical equipment would be bounded to the grounding system.

31. Restoration of natural values. All disturbed areas which are not paved would be restored as nearly as possible to their original state and seeded as necessary to secure grass establishment. Levees and berms constructed of rock would not be seeded.

32. Recreation. Florida Law, Chapter 73-24G, enacted 1 July 1973, designated the Florida Game and Fresh Water Fish Commission as the agency responsible for developing recreational facilities in the Everglades and the conservation areas under the direction of the Everglades Recreational Planning Board. The board was also created by this law. As a part of this project, only relocation of portions of recreational facilities (boat ramps, access roads, etc.) would be accomplished. Future planning and development would be coordinated with the Everglades Recreational Planning Board.

33. Environmental assessment. Environmental considerations are discussed in the General Design Memorandum (Part V, Supplement 52).

34. Water quality. Information pertaining to water quality and water quality data previously presented in the General Design Memorandum (Part V, Supplement 52) indicate existing "waters available in Conservation Area No. 3 are generally of good quality and of acceptable quality even under extreme flow conditions" and "construction of the proposed project additions and alterations would not result in significant change in water quality within the systems."

35. Relocations and alterations. Local interests are required by the project document to assume the cost of all relocations and alterations. These would include rebuilding existing boat ramps, building bridges over Levee 29 borrow canal where necessary to provide access for private and public use and building an acceleration and deceleration lane with guardrail adjacent to Structure 334. There is also an overhead power line at the existing Structure 194 which would need to be relocated prior to modifying the structure.

36. Interference with local activity. Facilities for maintaining the traffic flow along U. S. Highway 41 and access to recreation areas would be provided for at the proposed bridge and construction sites.

37. Restrictive ordinances. Inquiry made concerning restrictive ordinances in Dade County has revealed that work involving explosives and burning would have effect on the proposed construction. Chapter 13 of the Ordinances of Dade County indicates that blasting operations must be conducted during the hours of 8:00 a.m. to 5:00 p.m. and a permit would be required for such operations from the Director of Dade County Public Works. Burning operations would be coordinated with the Dade County Department of Pollution Control.

38. Required lands. a. General. The project document requires the local sponsor to furnish the necessary land for the proposed work. Those land requirements for L-29 are shown on plates 4 through 9.

b. Structure 194 (Mod). Construction of Culvert Structure 194 (Mod) will require additional lands in the form of temporary easements.

These easements are necessary to provide a traffic bypass during construction. No additional permanent right-of-way would be required.

c. Structure 332. Structure 332 would be located in Everglades National Park. At this time an agreement and permit between the Corps of Engineers, Central and Southern Florida Flood Control District, and Department of the Interior, National Park Service is being prepared and negotiated. The agreement and permit would be for a period of fifty (50) years with option to renew for an additional fifty (50) years.

d. Structures 333, 334, 335, and 336. Structures 333, 334, 335, and 336 would be constructed within existing right-of-way. During construction, temporary easements would be needed, some of which are outside existing right-of-way.

e. Structure 338. Additional permanent right-of-way would be needed for the access road to Structure 338. During construction, temporary easements outside of existing right-of-way would also be required.

39. Construction schedule. The estimated construction schedule and time of construction for the project features presented herein are as follows:

	Start of Construction	Construction time
Levee 29	1st quarter FY-76	18 months
Structure 332	2nd quarter FY-76	24 months
Levee 31(N), Structures 333, 334, and 335	2nd quarter FY-76	36 months
C-1, C-103, Structures 336, 338, and 194 (Mod)	3rd quarter FY-76	36 months

40. Maintenance. General. The local sponsor would be responsible for the operation and maintenance of the canals and structures upon completion of the construction contract. Maintenance would be performed in accordance with the Operation and Maintenance Manual, Central and Southern Florida Flood Control Project. The contractor would be responsible for maintenance during construction, including repairs to any erosion and removal of all shoaling within the canal during the contract period.

41. Coordination of plan with others. The plan presented in this report was coordinated during preparation of the General Design Memorandum. The District Engineer's coordination letter of 30 October 1972 stating the plan and replies from various agencies are presented

as Appendix D to Part V, Supplement 52, the General Design Memorandum. Additional comments are expected and the coordination will continue as part of that report.

42. Deviations from the General Design Memorandum. a. General. The overall plan presented in this report is essentiallythe same as that presented in the General Design Memorandum, Part V, Supplement 52.

b. Structure 332. This pumping station structure has been revised to provide for six pumping units of various nominal discharge diameters in lieu of two pumping bays with vertical axial-flow type pumps. Each pump would be driven by an electric motor.

c. Structure 333. The service bridge at Structure 333 would be widened to 23' 8" to provide access across L-29 borrow canal to Recreation Area No. 4 and by using the service bridge for access to proposed bridge at Sta. 570+00 in the General Design Memorandum would not be required.

d. Structure 334. The proposed site of Structure 334 was relocated approximately 1,300 feet west of the location presented in the General Design Memorandum in order to reduce the bridge cost for the proposed U. S. Highway 41 bridge spanning L-30 borrow canal. Also, the service bridge for Structure 334 would be widened to 23' 8" to provide access across L-29 borrow canal to Recreation Area No. 1. By widening the service bridge and by using the service bridge for access the proposed bridge at Sta. 10+00 in the General Design Memorandum would not be required.

e. Gate access slots. The gate access slots for Structures 333, 334, and 335 have been moved down in order to reduce the height of the operating platform tower and eliminate the cable slings. Plates 33, 43, and 48 show the new location of the access slots.

f. Bridges. The bridges to Fish Management Areas #1 and #4 have been eliminated by providing for a wider service bridge on Structures 333 and 334.

g. Structure 338. The National Park Service acceptance of the plan presented in the General Design Memorandum, Part V, Supplement 52, was conditional on provision of a control structure in Canal 1 near its western terminus. A double-barrel 84" ø Culvert Structure 338 has been added to the project to provide control in Canal 1. The addition of this structure increases the overall cost of the project as shown on table 25.

E. QUANTITIES AND COST ESTIMATES

43. Levee 29 borrow canal and Levee 29. The estimated construction cost as well as Federal and non-Federal cost are given in table 9.

44. Structures 194 (mod), 332, 333, 334, 335, 336, and 338. The estimated quantities and contract price for each structure is given in tables 13, 10, 15, 17, 19, 21, and 23, respectively. A summary of Federal and non-Federal costs are shown on tables 14, 12, 16, 18, 20, 22, and 24, respectively.

45. Bridges. The estimated initial costs for construction of bridges are given in table 8.

46. Comparison of costs. a. General. A comparison of the design memorandum estimate presented herein with the current PB-3 estimate is shown in table 25.

b. Explanation of differences in cost estimates. (1) General Cost escalations since current PB-3 estimates have resulted in increased costs in all features of the work presented herein. Deviations in cost not attributable to escalation are discussed in subsequent paragraphs.

(2) Structure 332. The change in mechanical designs (six pumps in lieu of two) required a larger pumping station structure than previously estimated.

(3) Structures 333 and 334. In order to increase the service bridge width on the structures as discussed heretofore, it was necessary to increase the structure length. The wider bridges and increased length increased the cost over that previously estimated. The relocation of Structure 334 approximately 1,300 feet westward of its General Design Memodrandum location resulted in a decrease in the excavation quantity. As a result of the service bridge width and structure length increase and the excavation quantity decrease Structure 334 estimated cost increased but at a lesser rate than escalation.

(4) Structure 335. Updated topographic information indicated that more excavation would be required than previously estimated. Also, stone protection quantities were increased.

(5) Structure 336. Structure 336 was previously estimated using a timber walkway supported on timber pilings. Due to its proximity to U. S. Highway 41 and Fish Management Area #1, it was determined that a structure with a concrete walkway and headwalls would be aesthetically desirable, thus requiring a design change.

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(4) Structure 335. Updated topographic information indicated that more excavation would be required than previously estimated. Also, stone protection quantities were increased.

(5) Structure 336. Structure 336 was previously estimated using a timber walkway supported on timber pilings. Due to its proximity to U. S. Highway 41 and Fish Management Area #1, it was determined that a structure with a concrete walkway and headwalls would be aesthetically desirable, thus requiring a design change.

F. RECOMMENDATIONS

47. Recommendations. The proposed plan presented in this report is recommended for approval.